Private Public Partnership Project (PPP)

Large-scale Integrated Project (IP)

D.3.1.3: FI-WARE GE Open Specification

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1.1 Executive Summary

This document describes the Generic Enablers in the Apps and Services Ecosystem chapter, their basic functionality and their interaction. These Generic Enablers form the core business framework of the FI-WARE platform by supporting the business functionality for commercializing services.
The functionality of the frame work is illustrated with several abstract use case diagrams, which show how the individual GE can be used to construct a domain-specific application environment and system architecture. Each GE Open Specification is first described on a generic level, describing the functional and non-functional properties and is supplemented by a number of specifications according to the interface protocols, API and data formats.

1.2 About This Document

FI-WARE GE Open Specifications describe the open specifications linked to Generic Enablers GEs of the FI-WARE project (and their corresponding components) being developed in one particular chapter.

GE Open Specifications contain relevant information for users of FI-WARE to consume related GE implementations and/or to build compliant products which can work as alternative implementations of GEs developed in FI-WARE. The later may even replace a GE implementation developed in FI-WARE within a particular FI-WARE instance. GE Open Specifications typically include, but not necessarily are limited to, information such as:

- Description of the scope, behavior and intended use of the GE
- Terminology, definitions and abbreviations to clarify the meanings of the specification
- Signature and behavior of operations linked to APIs (Application Programming Interfaces) that the GE should export. Signature may be specified in a particular language binding or through a RESTful interface.
- Description of protocols that support interoperability with other GE or third party products
- Description of non-functional features

1.3 Intended Audience

The document targets interested parties in architecture and API design, implementation and usage of FI-WARE Generic Enablers from the FI-WARE project.

1.4 Chapter Context

The Generic Enablers for the Apps Chapter together can be used to build the core infrastructure for enabling a sustainable ecosystem of applications and services of future internet application domains, which foster innovation as well as cross-fertilization. In particular the Apps Generic Enablers supports unified description and publishing of services, offering of services in a store, matching demand and offering via marketplace capabilities, creating composed value added services and service networks, and monetization and revenue sharing, all in a complementary and harmonized business framework.

The concept of the Generic Enabler implies that there can be several possible implementations. There are various degrees of flexibility in the non-functional properties or functional profile of the Generic Enabler description. Not every GE has a RESTful Web interface. Especially the composition editors expose their functionality mainly through a User Interface. This case requires the interface to be described in an abstract way (e.g. what a user can do) and illustrated by screenshots of specific enabler implementations.

A couple of basic enablers are important to realize the vision of such a service business framework which enables new business models in an agile and flexible way:

- **Repository** - defines a standard way of publishing service description in the Web in a scalable way.
- **Registry** - serves as a common database layer for run-time configuration and defines a common model and access interface.
- **Store** - allows to offer services for consumers as well as developers of future internet applications.

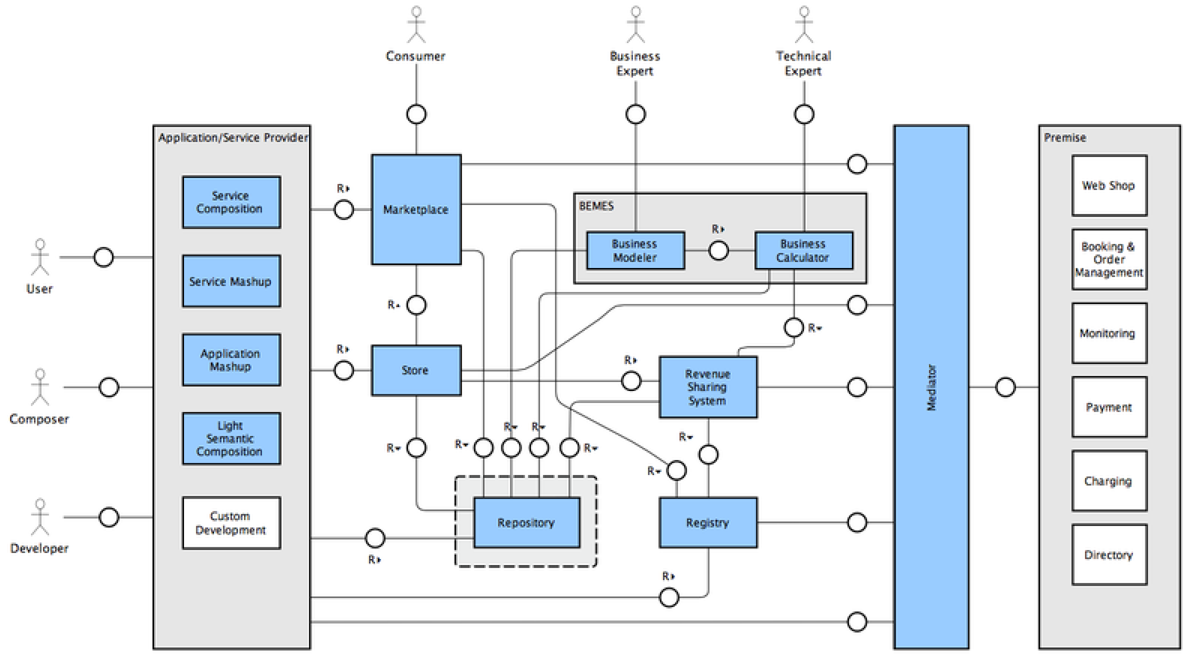
- **Marketplace** - defines a standard way to access market places in order to find and compare offerings from different stores and provides further functionality to foster the market for future internet applications and services in a specific domain.
- **Revenue Sharing System** - provides a common scheme and protocols for the calculation and distribution of revenues according to the agreed business models.
- **Composition** - to allow or to perform light semantic composition, furthermore composition of existing services to value added composite services and applications, which can be monetized in the Business Framework.
- **Business Modeler and Business Calculator** - handle the monetization of services or applications as well as their compositions/aggregations. Pricing schemes are modelled in business model definitions. The information in these business model definitions is stored and handled in the rating/charging/billing systems.
- **Mediator** - enables the interoperability between future internet services and applications and also allow to interface to existing enterprise systems.

This set of self-contained enablers represents only an initial starting point for a future business framework. It is expected that supplemental enablers (e.g. for contracting, quotation ...) will be developed outside the FI-WARE projects.

The Business Framework has been designed to inter operate with each other relying on Linked USDL as common uniform description format for services, which does not only focus on technical aspects of service but also covers business aspects as well as functional and non-functional service attributes. Linked USDL itself is not a Generic Enabler, since it is a data format and vocabulary specification. Nevertheless, it will be introduced as an Open Specification, which is used by different enablers in their provided and consumed APIs.

The Applications and Services Generic Enablers are named according to their main functionality. While the role names, introduced in the FI-WARE Vision (Aggregator, Gateway ...), are used to describe the stakeholders of the service ecosystem in an abstract way, the enablers names now are referring to concrete software components.

The following diagram gives an example of how the Generic Enablers can be combined to form a concrete architecture for a Service Business Framework.



More information about the Apps Chapter and FI-WARE in general can be found within the following pages:

http://wiki.fi-ware.eu
Architecture_of_Applications_and_Services_Ecosystem_and_Delivery_Framework
Materializing_Applications/Services_Ecosystem_and_Delivery_Framework_in_FI-WARE

1.5 Structure of this Document

The document is generated out of a set of documents provided in the public FI-WARE wiki. For the current version of the documents, please visit the public wiki at http://wiki.fi-ware.eu/

The following resources were used to generate this document:

D.3.1.3 FI-WARE GE Open Specifications front page
FIWARE.OpenSpecification.Apps.Repository
FIWARE.OpenSpecification.Apps.RepositoryREST
FIWARE.OpenSpecification.Apps.Marketplace
FIWARE.OpenSpecification.Apps.MarketplaceRegistrationREST
FIWARE.OpenSpecification.Apps.MarketplaceOfferingsREST
FIWARE.OpenSpecification.Apps.MarketplaceSearchREST
FIWARE.OpenSpecification.Apps.MarketplaceReviewAndRatingREST
FIWARE.OpenSpecification.Apps.MarketplaceRecommendationREST
FIWARE.OpenSpecification.Apps.Registry
FIWARE.OpenSpecification.Apps.RegistryREST
FIWARE.OpenSpecification.Apps.Mediator
FIWARE.OpenSpecification.Apps.MediatorREST
FIWARE.OpenSpecification.Apps.ServiceMashup
FIWARE.OpenSpecification.Apps.ApplicationMashup
FIWARE.OpenSpecification.Apps.WidgetAPI
FIWARE.OpenSpecification.Apps.ApplicationMashupAPI
FIWARE.OpenSpecification.Apps.ServiceComposition
FIWARE.OpenSpecification.Apps.ServiceCompositionREST
FIWARE.OpenSpecification.Apps.LightSemanticComposition
FIWARE.OpenSpecification.Apps.Store
FIWARE.OpenSpecification.Apps.StoreREST
FIWARE.OpenSpecification.Apps.RSS
FIWARE.OpenSpecification.Apps.RSSRest
FIWARE.OpenSpecification.Apps.RSS.RSS-Models
FIWARE.OpenSpecification.Apps.BusinessModeler
FIWARE.OpenSpecification.Apps.BusinessCalculator

FI-WARE_Open_Specification_Legal_Notice_(essential_patents_license)
FI-WARE_Open_Specification_Legal_Notice_(implicit_patents_license)

1.6 Typographical Conventions

Starting with October 2012 the FI-WARE project improved the quality and streamlined the submission process for deliverables, generated out of the public and private FI-WARE wiki.

The project is currently working on the migration of as many deliverables as possible towards the new system.
This document is rendered with semi-automatic scripts out of a MediaWiki system operated by the FI-WARE consortium.

1.6.1 Links within this document

The links within this document point towards the wiki where the content was rendered from. You can browse these links in order to find the "current" status of the particular content.
Due to technical reasons part of the links contained in the deliverables generated from wiki pages cannot be rendered to fully working links. This happens for instance when a wiki page references a section within the same wiki page (but there are other cases). In such scenarios we preserve a link for readability purposes but this points to an explanatory page, not the original target page.
In such cases where you find links that do not actually point to the original location, we encourage you to visit the source pages to get all the source information in its original form. Most of the links are however correct and this impacts a small fraction of those in our deliverables.

1.6.2 Figures

Figures are mainly inserted within the wiki as the following one:

```
[[Image:....|size|alignment|Caption]]
```

Only if the wiki-page uses this format, the related caption is applied on the printed document. As currently this format is not used consistently within the wiki, please understand that the rendered pages have different caption layouts and different caption formats in general. Due to technical reasons the caption can't be numbered automatically.

1.6.3 Sample software code

Sample API-calls may be inserted like the following one.

```
http://[SERVER_URL]?filter=name:Simth*&index=20&limit=10
```

1.7 Acknowledgements

The following partners contributed to this deliverable: SAP, UPM, ATOS, TID, iMinds.

1.8 Keyword list

FI-WARE, PPP, Architecture Board, Steering Board, Roadmap, Reference Architecture, Generic Enabler, Open Specifications, I2ND, Cloud, IoT, Data/Context Management, Applications/Services Ecosystem, Delivery Framework , Security, Developers Community and Tools , ICT, es.Internet, Latin American Platforms, Cloud Edge, Cloud Proxy.

1.9 Changes History

Release	Major changes description	Date	Editor
v1	First draft of deliverable submission	2014-02-04	SAP
v2	Next version for internal review	2014-03-10	SAP
v3	Version for final check	2014-04-25	SAP
v4	Version for delivery	2014-04-28	SAP
v5	Version for delivery	2014-05-14	SAP

1.10 Table of Content

Contents

2 FIWARE OpenSpecification Apps Repository

You can find the content of this chapter as well in the wiki of fi-ware.

Name	FIWARE.OpenSpecification.Apps.Repository
Chapter	Apps,
Catalogue-Link to Implementation	Service Description Repository
Owner	SAP AG, Torsten Leidig

2.1 Preface

Within this document you find a self-contained open specification of a FI-WARE generic enabler, please consult as well the FI-WARE Product Vision, the website on http://www.fi-ware.org and similar pages in order to understand the complete context of the FI-WARE project.

2.2 Copyright

2.3 Legal Notice

Please check the following **FI-WARE Open Specification Legal Notice (essential patents license)** to understand the rights to use this open specification. As all other FI-WARE members, SAP has chosen one of the two FI-WARE license schemes for open specifications.

To illustrate this open specification license from our SAP perspective:

- SAP provides the specifications of this Generic Enabler available under IPR rules that allow for a exploitation and sustainable usage both in Open Source as well as proprietary, closed source products to maximize adoption.
- This Open Specification is exploitable for proprietary 3rd party products and is exploitable for open source 3rd party products, including open source licenses that require patent pledges.
- If the owner (SAP) of this GE spec holds a patent that is essential to create a conforming implementation of the GE spec (i.e. it is impossible to write a conforming implementation without violating the patent) then a license to that patent is deemed granted to the implementation.

Software associated to the Repository - RI is provided as open source under the BSD License. Please check the specific terms and conditions linked to this open source license at https://github.com/service-business-framework/Repository-RI/blob/master/license.txt. You can also obtain the Repository GE software using the FI-WARE Catalogue at http://catalogue.fi-ware.org/enablers/repository-sap-ri

2.4 Overview

Together with the Registry and the Marketplace, the Repository is a core enabler of the FI-WARE Business Framework. The Repository provides a consistent uniform API to access USDL service descriptions and associated media files for applications of the business framework. A service provider can use the Repository to publish the description of various aspects of the service according to a unified description language. Whereas the Repository is used to publish service descriptions (service models), the Registry is used for storing runtime information about concrete instances and their configuration settings.
USDL is used in its Linked Data version "Linked USDL". Documentation can be found at <http://linked-usdl.org/> . Information about the FI-WARE Platform is available at http://wiki.fi-ware.eu . USDL describes services on a metadata level and can refer to supplemental resources of any media type. Therefore the Repository must be able to store resources in arbitrary formats. The RDF datamodel of USDL allows to refer to entities of the service description via the resource URL. Therefore Linked-USDL is already well prepared to allow the distribution of service descriptions all over the Internet.

2.4.1 Target usage

The Repository is a place to store service models, especially USDL descriptions but also other models required by components of the overall delivery framework (e.g. technical models for service composition and mashup). The repository provides a common location for storage (centrally or distributed and replicated), reference and/or safety.
The use of a repository is required in order to appear at the marketplace or other tools. These tools may refer to a number of central repositories containing information relevant for interoperation of the enablers and roles within the FI-WARE platform. The repository contains published descriptions which can be utilized by any component in respect to privacy and authorization constraints imposed by the business models. Usually a repository is under control of an authority and usually is keeping track of versions, authenticity and publication dates.

2.4.1.1 *User roles*

- The Provider creates services describing basic service information as well as technical information. He needs to upload and publish service descriptions on the repository in order to make them available to other components of the platform, such as the Shops/Stores, Aggregators, etc.
- The Aggregator will use for example technical and service-level information of existing services in the Repository in order to perform a composition of a value added service or application. So for example, in order to give a valid statement about the availability of the new composed service. The availability of each contained service needs to be considered. The Aggregator also needs information about the technical interfaces of a service in order to develop code to call them correctly . Service

descriptions for the newly created composite service can be uploaded and published to the repository again.

- The Marketplace Provider enables consumers to make comparisons between services therefore needs all kind of business relevant descriptions of services, such as general descriptions, business partners, service-levels, and pricing, to be presented in the store or within the marketplace. Also technical information can be required, on a level to be able to do comparisons between services for the consumer.
- The Channel Maker. The internet consists of various channels and heterogeneous devices for consuming information such as Web (browser), Android, iOS but also global as well as local social networking and community platforms such as Facebook, LinkedIn, MySpace, Xing, KWICK! The Channel Maker needs detailed information about the channel to ensure the proper channel creation or selection. Further a channel may require embedding or wrapping the service so it can be accessed by the user through the specific channel.
- The Hoster requires information on service-level descriptions, deployment and hosting platform requirements to provide the necessary infrastructure needed to host applications/services in a reliable and scalable way.
- The Gateway will use information about technical interfaces to provide data, protocol and process mediation services. The gateway also provides services for mediation towards premise systems outside of the FI-Ware platform.

2.5 Basic Concepts

2.5.1 Web Citizen

The Repository is relying on Web principles:

- URI to identify resources
- consistent URI structure based on REST style protocol
- HTTP content negotiation to allow the client to choose the appropriate data format supporting HTML, RDF, XML, RSS, JSON, Turtle, ...
- Human readable output format using HTML rendering ('text/html' accept header) including hyperlinked representation
- Use of HTTP response codes including ETags (proper caching)
- Linked Data enablement supporting RDF input and output types

2.5.2 Open Distributed Architecture

The Repository Open Specification has to be seen as a specification of the repository abstract functionality. There can be many technologies used to implement the functionality. Often the repository protocol is implemented on top of a Web content management system.

Also we envision a large number of repositories containing service descriptions, which also might to refer to descriptions in other repositories. Repositories can be hosted by the provider or a provider may use repository services of other platform providers. The latter might be an alternative for small sized providers, which don't want to provide an own infrastructure.

The service descriptions in a repository are typically used by different other components of the platform, such as service stores or marketplaces, by extracting information needed for the specific functionality.

2.5.3 Data Model

The Repository is structured into core objects, which are *resources* and *collections*. These objects constitute also the granularity of access control. Collections are containers for storing resources, which are typically used to maintain all resources belonging to a certain service description in one place.

2.5.3.1 ***Resources***

The resources are mainly the USDL service descriptions themselves as well as complementary media files that are used within the service descriptions.

2.5.3.2 ***Collections***

A collection is a container for collecting resources. Multiple collections can be used on the repository for various purposes. Collections can be nested and may provide versioning of the resources. Collections are used to keep all content that is locally referred from the service descriptions together in one place. For example a service description often has additional documentation, depictions and other collateral information, which can be bundled together in one collection.

2.5.3.3 ***Recipes***

Recipes are virtual containers selecting resources from different collections.

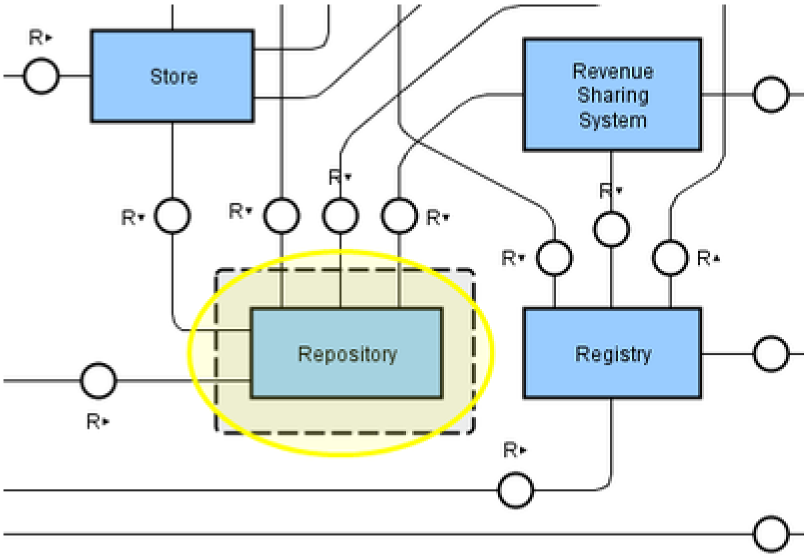
2.5.4 Content Negotiation

For optimal interoperability and flexible use, the repository should be able to deliver the results of an operation in multiple formats. HTTP content negotiations should be used to let the client choose an appropriate content type. Basic content types (mime-type) are

- HTML - to deliver the results in hyper-linked HTML that can be rendered directly in a Web Browser
- RDF - various RDF serializations for processing in applications
- JSON - Javascript Object Notation for easy processing in a mashup environment.

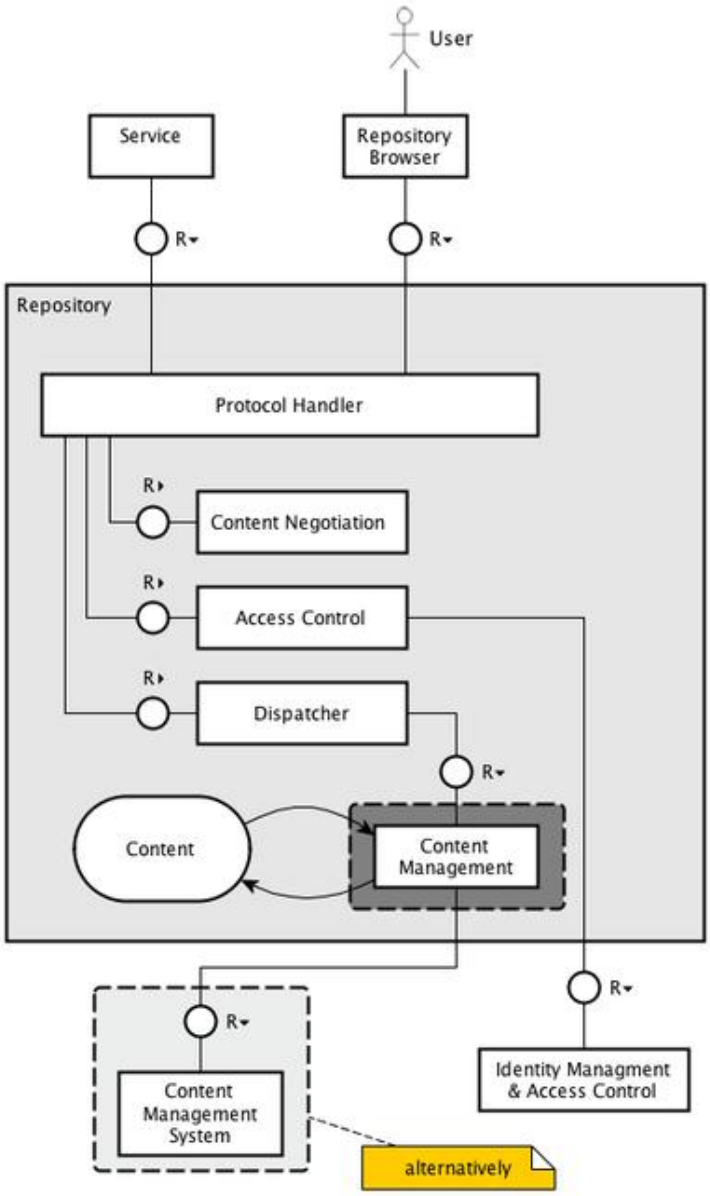
2.6 Repository Architecture

The Repository GE is used by various other GEs within the FI-WARE platform. Namely Marketplace, Store, Composition Environment as well as SLA monitoring and Revenue Sharing can access repositories to retrieve detailed information about a service or application. The composition environment for example can retrieve available service offerings for composition from the Marketplace. In order to get detailed information about the respective services, the repository API is used. Finished composite services or applications in turn can be described in Linked USDL and published in a Repository. New offerings for the service can be posted to the Marketplace. Similarly the mediation GE can get details about a service to be mediated from the Repository and push back mediator proxy services for a complex mediation type, to be reused by many applications. The Repository is also used to store business models according to composite services and applications, which will be used by the business model execution environment and revenue sharing system.



Repository in the context of the Business Framework

Besides the FI-WARE platform, Future Internet applications or composite services on top of the FI-Ware platform can also use the repository as a service for their own purpose. An example of the inner architecture of the Repository is shown in the following diagram.



Example of high-level architecture of a repository implementation

The architecture shown here is only a blueprint for possible implementations of the repository and depicts the functional components, necessary to realize this functionality. There are many technology options for a concrete implementation, depending on the context and application domain and its nonfunctional requirements. Since the requirements according to repository size, workload and other parameters can be quite different, there is no obvious all-encompassing implementation solution. The implementations can span very simple ones, which provide only few extensions to a standards Web service to very sophisticated ones that utilizes enterprise content management systems (e.g. based on the "CMIS - Content Management Interoperability Services" standard).
The repository only stores and provides access to service descriptions. Since there is no common standard for versioning, and the requirement according to versioning may vary depending on the use case scenario, we do not require version control from a repository

implementation, although a real implementation can provide versioning models and mechanism (e.g. using the capabilities of the underlying CMS system).

Also there is no requirement regarding consistency checking of the service descriptions in the repository. The applications themselves have to ensure that the descriptions are consistent. All clients of a repository have to cope with incomplete and inconsistent information by default. This reflects the architecture of the Web, where also no consistency commitment of the pages on different Web servers can be made. To ensure integrity additional measures have to be taken.

2.6.1 Technical Interfaces

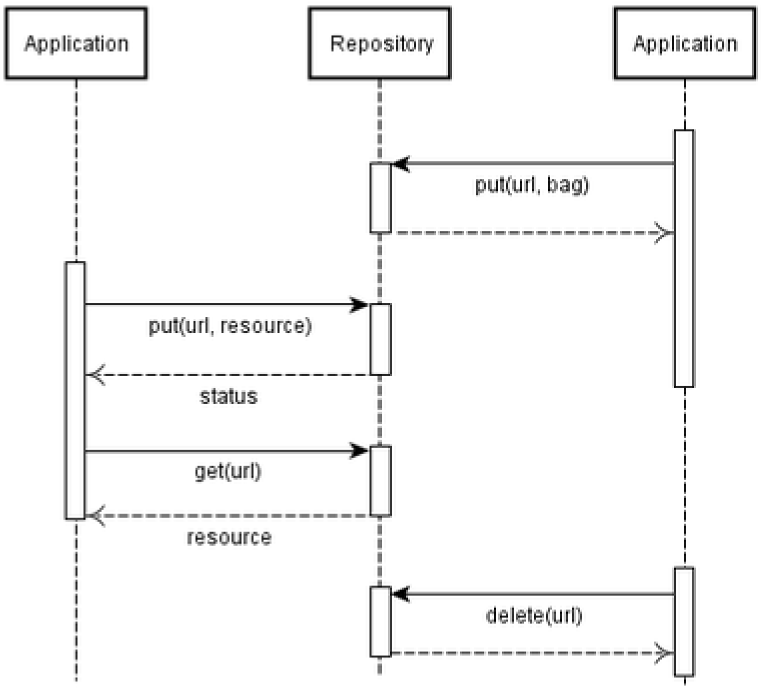
- FIWARE.Interface.Apps.USDLRepositoryRest - A very simple REST based protocol based on plain HTTP.

2.7 Main Interactions

The Repository operation protocol is kept very simple. It basically provides operations to get and put resources, such as service descriptions and media content. Additional operations are used to structure the repository into collections of resources.

2.7.1 Managing Resources (mandatory)

The core functionality of a repository is to store resources and retrieve them when necessary. Further resources sometimes need to be updated and eventually deleted. The following diagram shows an example sequence of resource management operations of a repository.



Example sequence of resource management operations

The ***Get Resource*** operation can be used to retrieve a resource from the repository. This operation delivers the actual content of the resource and/or metadata about the resource, such as the media type, creator, or modification date, depending on the used technical interface. The following parameters need to be exchanged:

- *resource identifier* - Resource identifier of the resource to be returned.

If only information about collections is requested, the collection identifier is used instead of the resource identifier.

- *collection identifier* - Identifier for the collection, which contains the resource.
- *resource* - Resource which will be returned
- *media type* - Media type of the resource which will be returned.

The ***Put Resource*** operation is used to store a new resource into the repository or update an existing resource with the same resource identifier. The repository should take precautions to provide inconsistent changes due to concurrent access. The following parameters need to be exchanged:

- *resource identifier* - Identifier which contains the resource.
- *collection identifier* - Identifier which denotes the collection into which the resource will be put. The collection can be a part of the resource identifier, if for example URL paths are used to identify a resource.
- *resource* - the content of the resource to be stored into the repository

In order to delete a resource irrevocably from the repository the ***Delete Resource*** operation is used. The following parameters are exchanged:

- *resource identifier* - Resource identifier of the resource to be deleted.

2.7.2 Managing Collections

Collections are used to put a structure into the repository. In order to easily access parts of the repository, it allows clients to get information about the contents of individual collections.
The ***Create Collection*** operation creates a new collection in the repository, containing the necessary details such as owner, policies, and other metadata attributes. It requires the parameter:

- *description* - Description of the collection to be created, which contains the location path within the repository and administrative data such as creator and access policies.

To get the details and contents of a collection the ***Get Collection*** operation is used. The collection information contains information such as owner, policies, textual descriptions, dates, versions, number of resources, and more. The level of detail of the description may depend on the authorization level of the requester. The following parameters can be involved in the operation:

- *collection identifier* - Collection identifier for which a description is to be returned.
- *filter* - Optional filter expression to select the properties to be filtered.
- *description* - Returned collection description containing information according to the filter expression.

A collection in the repository can be deleted with the ***Delete Collection*** operation. This operation can only be successful for a requester that has the appropriate authorization. The delete operation requires the identifier of the collection as input. After this operation the collection is no longer accessible for clients. Only one parameter is necessary:

- *collection* - Collection identifier for the collection to be deleted

2.7.3 Listing Content

The ***List*** operation lists collections and/or resources contained in the repository, which are accessible by the user. This operation usually is needed for a repository browser and maintenance tool as well as an editor tool in order to select the resource to be maintained.
The operations using the following parameters: No input parameters are required. However, for practical reasons it might be useful to restrict the list of collections and resources by specifying the number of results and the starting offset.

- *collection* - Collection for which the list is restricted to.
- *index* - Index of the first element of the result set to be returned.
- *limit* - Maximal number of results to be returned.
- *filter* - A repository implementation might also offer the possibility to filter the list of collections according to specific criteria. An optional filter expression can be used to reduce the number of delivered results. A repository may support different criteria to filter the output
- *result list* - The operation results in a list of collections/resources that is returned to the client and contains resource descriptions according to the collection, filter, index, and limit expressions.

2.7.4 List the additional services

Besides the operations described above, a repository might provide ***additional services***, such as search, backup, etc. A repository should list and describe the ***additional services*** to the clients when the ***List Services*** operation is invoked. If ***additional services*** are offered only for specific collections of the Repository, the collection identifier can be used to list the actual available functionalities for this collection. The required parameters for this operation are:

- *collection* - Collection identifier for which the ***additional services*** will be listed.
- *result list* - List of ***additional services*** are returned to the client.

2.7.5 Searching the Repository

A Repository might provide searching service, to search service descriptions according to the occurrence search terms in properties of the description and media content. It is desirable that in compliance to OpenSearch the repository provides an OpenSearch description to the search API.

2.7.6 Querying the Repository

A repository might also provide a more complex querying service in a specific query language. As an example a query service based on SPARQL [REP2]would allow to execute complex queries on the Linked Data RDF model [REP1].

2.8 Basic Design Principles

2.8.1 Rationale

There are many proprietary solutions implementing repository functionality and also many standards for various types of repositories. Within FI-WARE we try to abstract this functionality into a Generic Enabler.

2.8.2 Implementation agnostic

The API abstracts from the concrete implementation technology. Implementations using various kinds of databases should be possible. Although the main goal is to store services descriptions in a distributed environment, any implementation of a repository can be used as long as the technical interfaces comply with the GE operation protocol and can be mapped (mediated) to the FI-Ware preferred REST-based reference implementation.

2.9 Detailed Open Specifications

- **FIWARE.OpenSpecification.Apps.Repository**

2.9.1 Open API Specifications

- Repository Open RESTful API Specification

2.9.2 Other Open Specifications

The data formats for the API rely on the Linked USDL specifications:

- Linked USDL Core Vocabulary
- Linked USDL Pricing Vocabulary
- Linked USDL Service Level Agreements Vocabulary
- Linked USDL Security Vocabulary

2.10 References

REP1 RDF Primer W3C Recommendation 10 February 2004 (http://www.w3.org/TR/2004/REC-rdf-primer-20040210/)

REP2 SPARQL 1.1 Overview, W3C Working Draft 01 May 2012 (http://www.w3.org/TR/2012/WD-sparql11-overview-20120501/9

2.11 Re-utilised Technologies/Specifications

The Repository GE is based on RESTful Design Principles. The technologies and specifications used in this GE are:

- RESTful web services
- HTTP/1.1
- JSON and XML data serialization formats

2.12 Terms and definitions

This section comprises a summary of terms and definitions introduced during the previous sections. It intends to establish a vocabulary that will be help to carry out discussions internally and with third parties (e.g., Use Case projects in the EU FP7 Future Internet PPP). For a summary of terms and definitions managed at overall FI-WARE level, please refer to FIWARE Global Terms and Definitions

- **Aggregator (Role):** A Role that supports domain specialists and third-parties in aggregating services and apps for new and unforeseen opportunities and needs. It does so by providing the dedicated tooling for aggregating services at different levels: UI, service operation, business process or business object levels.
- **Application:** Applications in FI-WARE are composite services that have a IT supported interaction interface (user interface). In most cases consumers do not buy the application, instead they buy the right to use the application (user license).
- **Broker (Role):** The business network's central point of service access, being used to expose services from providers that are delivered through the Broker's service delivery functionality. The broker is the central instance for enabling monetization.
- **Business Element:** Core element of a business model, such as pricing models, revenue sharing models, promotions, SLAs, etc.
- **Business Framework:** Set of concepts and assets responsible for supporting the implementation of innovative business models in a flexible way.
- **Business Model:** Strategy and approach that defines how a particular service/application is supposed to generate revenue and profit. Therefore, a Business Model can be implemented as a set of business elements which can be combined and customized in a flexible way and in accordance to business and market requirements and other characteristics.
- **Business Process:** Set of related and structured activities producing a specific service or product, thereby achieving one or more business objectives. An operational business process clearly defines the roles and tasks of all involved parties inside an organization to achieve one specific goal.
- **Business Role:** Set of responsibilities and tasks that can be assigned to concrete business role owners, such as a human being or a software component.
- **Channel:** Resources through which services are accessed by end users. Examples for well-known channels are Web sites/portals, web-based brokers (like iTunes, eBay

and Amazon), social networks (like Facebook, LinkedIn and MySpace), mobile channels (Android, iOS) and work centers. The access mode to these channels is governed by technical channels like the Web, mobile devices and voice response, where each of these channels requires its own specific workflow.

- **Channel Maker (Role):** Supports parties in creating outlets (the Channels) through which services are consumed, i.e. Web sites, social networks or mobile platforms. The Channel Maker interacts with the Broker for discovery of services during the process of creating or updating channel specifications as well as for storing channel specifications and channeled service constraints in the Broker.
- **Composite Service (composition):** Executable composition of business back-end MACs (see MAC definition later in this list). Common composite services are either orchestrated or choreographed. Orchestrated compositions are defined by a centralized control flow managed by a unique process that orchestrates all the interactions (according to the control flow) between the external services that participate in the composition. Choreographed compositions do not have a centralized process, thus the services participating in the composition autonomously coordinate each other according to some specified coordination rules. Backend compositions are executed in dedicated process execution engines. Target users of tools for creating Composites Services are technical users with algorithmic and process management skills.
- **Consumer (Role):** Actor who searches for and consumes particular business functionality exposed on the Web as a service/application that satisfies her own needs.
- **Desktop Environment:** Multi-channel client platform enabling users to access and use their applications and services.
- **Event-driven Composition:** Components concerned with the composition of business logic, which is driven by asynchronous events. This implies run-time selection of MACs and the creation/modification of orchestration workflows based on composition logic defined at design-time and adapted to context and the state of the communication at run-time.
- **Front-end/Back-end Composition:** Front-end compositions define a front-end application as an aggregation of visual mashable application pieces (named as widgets, gadgets, portlets, etc.) and back-end services. Front-end compositions interact with end-users, in the sense that front-end compositions consume data provided by the end-users and provide data to them. Thus the front-end composition (or mashup) will have a direct influence on the application look and feel; every component will add a new user interaction feature. Back-end compositions define a back-end business service (also known as process) as an aggregation of backend services as defined for service composition term, the end-user being oblivious to the composition process. While back-end components represent atomization of business logic and information processing, front-end components represent atomization of information presentation and user interaction.
- **Gateway (Role):** The Gateway role enables linking between separate systems and services, allowing them to exchange information in a controlled way despite different technologies and authoritative realms. A Gateway provides interoperability solutions for other applications, including data mapping as well as run-time data store-forward

and message translation. Gateway services are advertised through the Broker, allowing providers and aggregators to search for candidate gateway services for interface adaptation to particular message standards. The Mediation is the central generic enabler. Other important functionalities are eventing, dispatching, security, connectors and integration adaptors, configuration, and change propagation.

- **Hoster (Role):** Allows the various infrastructure services in cloud environments to be leveraged as part of provisioning an application in a business network. A service can be deployed onto a specific cloud using the Hoster's interface. This enables service providers to re-host services and applications from their on-premise environments to cloud-based, on-demand environments to attract new users at much lower cost.
- **Marketplace:** Part of the business framework providing means for service providers, to publish their service offerings, and means for service consumers, to compare and select a specific service implementation. A marketplace can offer services from different stores and thus different service providers. The actual buying of a specific service is handled by the related service store.
- **Mashup:** Executable composition of front-end MACs. There are several kinds of mashups, depending on the technique of composition (spatial rearrangement, wiring, piping, etc.) and the MACs used. They are called application mashups when applications are composed to build new applications and services/data mash-ups if services are composed to generate new services. While composite service is a common term in backend services implementing business processes, the term 'mashup' is widely adopted when referring to Web resources (data, services and applications). Front-end compositions heavily depend on the available device environment (including the chosen presentation channels). Target users of mashup platforms are typically users without technical or programming expertise.
- **Mashable Application Component (MAC):** Functional entity able to be consumed executed or combined. Usually this applies to components that will offer not only their main behaviour but also the necessary functionality to allow further compositions with other components. It is envisioned that MACs will offer access, through applications and/or services, to any available FI-WARE resource or functionality, including gadgets, services, data sources, content, and things. Alternatively, it can be denoted as 'service component' or 'application component'.
- **Mediator:** A mediator can facilitate proper communication and interaction amongst components whenever a composed service or application is utilized. There are three major mediation area: Data Mediation (adapting syntactic and/or semantic data formats), Protocol Mediation (adapting the communication protocol), and Process Mediation (adapting the process implementing the business logic of a composed service).
- **Monetization:** Process or activity to provide a product (in this context: a service) in exchange for money. The Provider publishes certain functionality and makes it available through the Broker. The service access by the Consumer is being accounted, according to the underlying business model, and the resulting revenue is shared across the involved service providers.
- **Premise (Role):** On-Premise operators provide in-house or on-site solutions, which are used within a company (such as ERP) or are offered to business partners under specific terms and conditions. These systems and services are to be regarded as

external and legacy to the FI-Ware platform, because they do not conform to the architecture and API specifications of FI-WARE. They will only be accessible to FI-WARE services and applications through the Gateway.

- **Prosumer:** A user role able to produce, share and consume their own products and modify/adapt products made by others.
- **Provider (Role):** Actor who publishes and offers (provides) certain business functionality on the Web through a service/application endpoint. This role also takes care of maintaining this business functionality.
- **Registry and Repository:** Generic enablers that able to store models and configuration information along with all the necessary meta-information to enable searching, social search, recommendation and browsing, so end users as well as services are able to easily find what they need.
- **Revenue Settlement:** Process of transferring the actual charges for specific service consumption from the consumer to the service provider.
- **Revenue Sharing:** Process of splitting the charges of particular service consumption between the parties providing the specific service (composition) according to a specified revenue sharing model.
- **Service:** We use the term service in a very general sense. A service is a means of delivering value to customers by facilitating outcomes customers want to achieve without the ownership of specific costs and risks. Services could be supported by IT. In this case we say that the interaction with the service provider is through a technical interface (for instance a mobile app user interface or a Web service). Applications could be seen as such IT supported Services that often are also composite services.
- **Service Composition:** in SOA domain, a service composition is an added value service created by aggregation of existing third party services, according to some predefined work and data flow. Aggregated services provide specialized business functionality, on which the service composition functionality has been split down.
- **Service Delivery Framework:** Service Delivery Framework (or Service Delivery Platform (SDP)) refers to a set of components that provide service delivery functionality (such as service creation, session control & protocols) for a type of service. In the context of FI-WARE, it is defined as a set of functional building blocks and tools to (1) manage the lifecycle of software services, (2) creating new services by creating service compositions and mashups, (3) providing means for publishing services through different channels on different platforms, (4) offering marketplaces and stores for monetizing available services and (5) sharing the service revenues between the involved service providers.
- **Service Level Agreement (SLA):** A service level agreement is a legally binding and formally defined service contract, between a service provider and a service consumer, specifying the contracted qualitative aspects of a specific service (e.g. performance, security, privacy, availability or redundancy). In other words, SLAs not only specify that the provider will just deliver some service, but that this service will also be delivered on time, at a given price, and with money back if the pledge is broken.
- **Service Orchestration:** in SOA domain, a service orchestration is a particular architectural choice for service composition where a central orchestrated process manages the service composition work and data flow invocations of the external third

party services in the order determined by the work flow. Service orchestrations are specified by suitable orchestration languages and deployed in execution engines who interpret these specifications.

- **Store:** An external component integrated with the business framework, offering a set of services that are published to a selected set of marketplaces. The store thereby holds the service portfolio of a specific service provider. In case a specific service is purchased on a service marketplace, the service store handles the actual buying of a specific service (as a financial business transaction).
- **Unified Service Description Language (USDL):** USDL is a platform-neutral language for describing services, covering a variety of service types, such as purely human services, transactional services, informational services, software components, digital media, platform services and infrastructure services. The core set of language modules offers the specification of functional and technical service properties, legal and financial aspects, service levels, interaction information and corresponding participants. USDL is offering extension points for the derivation of domain-specific service description languages by extending or changing the available language modules.

3 FIWARE OpenSpecification Apps Repository REST

You can find the content of this chapter as well in the wiki of fi-ware.

3.1 Introduction to the *Repository* API

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- This Open Specification is exploitable for proprietary 3rd party products and is exploitable for open source 3rd party products, including open source licenses that require patent pledges.
- If the owner (SAP) of this GE spec holds a patent that is essential to create a conforming implementation of the GE spec (i.e. it is impossible to write a conforming implementation without violating the patent) then a license to that patent is deemed granted to the implementation.

3.1.1 Repository API Core

The Repository API is a RESTful, resource-oriented API accessed via HTTP that uses various representations for information interchange. The Repository provides a consistent uniform API to USDL service descriptions and associated media files.

3.1.2 Intended Audience

This specification is intended for both software developers and reimplementers of this API. For the former, this document provides a full specification of how to interoperate with products that implement the Repository API. For the latter, this specification indicates the interface to be implemented and provided to clients.

To use this information, the reader should firstly have a general understanding of the Generic Enabler service Repository. You should also be familiar with:

- RESTful web services
- HTTP/1.1
- JSON and/or XML data serialization formats.

3.1.3 API Change History

This version of the Repository API Guide replaces and obsoletes all previous versions. The most recent changes are described in the table below:

Revision Date	Changes Summary

Apr 2, 2012	• Initial version
Apr 03, 2014	• Final version

3.1.4 How to Read This Document

It is assumed that the reader is familiar with the REST architecture style. Within the document, some special notations are applied to differentiate some special words or concepts. The following list summarizes these special notations.

- A bold, mono-spaced font is used to represent code or logical entities, e.g., HTTP method (`GET, PUT, POST, DELETE`).
- An italic font is used to represent document titles or some other kind of special text, e.g., *URI*.
- Variables are represented between brackets, e.g. {id} and in italic font. The reader can replace the id with an appropriate value.

For a description of some terms used along this document, see Repository.

3.1.5 Additional Resources

You can download the most current version of this document from the FI-WARE API specification website at **Repository API** . For more details about the Repository GE that this API is based upon, please refer to High Level Description. Related documents, including an Architectural Description, are available at the same site.

3.2 General *Repository* API Information

3.2.1 Resources Summary

The repository is structured into core objects, which are *resources*, and *collections*. These objects constitute also the granularity of access control. Collections are containers for storing resources. Any object can provide services such as search, query, transform, maintain, depending on the type of the resource.

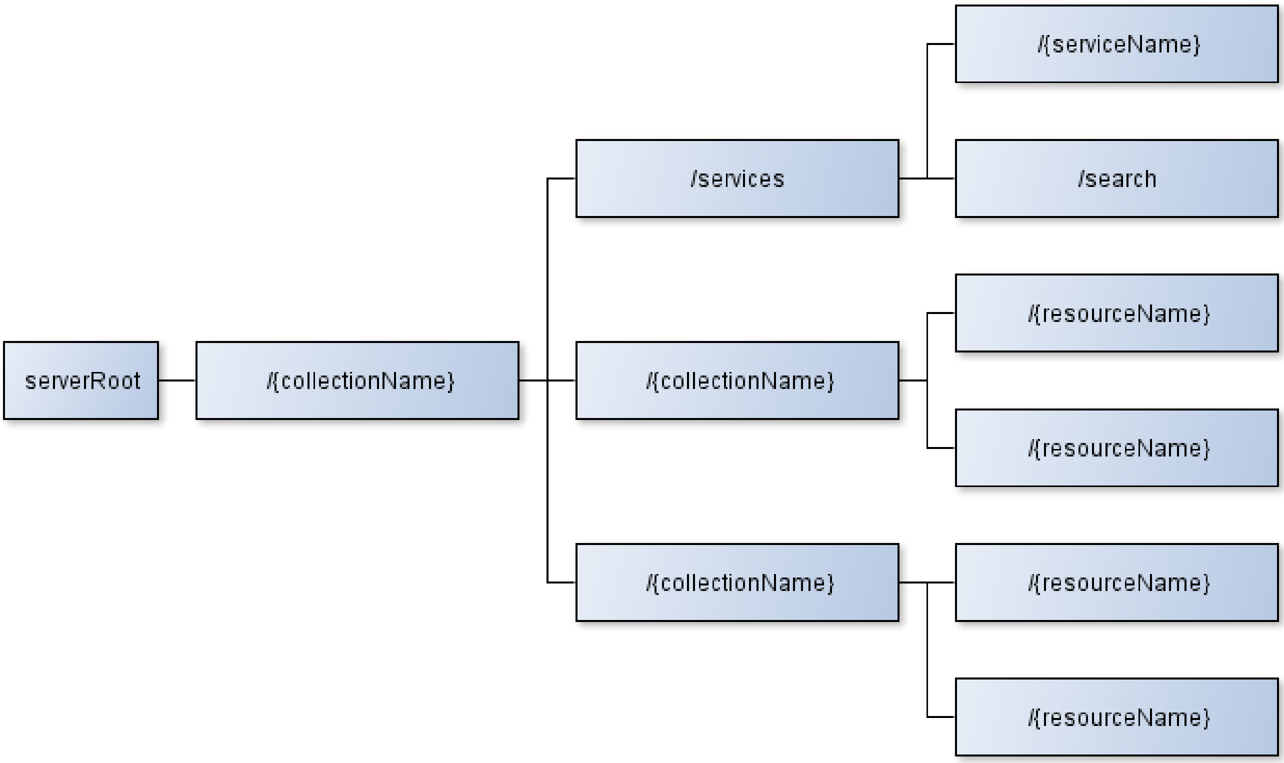
3.2.1.1 *Resources*

The resources are mainly the USDL service descriptions themselves as well as complementary media files that are used within the service descriptions.

3.2.1.2 *Collections*

A collection is a container for collecting resources and other collections. Multiple collections can be used on the repository for various purposes. Collections provide versioning of the resources.

Graphical diagram in which the different URIs that can be used in the API is shown here.



Schematic resoure tree of the Repository

3.2.2 Authentication

Each HTTP request against the *Repository GE* requires the inclusion of specific authentication credentials. The specific implementation of this API may support multiple authentication schemes (OAuth, Basic Auth, Token). It is left open how authentication is realized. In practice ith will be determined by the specific environment and the provider implementing the GE. Some authentication schemes may require that the API operate using SSL over HTTP (HTTPS).

3.2.3 Representation Format

The *Repository* API supports XML and JSON for delivering metadata resources and any kind of media type for media resources, it may also support RDF, Turtle (http://www.w3.org/TeamSubmission/turtle/) and Atom (http://tools.ietf.org/html/rfc4287) HTML for delivering metadata. The request format is specified using the Content-Type header and is required for operations that have a request body. The response format can be specified in requests using the Accept header. Note that it is possible for a response to be serialized using a format different from the request (see example below).

If no Content-Type is specified, the content is delivered in the format that was choosen to upload the resource.

The interfaces should support data exchange through multiple formats:

- *text/plain* - A linefeed separated list of elements for easy mashup and scripting.
- *text/html* - An human-readable HTML rendering of the results of the operation as output format.

- *application/json* - A JSON representation of the input and output for mashups or JavaScript-based Web Apps
- *application/rdf+xml* - A RDF description of the input and output.

In a concrete implementation of this GE other formats like RSS, Atom, etc. may also be possible.

3.2.4 Representation Transport

Resource representation is transmitted between client and server by using HTTP 1.1 protocol, as defined by IETF RFC-2616. Each time an HTTP request contains payload, a Content-Type header shall be used to specify the MIME type of wrapped representation. In addition, both client and server may use as many HTTP headers as they consider necessary.

3.2.5 Resource Identification

The resource identification for HTTP transport is made using the mechanisms described by HTTP protocol specification as defined by IETF RFC-2616.

3.2.6 Links and References

3.2.6.1 *Web citizen*

The repository is relying on Web principles:

- URI to identify resources
- consistent URI structure based on REST style protocol
- HTTP content negotiation to allow the client to choose the appropriate data format supporting HTML, RDF, XML, RSS, JSON, Turtle, ...
- Human readable output format using HTML rendering ('text/html' accept header) including hyperlinked representation
- Use of HTTP response codes including ETags (proper caching)
- Linked Data enablement supporting RDF input and output types

3.2.6.2 *Linked Open Data*

Publishing data as linked data requires every resource to be directly resolvable given their URL. The basic idea of Linked Data is simple. Tim Berners-Lee's note on Linked Data (http://www.w3.org/DesignIssues/LinkedData) describes four rules for publishing data on the Web:

- Use URIs as names for things
- Use HTTP URIs so that people can look up those names.
- When someone looks up a URI, provide useful information, using the standards (RDF*, SPARQL)
- Include links to other URIs, so that they can discover more things.

This can actually achieved by different approaches. One is the use of a special resolver similar to URL shorteners.

So the authoring environment has to ensure that every URI (actually IRI - Internationalized Resource Identifiers - RFC 3987) can be resolved by a HTTP `GET` request. For example: If a resource is maintained in a repository under the URL http://repository.acme.com/service/xyz but the IRI used in service descriptions is actually http://fi-ware.org/service/xyz, we need a resolver at this location which redirects the request to the actual repository.
Setting up resolvers is more complex task. Therefore we try to follow a simpler approach for the USDLRepositoryRest. The API is designed to be directly used for Linked Data publishing without the need for a resolver.

3.2.7 Paginated Collections

In order to reduce the load on the service, we can decide to limit the number of elements to return when it is too big. This section explain how to do that using for example a limit parameter (optional) and a last parameter (optional) to express which is the maximum number of element to return and which was the last element to see.
These operations will have to cope with the possibility to have over limit fault (413) or item not found fault (404).

3.2.8 Limits

We can manage the capacity of the system in order to prevent the abuse of the system through some limitations. These limitations will be configured by the operator and may differ from one implementation to other of the GE implementation.

3.2.8.1 ***Rate Limits***

These limits are specified both in human readable wild-card and in regular expressions and will indicate for each HTTP verb which will be the maximum number of operations per time unit that a user can request. After each unit time the counter is initialized again. In the event a request exceeds the thresholds established for your account, a 413 HTTP response will be returned with a Retry-After header to notify the client when they can attempt to try again.

3.2.9 ETag Handling

For standard caching an ETag HTTP header is provided for `GET` and `PUT` requests. If a `GET` requests has a "If-None-Match" header, than the content is only delivered if the stored ETag of the object matches the requested ETag. HTTP status code 304 (not changed) is responded otherwise.
For `PUT` requests the ETag header can be used to ensure integrity of the repository. The `PUT` operation will only be executed if the "If-Match" header matches the stored ETag of the resource in the repository. If no "If-Match" header is given for an existing resource or the "If-Match" header does not match the existing ETag of the resource, status code 409 (Conflict)will be returned. If the resource was changed, then a new ETag header will be returned in the response header.

3.2.10 Extensions

The Repository could be extended in the future. At the moment, we foresee the following resource to indicate a method that will be used in order to allow the extensibility of the API. This allow the introduction of new features in the API without requiring an update of the version, for instance, or to allow the introduction of vendor specific functionality.

Verb	URI	Description
GET	/extensions	List of all available extensions

3.2.11 Faults

3.2.11.1 *Synchronous Faults*

Error codes are returned in the body of the response. The description section returns a human-readable message for displaing end users.
Example:

```
<exception>
       <description>Resource Not found</description>
       <errorCode>404</errorCode>
       <reasonPhrase>Not Found</reasonPhrase>
</exception>
```

Fault Element	Associated Error Codes	Expected in All Requests?
Unauthorized	403	YES
Not Found	404	YES
Limit Fault	413	YES
Internal Server error	50X	YES

3.3 API Operations

3.3.1 Managing Collections

Verb	URI	Description
GET	/{CollectionPath}	Get a collection

PUT	/{CollectionPath}	Create or update a collection
DELETE	/{CollectionPath}	Delete a collection

3.3.1.1 *Status Codes*

200 OK

The request was handled successfully and transmitted in response message.

201 Created

The request has been fulfilled and resulted in a new resource being created.

204 No Content

The server successfully processed the request, but is not returning any content.

304 Not Modified

Indicates the resource has not been modified since last requested. Typically, the HTTP client provides a header like the If-Modified-Since header to provide a time against which to compare. Using this saves bandwidth and reprocessing on both the server and client, as only the header data must be sent and received in comparison to the entirety of the page being re-processed by the server, then sent again using more bandwidth of the server and client.

400 Bad Request

The request cannot be fulfilled due to bad syntax.

404 Not Found

The requested resource could not be found but may be available again in the future. Subsequent requests by the client are permissible.

409 Conflict

Indicates that the request could not be processed because of conflict in the request, such as an edit conflict.

500 Internal Server Error

A generic error message, given when no more specific message is suitable.

3.3.2 Managing Resources

Verb	URI	Description
GET	/{CollectionPath}/{ResourceID}	Get a resource
PUT	/{CollectionPath}/{ResourceID}	Create or update a resource
DELETE	/{CollectionPath}/{ResourceID}	Delete a resource

3.3.2.1 *Status Codes*

200 OK

The request was handled successfully and transmitted in response message.

201 Created

The request has been fulfilled and resulted in a new resource being created.

204 No Content

The server successfully processed the request, but is not returning any content.

304 Not Modified

Indicates the resource has not been modified since last requested. Typically, the HTTP client provides a header like the If-Modified-Since header to provide a time against which to compare. Using this saves bandwidth and reprocessing on both the server and client, as only the header data must be sent and received in comparison to the entirety of the page being re-processed by the server, then sent again using more bandwidth of the server and client.

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409 Conflict

Indicates that the request could not be processed because of conflict in the request, such as an edit conflict.

500 Internal Server Error

A generic error message, given when no more specific message is suitable.

3.3.3 Additional Services

Verb	URI	Description
GET	/{collectionPath}/services	Get a list of additional services in e.g. USDL format

3.3.3.1 *Status Codes*

200 OK

The request was handled successfully and transmitted in response message.

500 Internal Server Error

A generic error message, given when no more specific message is suitable.

3.3.4 Searching the Repository

Verb	URI	Description
GET	/{CollectionPath}/search?q={queryString}	Search a collection

3.3.4.1 *Status Codes*

200 OK

The request was handled successfully and transmitted in response message.

400 Bad Request

The request cannot be fulfilled due to bad syntax.

404 Not Found

The requested resource could not be found but may be available again in the future. Subsequent requests by the client are permissible.

500 Internal Server Error

A generic error message, given when no more specific message is suitable.

4 FIWARE OpenSpecification Apps Marketplace

You can find the content of this chapter as well in the wiki of fi-ware.

Name	FIWARE.OpenSpecification.Apps.Marketplace
Chapter	Apps,
Catalogue-Link to Implementation	Marketplace
Owner	SAP AG, Andreas Klein

4.1 Preface

Within this document you find a self-contained open specification of a FI-WARE generic enabler, please consult as well the FI-WARE Product Vision, the website on http://www.fi-ware.org and similar pages in order to understand the complete context of the FI-WARE project.

4.2 Copyright

- Copyright © 2014 by SAP

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Note: SAP provides the software associated to the Marketplace - RI as open source under the **BSD License**. Please check the specific terms and conditions linked to this BSD open source license at https://github.com/service-business-framework/Marketplace-RI/blob/master/license.txt. You can also obtain the Marketplace GE and Pricing Simulation Decision Support software using the FI-WARE Catalogue at http://catalogue.fi-ware.org/enablers/marketplace-sap-ri

4.4 Overview

In general a marketplace is an instrument to facilitate commerce by bringing together vendors and buyers, or offers and demand, or producers and consumers. A marketplace can support a variety of mechanisms to achieve this. This specification describes the FI-WARE Marketplace Generic Enabler, which is part of the Applications/Services Ecosystem. Any offering in context of the application and service business can be supported by marketplace functionality. A marketplace implementation can offer many different kinds of services to the participants.

The core functionality of the Marketplace is to provide a uniform service interface to discover and match application and service offerings from providers and sources (e.g. published by different stores) with demand of consumers. This core functionality provides a basis for extended services depending on the domain and nature of the target markets.

Some characteristics of the pricing decision process – especially its complex role in regulating economic interactions between autonomous market agents – make it an ideal candidate to be investigated by means of a simulation approach called Agent-Based Modeling and Simulation (ABMS). Using the Pricing Simulator Decision Support feature set of the marketplace GE, simulation experiments based on the ABMS approach can be conducted to support important business decisions, such as selecting an optimal price level or determining a balanced combination of price and product configuration (i.e., offering the right value, in terms of attributes and characteristics of the offered software product or service, for the money customers must spend in acquiring it).

4.4.1 Target usage

Internet based business networks require at least one marketplace and multiple stores, where people can offer and deal with services like goods and finally combine them to value added services. Offerings from stores are published on the marketplace where users can quickly find and compare them, which enables them to attend an industry-ecosystem better than before. Services become tradable goods, which can be offered and acquired on internet based marketplaces. Besides automated Internet services, this also applies for services that are provided by individuals. Partner companies can combine existing services to new services whereby new business models will be incurred and the value added chain is extended. The marketplace may also support the decision-making processes involved in the pricing choices a service provider in the FI-WARE environment must make for its offerings.

Given the multitude of apps and services that will be available on the Future Internet, providing efficient and seamless capabilities to locate those services and their providers will become crucial to establish service and app stores. Besides well-known existing commercial application stores like Apple App Store, Google Android Market, and Nokia Ovi, there are first efforts to establish open service and app marketplaces, e.g. in the Amazon Web Service Marketplace, the U.S. Government‘s Apps.Gov repository and Computer Associates‘ Cloud

Commons Marketplace. While these marketplaces already contain a considerable number of services, they are currently, at a premature stage, offering little more than a directory service. FI-WARE will fill this gap by defining Generic Enablers for marketplaces and providing reference implementations for them.

4.4.1.1 *User roles*

- Service provider will place offers on the marketplace or in a service/app store and is supported in pricing choices
- Consumer can search, browse and compare offers
- Repository will be used to get services descriptions
- Registry acts as a universal directory of information used for the maintenance, administration, deployment and retrieval of services. It will be used to store information necessary for service run-time execution.
- Service store will participate on a marketplace and publish offerings.
- Channel Maker give consumers access to the marketplace

4.5 Basic Concepts

The marketplace is structured into five core components. These components are *Registry & Directory*, *Offering & Demand*, *Discovery & Matching*, *Recommendation*, and the *Review and Rating* component. The optional Pricing Simulator Decision Support feature set of the marketplace GE is also described in this document.

4.5.1 Registry and Directory

The Registry and Directory component holds information of registered stores, participants and their role(vendors, buyers, resellers, ...) and takes care of registering, updating, and deleting information about market relevant entities.

4.5.2 Offering & Demand

A service offering consists of a link to a concrete USDL description, a pricing model and a classification of the service. The Offering component is responsible for exchanging service offerings with stores and version handling/archiving of out-dated offerings.
Symmetrically to offerings also the demand side of the market need to be represented. A service demand can be created according to expected functionality, pricing and service levels, classified and published to the marketplace.

4.5.3 Discovery & Matching

This component is about discovering and matching offering and demand, either explicitly expressed by concrete offerings or implicitly contained in the search criteria for the inquiry process.

4.5.4 Recommendation

This component provides the user service recommendations based on the user's profile and context in comparison to explicit semantics of available offerings as well as previous activities and experiences of the marketplace participants (Wisdom of the crowd and social networks).

4.5.5 Review & Rating

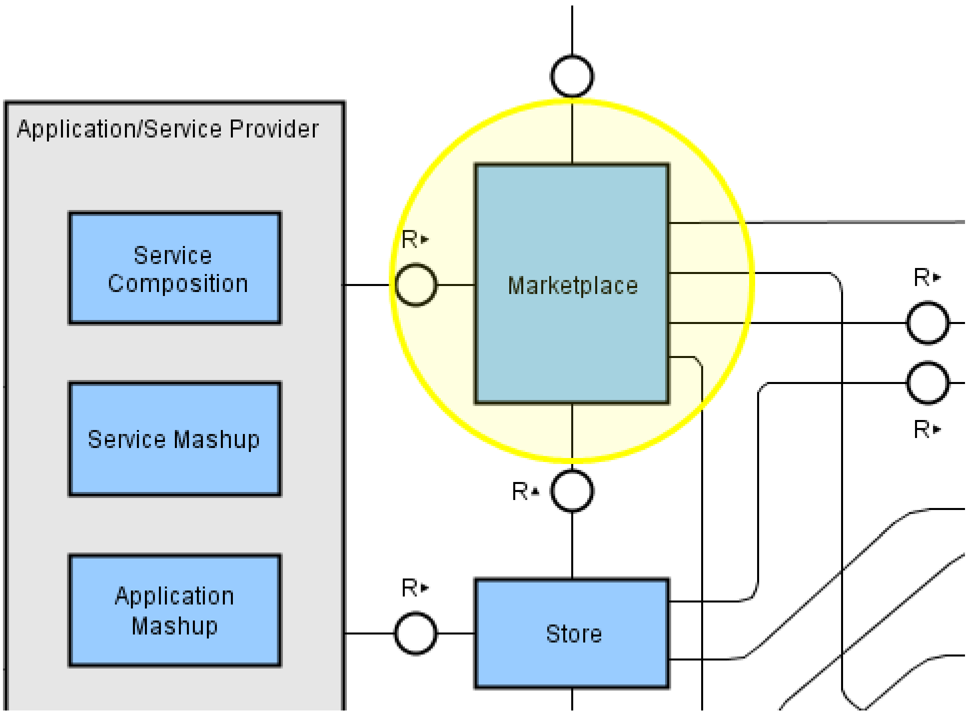
The Review and Rating component allows users of the marketplace to give textual and star-rating feedback for services and stores along predefined categories. Reviews of users and their overall rating about applications and services can be used to improve the quality of the recommendation.

4.5.6 Pricing Support

The optional Pricing Simulator Decision Support feature set of the marketplace GE supports the decision-making processes involved in the pricing choices a service provider in the FI-WARE environment must make for its offerings.

4.6 Marketplace Architecture

The Marketplace GE is used by other GEs within the FI-WARE platform, namely the Composition Editor and the Service IDE. The Marketplace itself relies on functionality provided by the Identity Management Service GE and the Repository.

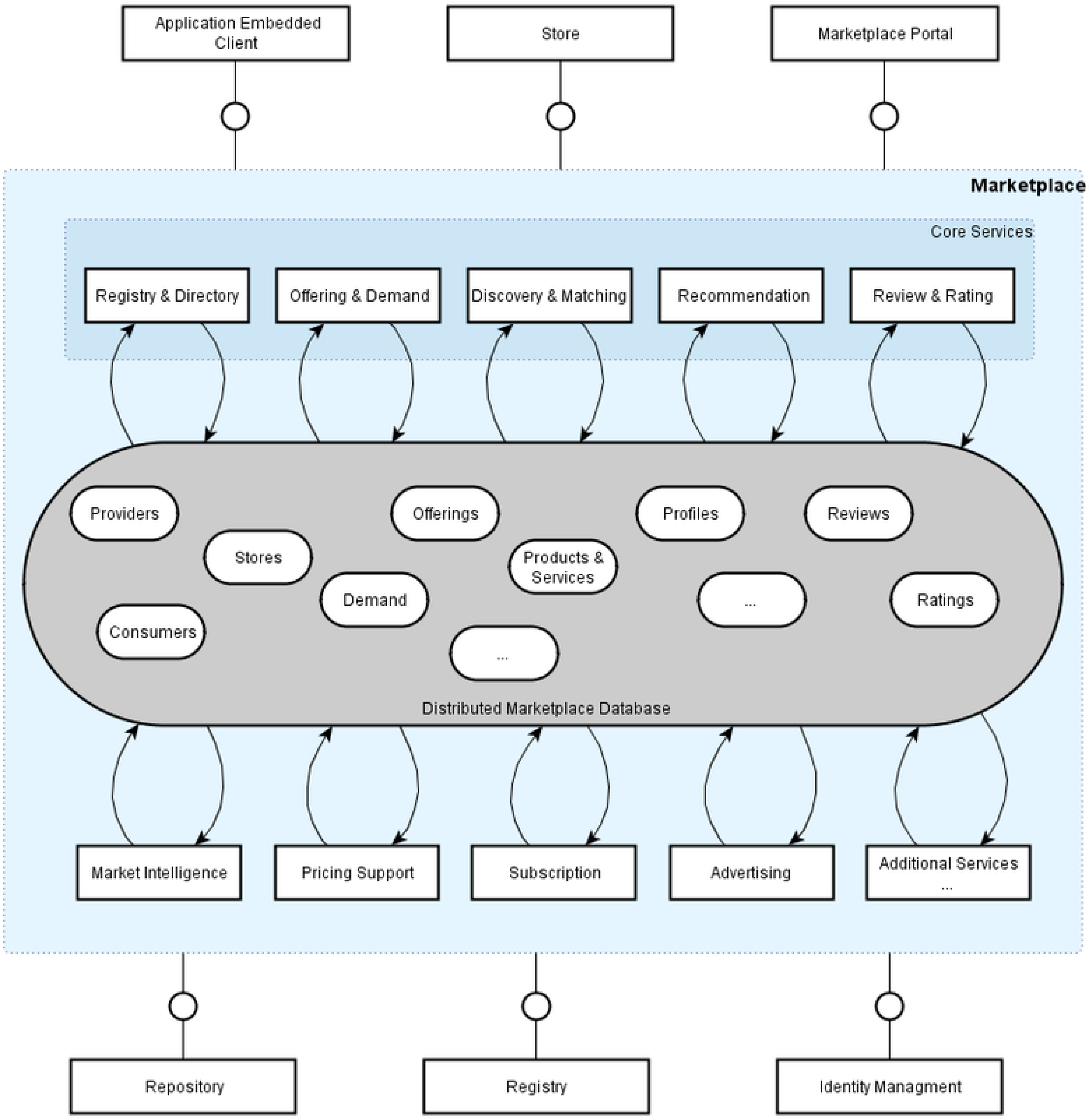


Marketplace in the context of the Business Framework

The Marketplace provides functionality necessary for bringing together offering and demand for making business. These functions include basic services for registering business entities, publishing and retrieving offerings and demands, search and discover offerings according to specific consumer requirements as well as lateral functions like review, rating and recommendation. FI-WARE will focus on the core functions but aims to provide a framework to offer also additional services. Beside the core functions, a marketplace may offer value based on its "knowledge" about the market in terms of market intelligence services, pricing support, advertising, information subscription and more.

Furthermore, the marketplace can be accessible by an HTML-based user interface for end users (Marketplace Portal), namely service consumers and service providers (stores) or a programmatic API, which allows embedding market place functionality into existing applications and environments. So for example, the marketplace API can be used in order to provide marketplace access directly embedded into the composition environment (in-app shopping). A service/application store can register at the marketplace in order to create new service offerings on the marketplace. The actual buying process always takes place at a store. So for ordering a specific service, the buyer gets redirected to the store's ordering management service.

The functional components of the marketplace implementation are outlined in the following diagram. This functional architecture figure is to be seen as a blueprint for implementers of the marketplace GE. It does not presume the use of a certain technology. The general idea is that all functions will operate on a huge (virtual) database of entities relevant for the business framework, such as people, organizations, products, services, offerings, ratings, etc. In practice this data might be in one uniform distributed database or a set of databases, which only virtually build the marketplace database. In fact for scaling reasons, in huge marketplaces the database is rather realized by many systems, distributed globally. Linked Data can be a good foundation for a marketplace database abstraction layer (the web is the database). In this case, which FI-WARE is focusing on, the marketplace database is more like a (semantic) index of all marketplace information bits and pieces stored elsewhere. As a query and update mechanism, we are relying on Semantic Web Repositories, Query Systems and a Query Language. The figure below shows the marketplace in context of the business framework.



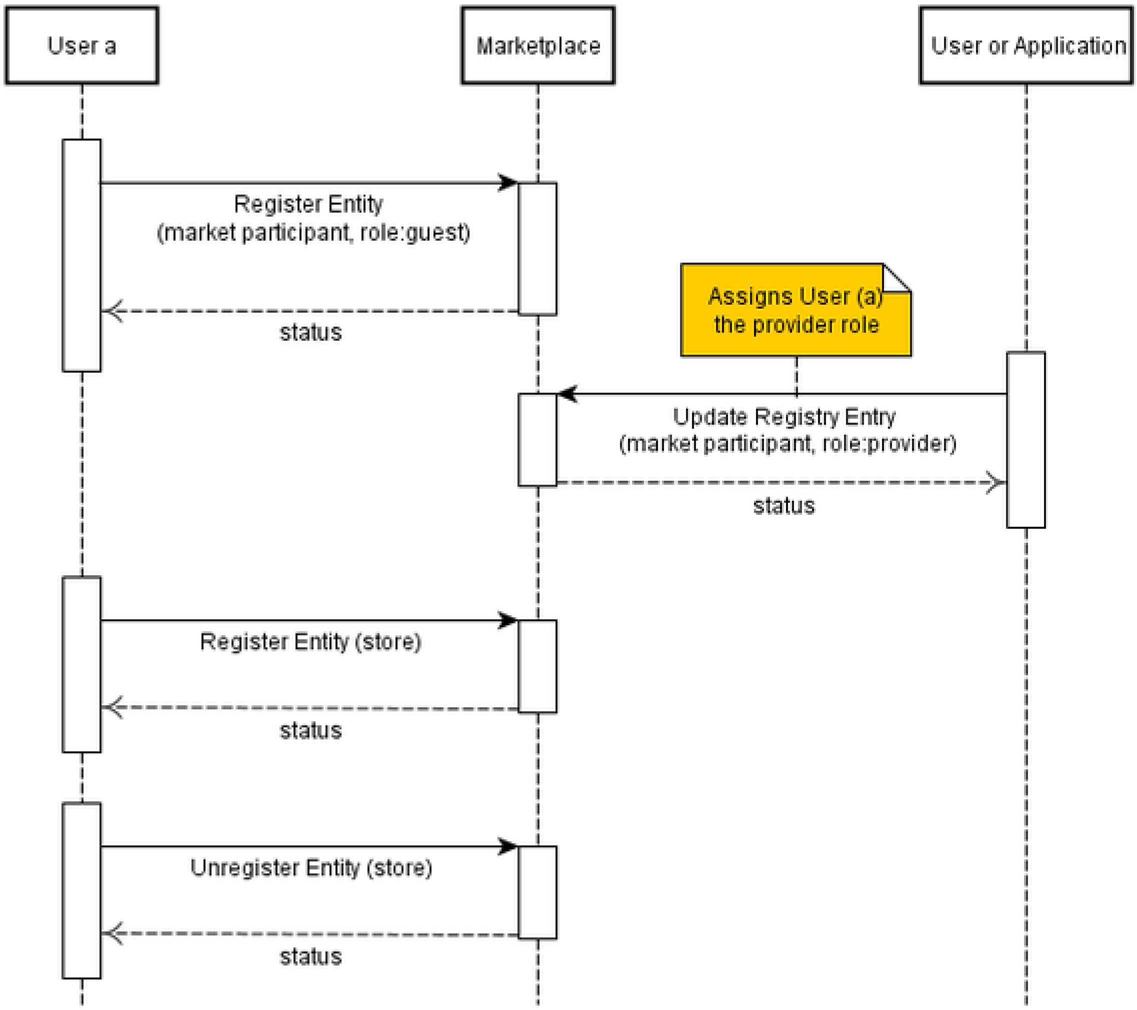
Architecture of a Marketplace implementation

4.7 Main Interactions

Each functional block of the Marketplace can be considered as a GE as well. Consequently it has an own abstract operation protocol specification attached.

4.7.1 Registration and Directory (mandatory)

It should be possible to register a number of marketplace relevant entity types such as stores, market participants and their roles in certain business aspects (provider, consumer, reseller ...). The diagram below depicts an exemplary sequence of operations with the Registration and Directory component. A user application refers to an application which has marketplace functionally embedded.



Sequence of registration operations

The Marketplace provides a ***Register Entity*** operation for registering market participants and related business elements. It can be used to register a new Store on the marketplace. Parameters:

- *entity* - Description of the entity to be created.

The following core entity types are supported:

- *Store* - The stores which are comprised by the marketplace. The target stores will be queried by other marketplace components, in order to retrieve store offerings and to perform any store operations on them
- *Market Participant* - The participants (users) of the marketplace. A market participant must have at least one of the following roles:
    - **Guest** - Guest users are only allowed to use the discovery capabilities of the marketplace.
    - **Consumer** - The actual buyers. The organizations or persons who can buy services and applications on the marketplace.

- **Provider** - Providers of services and applications available on the marketplace. Information about providers must be made available different components on the marketplace.
- **Reseller** - Reseller of services and applications. The reseller has no own service portfolio and sells services from other providers.

Existing registration information on the marketplace can be modified or updated with the ***Update Registry Entry*** operation. The parameters are similar to the Register Entity operation:

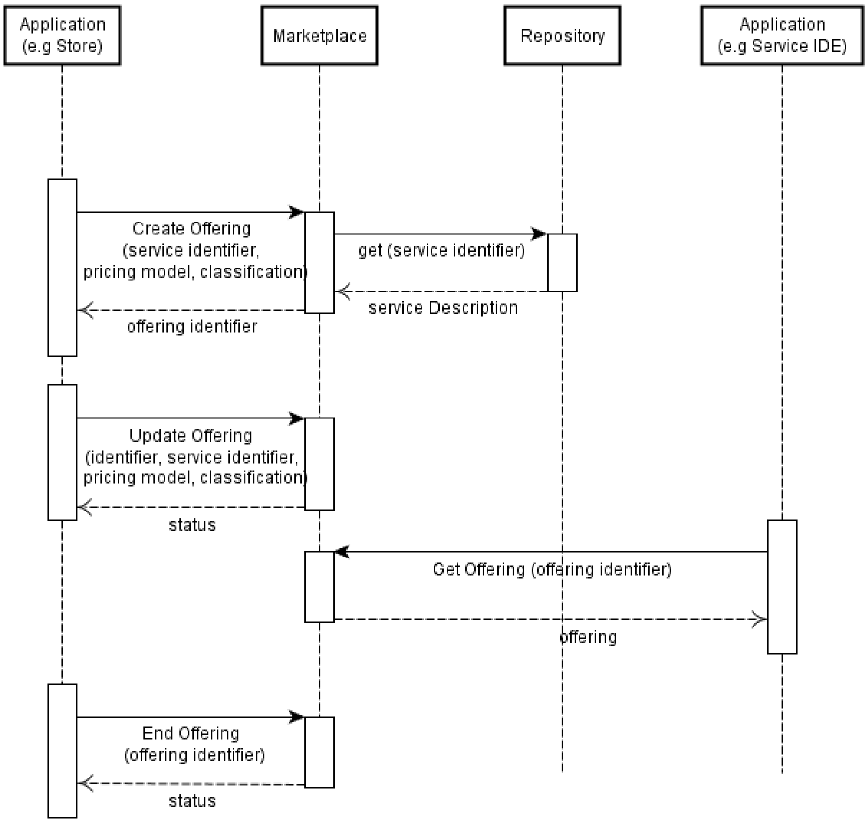
- *entity* - Description of the entity to be updated including the entity identifier.

For unregistering entities such as stores or market participants from the marketplace, the ***Unregister Entry*** operation will be used. Unregistering an entity from the Marketplace means that this entity gets flagged as unregistered and not further considered for the marketplace operation. So, complete deletion is not possible due to consistency and history-preservation reasons. The following parameter is required:

- *entity* - Entity to be unregistered from the marketplace registry.

4.7.2 Offering & Demand (mandatory)

Offerings are retrieved from various sources (actually mainly stores, but other sources would be also allowed). So one of the operations is to ask a registered store for actual offerings. The following diagram shows an example sequence of offering management on a marketplace.



Example sequence of offering management operations

The ***Create Offering*** operation can be used to actively push a new service offering from a registered store into a marketplace. This operation returns the identifier of the published offering. The following parameters need to be exchanged:

- *service identifier* - Identifier of the service to be offered / link to a USDL service description.
- *pricing model* - Pricing model for the service/app.
- *classification* - Optional - Classification of the offering, e.g. name of a category the offering belongs to

The ***Update Offering*** operation can be used to update an already published offering on the marketplace. The old offering information gets versioned on the marketplace. This operation returns an OK status result on success or a parameter allowing to identify the reason for fault for further exception handling. The following parameters need to be exchanged:

- *offering identifier* - Identifier of the offering.
- *service identifier* - Identifier of the service to be offered / link to a USDL service description.
- *pricing model* - New or updated pricing model for the service/app.
- *classification* - Optional - Classification of the offering.

In order to withdraw or end a concrete offering from the marketplace the ***End Offering*** operation is used. A complete deletion is not possible due to dependency and history reasons. The following parameters are exchanged:

- *offering identifier* - Identifier of the offering.

This operation returns an OK status result on success or a parameter allowing to identify the reason for fault for further exception handling.

The ***Get Offering*** operation can be used to retrieve a offering from the marketplace. This operation delivers the actual offering data, such as pricing information, service description, associated store, and the offering classification. The following parameters need to be exchanged:

- *offering identifier* - Identifier of the offering.
- *version* - Optional parameter. If not set, the latest version of the requested offering is returned

The ***Get Offering History*** operation can be used to retrieve the history of an offering from the marketplace. This operation delivers a list of all version IDs and dates of an offering. The following parameters need to be exchanged:

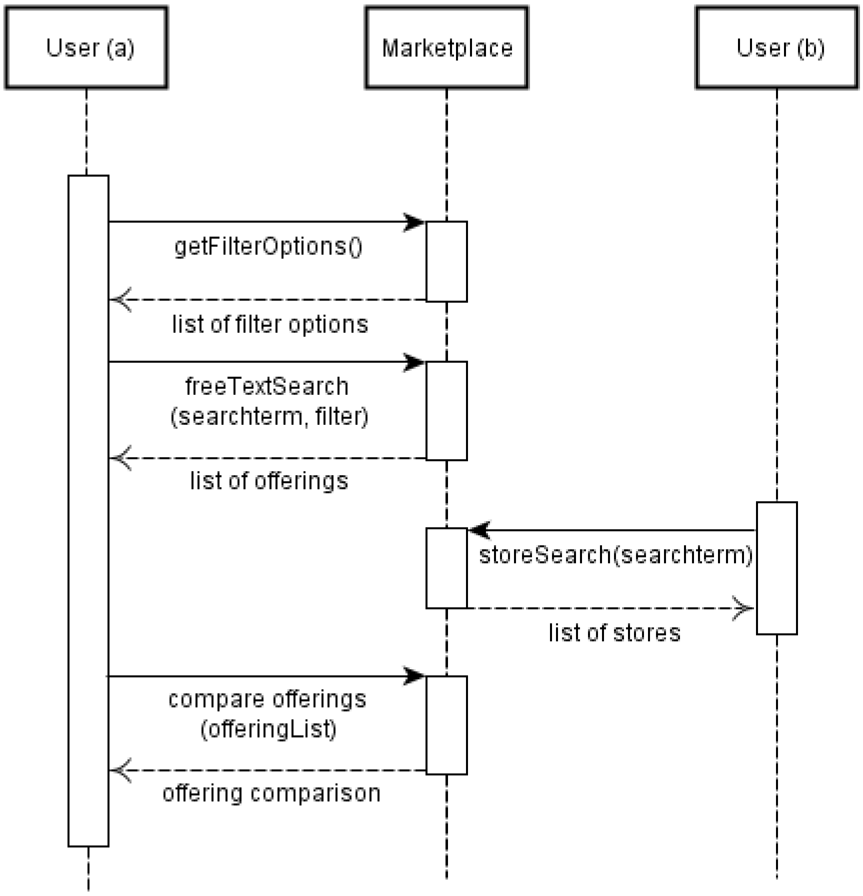
- *offering identifier* - Identifier of the offering.

The ***List Offerings for a Store*** operation can be used to retrieve all offerings from a specific store that is registered of the marketplace. For practical reasons it might be useful to restrict the list of offerings by specifying the number of results and the starting offset. The following parameters need to be exchanged:

- *store Identifier* - Identifier of the store.
- *filter* - Optional filter expression to reduce the number of delivered results.
- *index* - Index of the first offering to be returned.
- *limit* - Maximal number of results to be returned.

4.7.3 Discovery & Matching (mandatory)

The Discovery and Matching component supports primarily customers in finding offerings and stores matching their needs. The following diagram shows an example sequence of a marketplace user (a) searching and comparing offerings as well as a second user (b) searching for stores.



Example sequence of discovery and matching operations

The ***Free Text Search*** operation can be used to search the marketplace for offerings using a search string with wildcards and filters. This operation delivers a list of all offerings which matches the specified search term and filter constraints. The following parameters can be involved in the operation:

- *search string* - Search string, potentially with wildcard operators.
- *filter* - Optional - Filter expression to reduce the number of delivered results.
- *index* - Optional - Index of the first offering to be returned.
- *limit* - Optional - Maximal number of results to be returned.
- *page size* - Optional - Number of results per page.
- *sort by* - Optional - List of sort options, sorted by application order.

The ***Get Filter Options*** operation can be used to get the possible filter options for a free text search. There might exist some filter options which are specific to a certain classification category. If the classification input parameters is set, a list of these specific filter parameters gets returned.

- *classification* - Optional parameter to get filter options for offerings associated with the specified classification.

Sort options are used to define the order of an offering result list. ***The Get Sort Options (optional)*** operation returns a list of possible sort options for a list of offerings. If a classification category is specified in the request, category specific sort options get returned. The optional parameter for category specific sort options is:

- *classification category* - Optional parameter to get filter options for offerings associated with the specified classification.

To get a comparison of pricing models and USDL service descriptions among offerings the ***Compare Offerings (optional)*** operation is used. An optional filter expression can be used to reduce the number of delivered results. The parameters for this operation are:

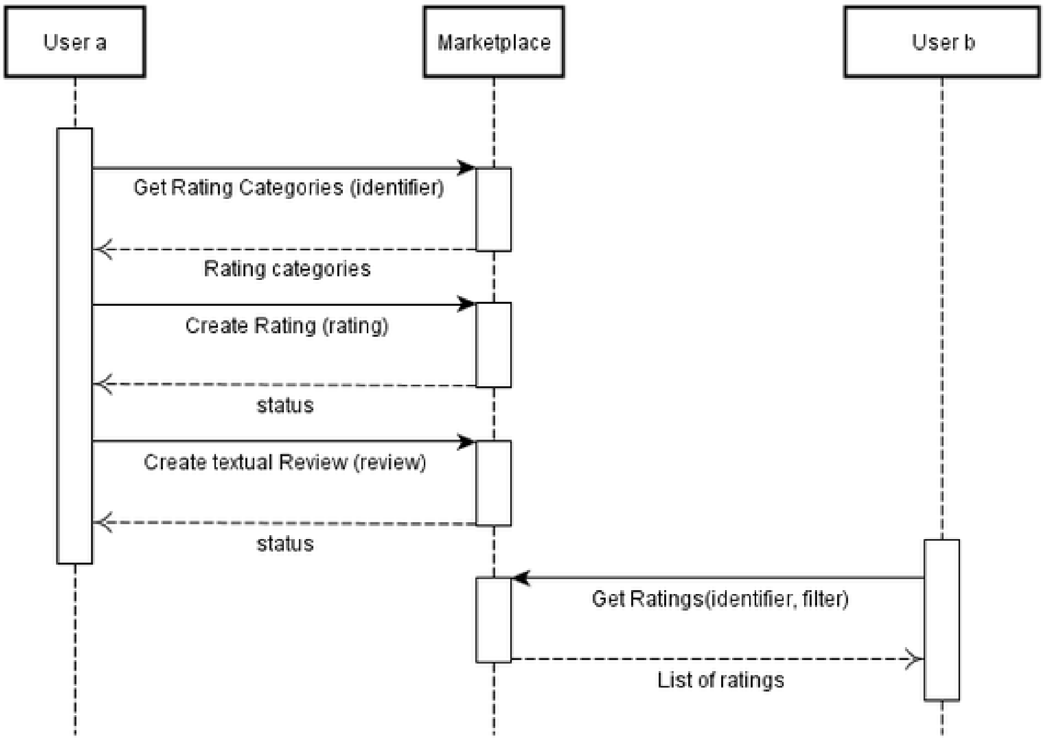
- *offering list* - List of offerings
- *filter* - Optional - Filter expression to reduce the number of delivered results.
- *index* - Optional - Index of the first offering to be returned.
- *limit* - Optional - number of results to be returned.

The ***Store Search*** operation enables a client to search a marketplace for registered stores using a search string with wildcards and filters. A list of stores matching the search string as well as the specified filter criteria is returned.

- *search string* - Search string, potentially with wildcard operators
- *filter* - Optional - Filter expression to reduce the number of delivered results.
- *index* - Optional - Index of the first store to be returned.
- *limit* - Optional - Maximal number of results to be returned.

4.7.4 Review and Rating (optional)

The Review and Rating component allows users of the marketplace to retrieve and create textual and star-rating feedback for rate-able entities such as stores and services. An example sequence of marketplace users creating and retrieving ratings is illustrated below.



Review and Rating Example sequence

To get the average rating for a store, a service or any other rate-able entity on the marketplace the ***Get Rating*** operation is used. This operation delivers the average ratings for a rate-able entity by means of different rating categories as well as an overall average rating. The following parameters need to be exchanged:

- *identifier* - Identifier of a store or a user or any other rate-able entity

The ***Get Ratings*** operation delivers the details of ratings for a rate-able entity. Filter expressions are supported to reduce the number of results. If no filter expression is given then all ratings for the specified entity instance are returned.

- *identifier* - Identifier of a store or a service or any other rate-able entity
- *filter* - Optional filter expression to reduce the number of delivered results.
- *index* - Index of the first rating to be returned.
- *limit* - Maximal number of results to be returned.

In order to retrieve a list of textual reviews for a rate-able entity the ***Get textual Reviews*** operation is used. It also supports filter expressions as well as limits and offsets. The following parameters are available for this operation:

- *identifier* - Identifier of a store or a user.
- *filter* - Optional filter expression to reduce the number of delivered results.
- *index* - Index of the first reviews to be returned.
- *limit* - Maximal number of results to be returned.

The ***Create Rating*** operation is used to persist a new rating for an entity in the marketplace. This operation returns the identifier of the new rating as result. To get the available rating categories for a rate-able entity use the later-described *Get Rating Categories* operation beforehand. The following parameter needs to be exchanged:

- *rating* - Rating entry which includes a rating value for each mandatory rating category as well as a link to the rate-able entity instance

To get the available rating categories for a rate-able entity the ***Get Rating Categories*** is used. It returns a list of available rating categories for the specified service, store, or any other rate-able entity instance. The following parameter has to be provided:

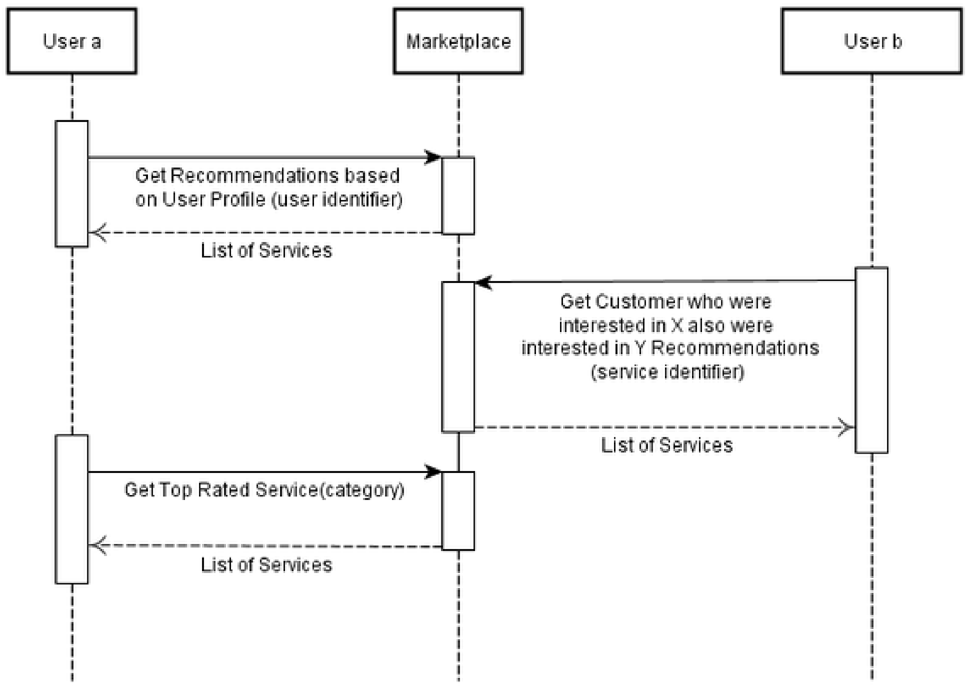
- *identifier* - Identifier of a rate-able entity instance.

The ***Create textual Review*** creates a textual review for an entity instance that is flagged as rate-able. It returns the identifier of the created review as result. As input parameter, the textual review is sufficient:

- *review* - Review entry which includes the textual review and an the identifier of the rate-able entity instance.

4.7.5 Recommendation (optional)

The Recommendation component supports users in finding services matching their needs based on user specific data. The following diagram outlines an example sequence of a user retrieving recommendations.



Example sequence of recommendation operations

To retrieve a list of recommendations for a user the ***Get Recommendations based on User Profile*** operation is used. Recommendations might be based on the users' profile, browsing behaviour, order history and other user specific data. This operation returns a list of recommended services till the specified limit. The following parameters need to be provided:

- *user identifier* - Identifier of a user
- *limit* - Optional - Maximal number of results to be returned.

The ***Get Customer who were interested in X also were interested in Y Recommendations*** returns a list of services that were often bought together with the a given service. The supported parameters for this operation are:

- *user identifier* - Identifier of a service
- *limit* - Optional - Maximal number of results to be returned.

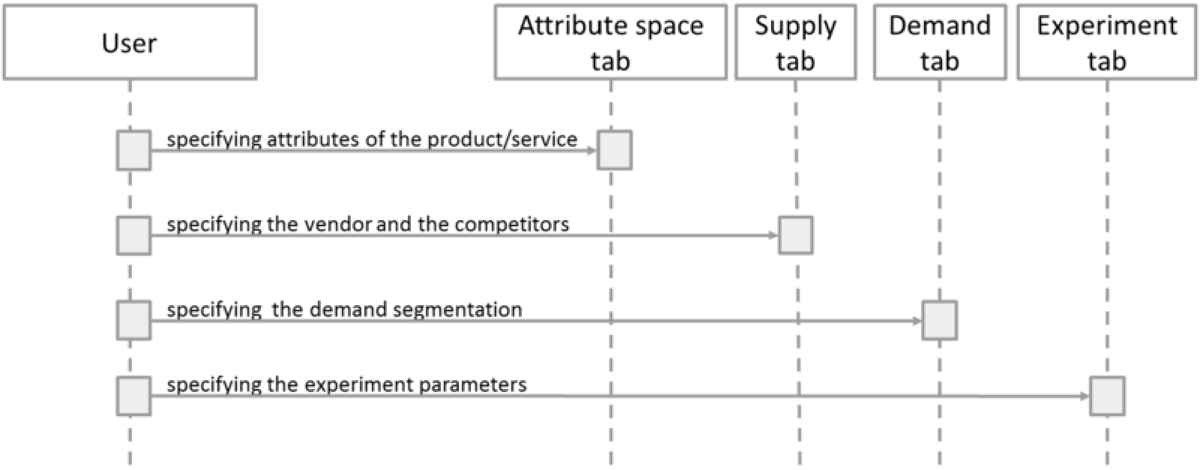
To get the top rated services on the marketplace as a whole or the top rated services for a certain classification category the ***Get Top Rated Services*** is used. The following parameters are supported:

- *classification category* - Optional parameter to get the top rated services for a certain classification category.
- *limit* - Optional - Maximal number of results to be returned.

4.7.6 Pricing Support (optional)

The optional Pricing Simulator Decision Support feature set of the marketplace GE supports service providers using the FI-WARE marketplace to sell its artifacts. A Service Provider can employ the FI-WARE Pricing Simulator to conduct a pricing analysis and to take pricing decisions with regards to the software and services it sells through the FI-WARE Marketplace.

The diagram below shows the sequence of operations required to run a simulation experiment using the FI-WARE Pricing Simulator's user interface.



Pricing Simulator - Activity Diagram Main Interactions

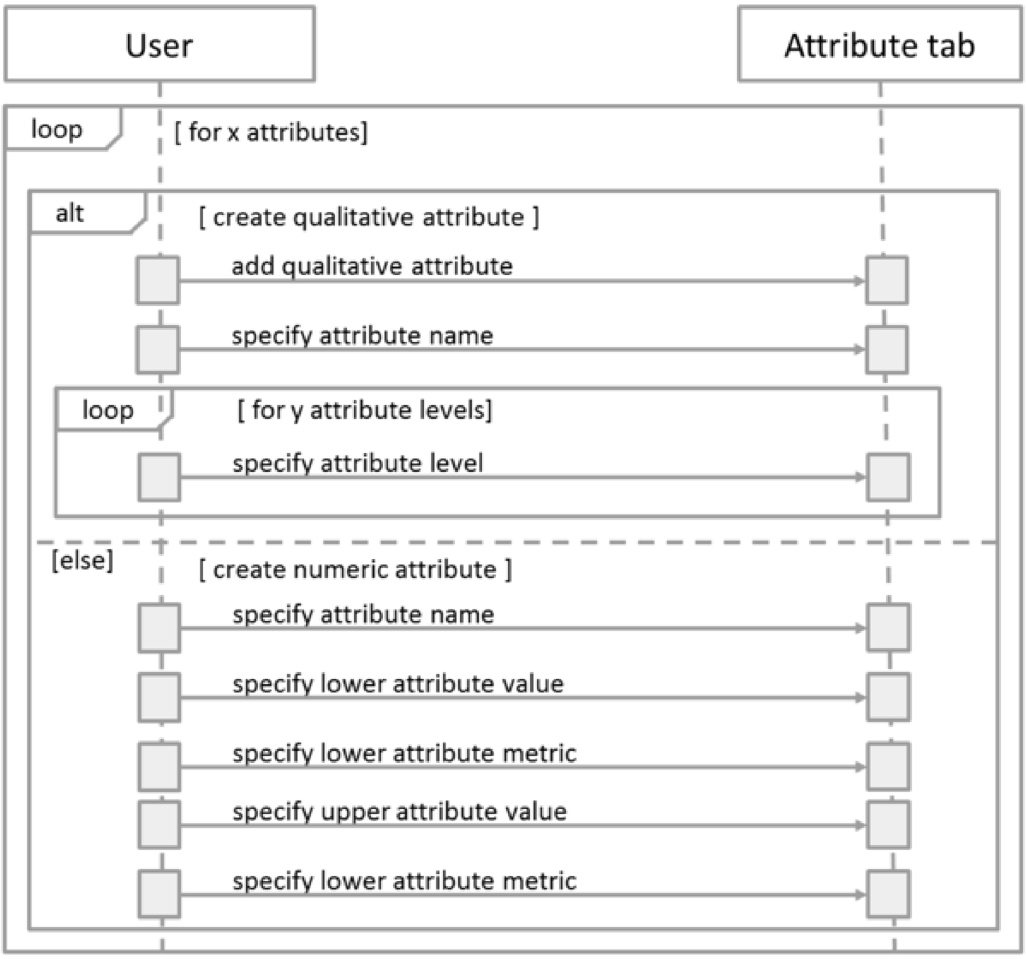
These steps are described in detail in the following sections.

4.7.6.1 *Attribute Space*

The Attribute Space allows the user to describe the characteristics of a software product or service by specifying its attributes. Each attribute can take one of a series of alternative levels. These levels are later on used to define concrete instances (or implementations) of an offering.

Create/Edit Attributes

This functionality allows the user to create and edit the attribute space, i.e., the set of attributes and their respective possible levels. When creating an attribute, the first step is to assign a name to it. Subsequently, the possible attribute levels have to be set using the attribute level fields.



Pricing Simulator - Activity Diagram Edit Attributes

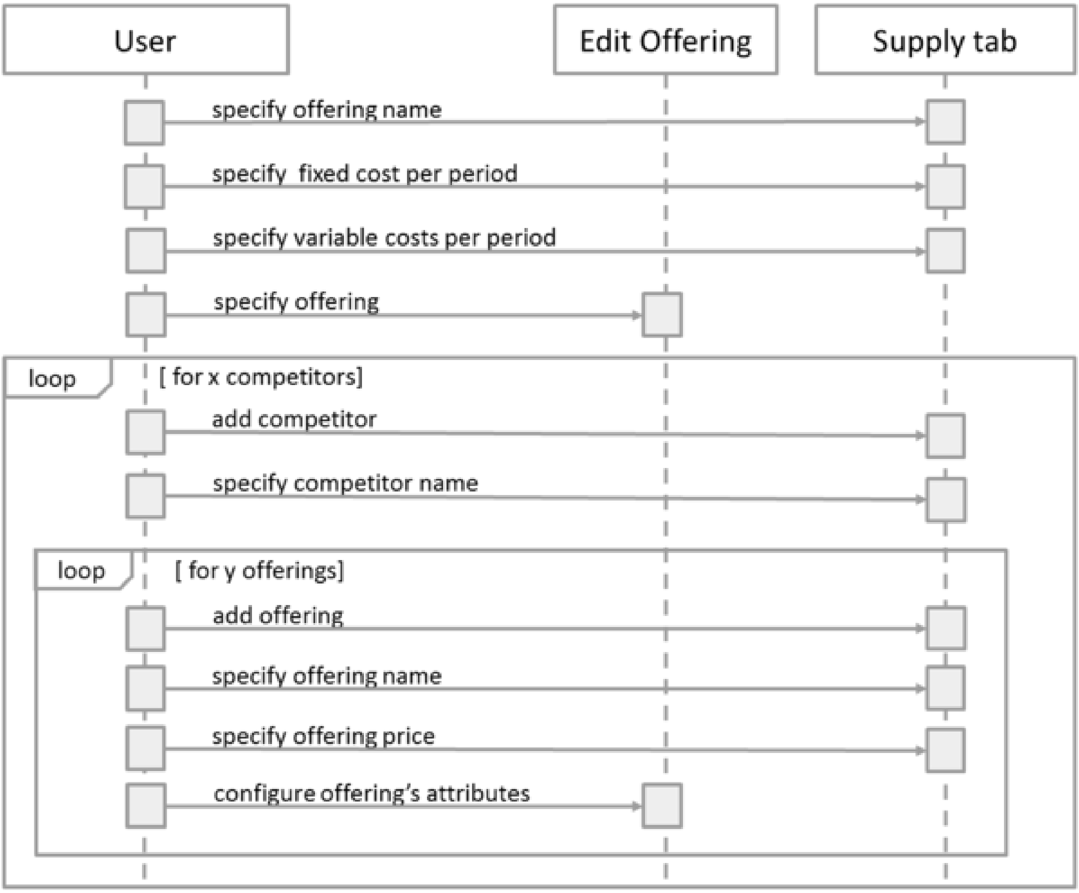
4.7.6.2 *Market Scenario*

The market environment consists of economic agents populating the two sides of the market and the entities exchanged by those agents in their economic transactions. The agents are the vendor and its competitors on the supply side, and the customers on the demand side. The entities are product/service offerings sold in the market during the simulation. An offering is a product/service defined through a specific combination of attribute levels and with an attached price.

(1)Supply

Create/Edit own and competitive offerings

The diagram below depicts an exemplary sequence of operations with the Supply component.



Pricing Simulator - Activity Diagram Edit Offerings

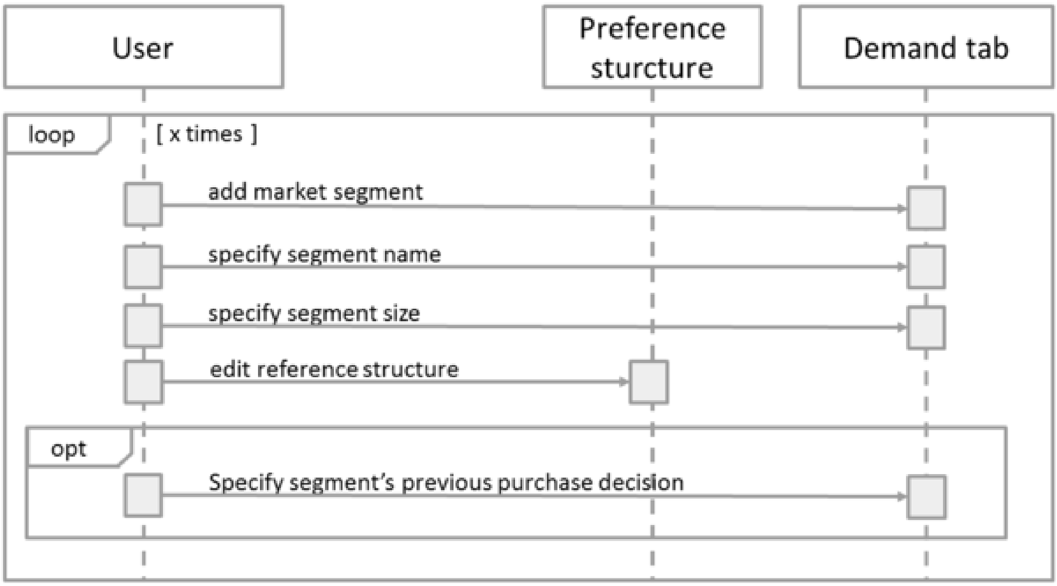
Setting a name for the user's own offering is the first step to specify the supply side of the market. If profit is among the desired decision variables, own offerings should also be characterized in terms of generated costs for the vendor using the appropriate fields to specify the fixed cost per period and the variable cost per user per period of the product/service. Finally, the offering has to be configured by selecting an attribute level for each attribute.

When the user's own offering has been described, competitors and their offerings can be described as well. In order to do this, the user must add a competitor-agent and give it a name. Then the user can add the competitor's offerings. The definition of such competitive offerings requires name, price level, and attributes configuration.

(2)Demand

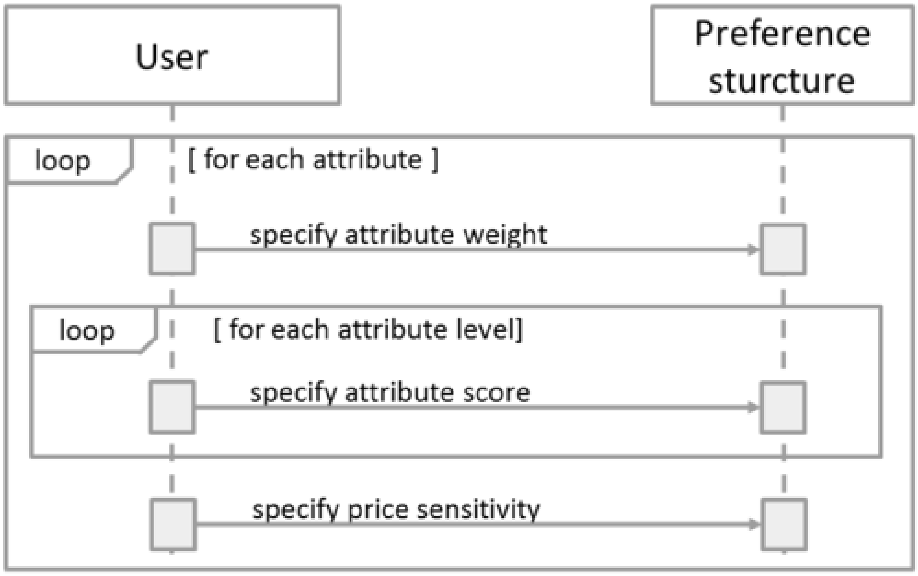
Create/Edit demand

The user has to define the demand side of the market as well, i.e., the market segmentation in terms of customer groups and their respective preference structures. A group of customers with a common preference structure is called a segment. For each segment an identification name and the size (the number of customers it includes) have to be entered by the user. The fundamental characteristic of a customer segment is its preference structure. A segment's preference structure can be easily configured by clicking on the edit button, which will open a pop-up window with the necessary configuration fields. A segment's preexistent adoption decision can be specified as well as selecting one among the offerings defined in the market model.



Pricing Simulator - Activity Diagram Edit Demand

In the preference structure an attribute weight for each attribute has to be set. The attribute weight describes how important for that specific user group this attribute is relative to other attributes. Furthermore, for qualitative attributes, a score must be entered for each attribute level. These values describe how different attribute levels rate against each other. For numerical attributes a mathematical function must be specified instead of discrete levels scores. The price has its own weight called price sensitivity.



Pricing Simulator - Activity Diagram Demand Preference

4.7.6.3 *Experiment*

Create/Edit an experiment

When the user has defined the attribute space and the market scenario, a simulation experiment can be configured and performed. The user is free to choose the length of the simulated period of time (field “execution length”) and the number of stochastic replications to be conducted in the experiment (field “number of runs”). The user can define an interval of prices (in a range between a minimum and a maximum price) to be evaluated. The price step field allows to set the granularity of the analysis (which will determine how many alternative price levels between the lower and upper bounds will be considered).

Pricing Simulator - Activity Diagram Edit Experiment

4.8 Basic Design Principles

- **API Technology Independence**

The Marketplace API is independent from implementation technology.

- **Interoperability and flexible use through HTTP content negotiation**

As described in the architecture, the Marketplace offers different interfaces in order to satisfy users' need to discover, compare, create, and update offerings. The Marketplace determines the right representation from information provided in the users’ header data, so a client can receive the best representation for its abilities.

- **Multiple store support**

The Marketplace GE is not limited to interact with one specific store. It supports multiple decoupled stores as long as they implement the marketplace interfaces for Registry and Offering & Demand.

4.9 Detailed Open Specifications

The optional Pricing Simulator Decision Support feature set of the marketplace GE is not exposed as a service but as a Rich Internet Application (tool), accessed through the end user's Web browser. Although some GE components are exposed as services, they only expose an API for internal consumption (within the GE), but it is not foreseen that they will be integrated by other GEs.

4.9.1 Open API Specifications

- FIWARE.OpenSpecification.Apps.MarketplaceRegistrationREST
- FIWARE.OpenSpecification.Apps.MarketplaceOfferingsREST
- FIWARE.OpenSpecification.Apps.MarketplaceSearchREST
- FIWARE.OpenSpecification.Apps.MarketplaceReviewAndRatingREST
- FIWARE.OpenSpecification.Apps.MarketplaceRecommendationREST

The Marketplace GE will access the Repository its REST API:

- FIWARE.OpenSpecification.Apps.RepositoryREST

4.9.2 Other Open Specifications

The data formats for the API rely on the Linked USDL specifications:

- Linked USDL Core Vocabulary
- Linked USDL Pricing Vocabulary
- Linked USDL Service Level Agreements Vocabulary
- Linked USDL Security Vocabulary

4.10 Re-utilised Technologies/Specifications

The Marketplace GE is based on RESTful Design Principles. The technologies and specifications used in this GE are:

- RESTful web services
- HTTP/1.1
- JSON and XML data serialization formats
- Linked USDL

4.11 Terms and definitions

This section comprises a summary of terms and definitions introduced during the previous sections. It intends to establish a vocabulary that will be help to carry out discussions internally and with third parties (e.g., Use Case projects in the EU FP7 Future Internet PPP). For a summary of terms and definitions managed at overall FI-WARE level, please refer to FIWARE Global Terms and Definitions

- **Aggregator (Role):** A Role that supports domain specialists and third-parties in aggregating services and apps for new and unforeseen opportunities and needs. It does so by providing the dedicated tooling for aggregating services at different levels: UI, service operation, business process or business object levels.
- **Application:** Applications in FI-WARE are composite services that have a IT supported interaction interface (user interface). In most cases consumers do not buy the application, instead they buy the right to use the application (user license).
- **Broker (Role):** The business network's central point of service access, being used to expose services from providers that are delivered through the Broker's service delivery functionality. The broker is the central instance for enabling monetization.
- **Business Element:** Core element of a business model, such as pricing models,

revenue sharing models, promotions, SLAs, etc.

- **Business Framework:** Set of concepts and assets responsible for supporting the implementation of innovative business models in a flexible way.
- **Business Model:** Strategy and approach that defines how a particular service/application is supposed to generate revenue and profit. Therefore, a Business Model can be implemented as a set of business elements which can be combined and customized in a flexible way and in accordance to business and market requirements and other characteristics.
- **Business Process:** Set of related and structured activities producing a specific service or product, thereby achieving one or more business objectives. An operational business process clearly defines the roles and tasks of all involved parties inside an organization to achieve one specific goal.
- **Business Role:** Set of responsibilities and tasks that can be assigned to concrete business role owners, such as a human being or a software component.
- **Channel:** Resources through which services are accessed by end users. Examples for well-known channels are Web sites/portals, web-based brokers (like iTunes, eBay and Amazon), social networks (like Facebook, LinkedIn and MySpace), mobile channels (Android, iOS) and work centers. The access mode to these channels is governed by technical channels like the Web, mobile devices and voice response, where each of these channels requires its own specific workflow.
- **Channel Maker (Role):** Supports parties in creating outlets (the Channels) through which services are consumed, i.e. Web sites, social networks or mobile platforms. The Channel Maker interacts with the Broker for discovery of services during the process of creating or updating channel specifications as well as for storing channel specifications and channeled service constraints in the Broker.
- **Composite Service (composition):** Executable composition of business back-end MACs (see MAC definition later in this list). Common composite services are either orchestrated or choreographed. Orchestrated compositions are defined by a centralized control flow managed by a unique process that orchestrates all the interactions (according to the control flow) between the external services that participate in the composition. Choreographed compositions do not have a centralized process, thus the services participating in the composition autonomously coordinate each other according to some specified coordination rules. Backend compositions are executed in dedicated process execution engines. Target users of tools for creating Composites Services are technical users with algorithmic and process management skills.
- **Consumer (Role):** Actor who searches for and consumes particular business functionality exposed on the Web as a service/application that satisfies her own needs.
- **Desktop Environment:** Multi-channel client platform enabling users to access and use their applications and services.
- **Event-driven Composition:** Components concerned with the composition of business logic, which is driven by asynchronous events. This implies run-time selection of MACs and the creation/modification of orchestration workflows based on composition logic defined at design-time and adapted to context and the state of the communication at run-time.

- **Front-end/Back-end Composition:** Front-end compositions define a front-end application as an aggregation of visual mashable application pieces (named as widgets, gadgets, portlets, etc.) and back-end services. Front-end compositions interact with end-users, in the sense that front-end compositions consume data provided by the end-users and provide data to them. Thus the front-end composition (or mashup) will have a direct influence on the application look and feel; every component will add a new user interaction feature. Back-end compositions define a back-end business service (also known as process) as an aggregation of backend services as defined for service composition term, the end-user being oblivious to the composition process. While back-end components represent atomization of business logic and information processing, front-end components represent atomization of information presentation and user interaction.
- **Gateway (Role):** The Gateway role enables linking between separate systems and services, allowing them to exchange information in a controlled way despite different technologies and authoritative realms. A Gateway provides interoperability solutions for other applications, including data mapping as well as run-time data store-forward and message translation. Gateway services are advertised through the Broker, allowing providers and aggregators to search for candidate gateway services for interface adaptation to particular message standards. The Mediation is the central generic enabler. Other important functionalities are eventing, dispatching, security, connectors and integration adaptors, configuration, and change propagation.
- **Hoster (Role):** Allows the various infrastructure services in cloud environments to be leveraged as part of provisioning an application in a business network. A service can be deployed onto a specific cloud using the Hoster’s interface. This enables service providers to re-host services and applications from their on-premise environments to cloud-based, on-demand environments to attract new users at much lower cost.
- **Marketplace:** Part of the business framework providing means for service providers, to publish their service offerings, and means for service consumers, to compare and select a specific service implementation. A marketplace can offer services from different stores and thus different service providers. The actual buying of a specific service is handled by the related service store.
- **Mashup:** Executable composition of front-end MACs. There are several kinds of mashups, depending on the technique of composition (spatial rearrangement, wiring, piping, etc.) and the MACs used. They are called application mashups when applications are composed to build new applications and services/data mash-ups if services are composed to generate new services. While composite service is a common term in backend services implementing business processes, the term ‘mashup’ is widely adopted when referring to Web resources (data, services and applications). Front-end compositions heavily depend on the available device environment (including the chosen presentation channels). Target users of mashup platforms are typically users without technical or programming expertise.
- **Mashable Application Component (MAC):** Functional entity able to be consumed executed or combined. Usually this applies to components that will offer not only their main behaviour but also the necessary functionality to allow further compositions with other components. It is envisioned that MACs will offer access, through applications and/or services, to any available FI-WARE resource or functionality, including

gadgets, services, data sources, content, and things. Alternatively, it can be denoted as ‘service component’ or ‘application component’.

- **Mediator:** A mediator can facilitate proper communication and interaction amongst components whenever a composed service or application is utilized. There are three major mediation area: Data Mediation (adapting syntactic and/or semantic data formats), Protocol Mediation (adapting the communication protocol), and Process Mediation (adapting the process implementing the business logic of a composed service).
- **Monetization:** Process or activity to provide a product (in this context: a service) in exchange for money. The Provider publishes certain functionality and makes it available through the Broker. The service access by the Consumer is being accounted, according to the underlying business model, and the resulting revenue is shared across the involved service providers.
- **Premise (Role):** On-Premise operators provide in-house or on-site solutions, which are used within a company (such as ERP) or are offered to business partners under specific terms and conditions. These systems and services are to be regarded as external and legacy to the FI-Ware platform, because they do not conform to the architecture and API specifications of FI-WARE. They will only be accessible to FI-WARE services and applications through the Gateway.
- **Prosumer:** A user role able to produce, share and consume their own products and modify/adapt products made by others.
- **Provider (Role):** Actor who publishes and offers (provides) certain business functionality on the Web through a service/application endpoint. This role also takes care of maintaining this business functionality.
- **Registry and Repository:** Generic enablers that able to store models and configuration information along with all the necessary meta-information to enable searching, social search, recommendation and browsing, so end users as well as services are able to easily find what they need.
- **Revenue Settlement:** Process of transferring the actual charges for specific service consumption from the consumer to the service provider.
- **Revenue Sharing:** Process of splitting the charges of particular service consumption between the parties providing the specific service (composition) according to a specified revenue sharing model.
- **Service:** We use the term service in a very general sense. A service is a means of delivering value to customers by facilitating outcomes customers want to achieve without the ownership of specific costs and risks. Services could be supported by IT. In this case we say that the interaction with the service provider is through a technical interface (for instance a mobile app user interface or a Web service). Applications could be seen as such IT supported Services that often are also composite services.
- **Service Composition:** in SOA domain, a service composition is an added value service created by aggregation of existing third party services, according to some predefined work and data flow. Aggregated services provide specialized business functionality, on which the service composition functionality has been split down.
- **Service Delivery Framework:** Service Delivery Framework (or Service Delivery Platform (SDP)) refers to a set of components that provide service delivery functionality (such as service creation, session control & protocols) for a type of

service. In the context of FI-WARE, it is defined as a set of functional building blocks and tools to (1) manage the lifecycle of software services, (2) creating new services by creating service compositions and mashups, (3) providing means for publishing services through different channels on different platforms, (4) offering marketplaces and stores for monetizing available services and (5) sharing the service revenues between the involved service providers.

- **Service Level Agreement (SLA):** A service level agreement is a legally binding and formally defined service contract, between a service provider and a service consumer, specifying the contracted qualitative aspects of a specific service (e.g. performance, security, privacy, availability or redundancy). In other words, SLAs not only specify that the provider will just deliver some service, but that this service will also be delivered on time, at a given price, and with money back if the pledge is broken.
- **Service Orchestration:** in SOA domain, a service orchestration is a particular architectural choice for service composition where a central orchestrated process manages the service composition work and data flow invocations of the external third party services in the order determined by the work flow. Service orchestrations are specified by suitable orchestration languages and deployed in execution engines who interpret these specifications.
- **Store:** An external component integrated with the business framework, offering a set of services that are published to a selected set of marketplaces. The store thereby holds the service portfolio of a specific service provider. In case a specific service is purchased on a service marketplace, the service store handles the actual buying of a specific service (as a financial business transaction).
- **Unified Service Description Language (USDL):** USDL is a platform-neutral language for describing services, covering a variety of service types, such as purely human services, transactional services, informational services, software components, digital media, platform services and infrastructure services. The core set of language modules offers the specification of functional and technical service properties, legal and financial aspects, service levels, interaction information and corresponding participants. USDL is offering extension points for the derivation of domain-specific service description languages by extending or changing the available language modules.

5 FIWARE OpenSpecification Apps Marketplace Registration REST

You can find the content of this chapter as well in the wiki of fi-ware.

5.1 Introduction to the *Marketplace Registration* API

Please check the following **FI-WARE Open Specification Legal Notice (essential patents license)** to understand the rights to use this open specification. As all other FI-WARE members, SAP has chosen one of the two FI-WARE license schemes for open specifications.

To illustrate this open specification license from our SAP perspective:

- SAP provides the specifications of this Generic Enabler available under IPR rules that allow for a exploitation and sustainable usage both in Open Source as well as proprietary, closed source products to maximize adoption.
- This Open Specification is exploitable for proprietary 3rd party products and is exploitable for open source 3rd party products, including open source licenses that require patent pledges.
- If the owner (SAP) of this GE spec holds a patent that is essential to create a conforming implementation of the GE spec (i.e. it is impossible to write a conforming implementation without violating the patent) then a license to that patent is deemed granted to the implementation.

5.1.1 Marketplace Registration Core

The Marketplace Registration is a RESTful, resource-oriented API accessed via HTTP that uses various representations for information interchange. The Marketplace Registration Component takes care of registering, updating, and deleting information about market relevant entities such as stores and marketplace participants.

5.1.2 Intended Audience

This specification is intended for both software developers and reimplementers of this API. For the former, this document provides a full specification of how to interoperate with products that implement the Repository API. For the latter, this specification indicates the interface to be implemented and provided to clients.

To use this information, the reader should firstly have a general understanding of the Generic Enabler service Marketplace. You should also be familiar with:

- RESTful web services
- HTTP/1.1
- JSON and/or XML data serialization formats.
- RDF, TURTLE and Atom

5.1.3 API Change History

This version of the Marketplace Registration API Guide replaces and obsoletes all previous versions. The most recent changes are described in the table below:

Revision Date	Changes Summary
Apr 25, 2012	• Initial version
Apr 03, 2014	• Final version

5.1.4 How to Read This Document

It is assumed that the reader is familiar with the REST architecture style. Within the document, some special notations are applied to differentiate some special words or concepts. The following list summarizes these special notations.

- A bold, mono-spaced font is used to represent code or logical entities, e.g., HTTP method (`GET`, `PUT`, `POST`, `DELETE`).
- An italic font is used to represent document titles or some other kind of special text, e.g., *URI*.
- Variables are represented between brackets, e.g. {id} and in italic font. The reader can replace the id with an appropriate value.

For a description of some terms used along this document, see Marketplace.

5.1.5 Additional Resources

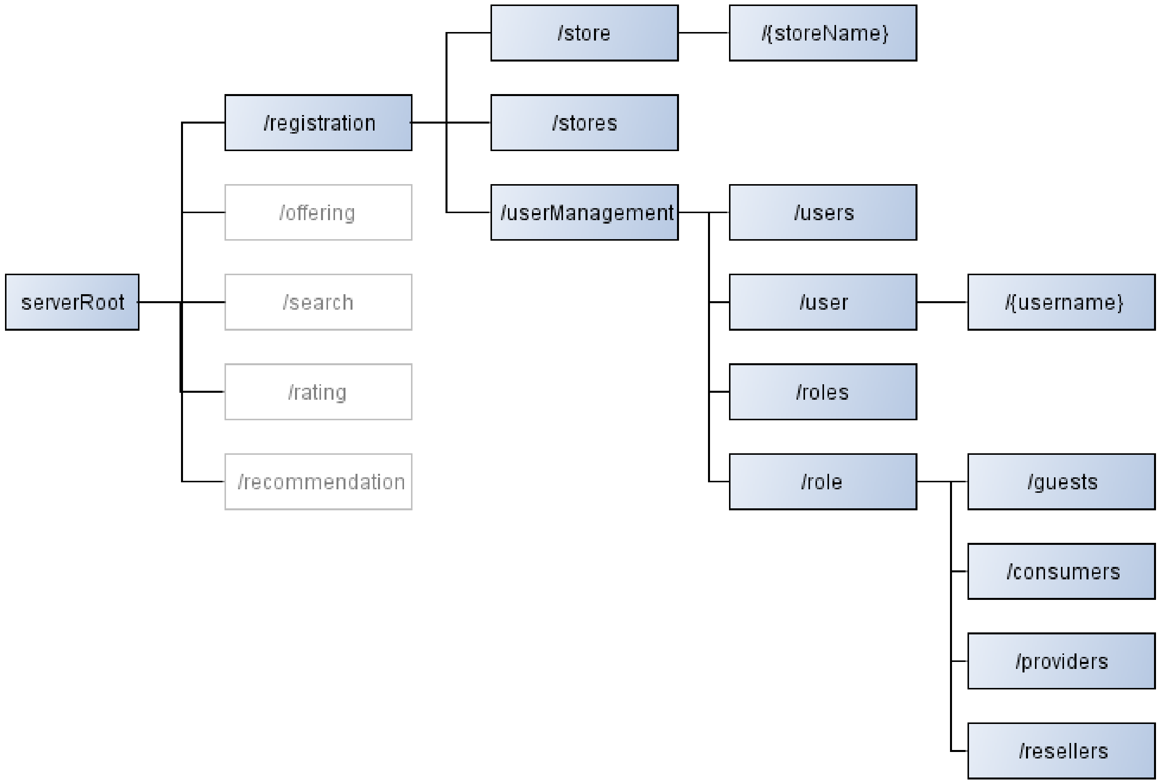
You can download the most current version of this document from the FI-WARE API specification website at **Marketplace Registration API** . For more details about the Marketplace GE that this API is based upon, please refer to High Level Description. Related documents, including an Architectural Description, are available at the same site.

5.2 General *Marketplace Registration* API Information

The Marketplace GE is structured into five core components. These components are Registry & Directory, Offering & Demand, Discovery & Matching, Recommendation, and the Review and Rating component. The API for the Registry & Directory component is described in this document.

5.2.1 Resources Summary

The Registry and Directory component holds information of registered stores, participants and their role(vendors, buyers, resellers, ...) and takes care of registering, updating, and deleting information about market relevant entities.



5.2.2 Authentication

Each HTTP request against the *Marketplace Registration API* requires the inclusion of specific authentication credentials (e.g. basic HTTP authentication). The specific implementation of this API may support multiple authentication schemes (OAuth, Basic Auth, Token) and will be determined by the specific provider that implements the GE. Please contact with it to determine the best way to authenticate against this API. Remember that some authentication schemes may require that the API operate using SSL over HTTP (HTTPS).

5.2.3 Representation Format

The *Marketplace Offering* API supports at least XML and JSON for delivering any kind of resources, it may also support simple text and HTML output format. The request format is specified using the Content-Type header and is required for operations that have a request body. The response format can be specified in requests using the Accept header. Note that it is possible for a response to be serialized using a format different from the request (see example below).

If no Content-Type is specified, the content is delivered in the format that was choosen to upload the resource.

The interfaces should support data exchange through multiple formats:

- *text/plain* - A linefeed separated list of elements for easy mashup and scripting.
- *text/html* - An human-readable HTML rendering of the results of the operation as output format.

- *application/json* - A JSON representation of the input and output for mashups or JavaScript-based Web Apps
- *application/xml* - A XML description of the input and output.

In a concrete implementation of this GE other formats like RSS, Atom, etc. may also be possible.

5.2.4 Representation Transport

Resource representation is transmitted between client and server by using HTTP 1.1 protocol, as defined by IETF RFC-2616. Each time an HTTP request contains payload, a Content-Type header shall be used to specify the MIME type of wrapped representation. In addition, both client and server may use as many HTTP headers as they consider necessary.

5.2.5 Resource Identification

The resource identification for HTTP transport is made using the mechanisms described by HTTP protocol specification as defined by IETF RFC-2616.

5.2.6 Links and References

5.2.6.1 *Web citizen*

The Marketplace Registration is relying on Web principles:

- URI to identify resources
- consistent URI structure based on REST style protocol
- HTTP content negotiation to allow the client to choose the appropriate data format supporting HTML, RDF, XML, RSS, JSON, Turtle, ...
- Human readable output format using HTML rendering ('text/html' accept header) including hyperlinked representation
- Use of HTTP response codes including ETags (proper caching)
- Linked Data enablement supporting RDF input and output types

5.2.6.2 *Linked Open Data*

Publishing data as linked data requires every resource to be directly resolvable given their URL. The basic idea of Linked Data is simple. Tim Berners-Lee's note on Linked Data describes four rules for publishing data on the Web:

- Use URIs as names for things
- Use HTTP URIs so that people can look up those names.
- When someone looks up a URI, provide useful information, using the standards (RDF*, SPARQL)
- Include links to other URIs, so that they can discover more things.

This can actually achieved by different approaches. One is the use of a special resolver similar to URL shorteners.

So the authoring environment has to ensure that every URI (actually IRI - Internationalized Resource Identifiers - RFC 3987) can be resolved by a HTTP `GET` request. For example: If a

resource is maintained in a Marketplace Registration under the URL http://marketplaceRegistration.acme.com/service/xyz but the IRI used in service descriptions is actually http://fi-ware.org/service/xyz, we need a resolver at this location which redirects the request to the actual Marketplace Registration.
Setting up resolvers is more complex task. Therefore we try to follow a simpler approach for the USDLMarketplace RegistrationRest. The API is designed to be directly used for Linked Data publishing without the need for a resolver.

5.2.7 Paginated Result Lists

In order to reduce the load on the service, we can decide to limit the number of elements to return when it is too big. This section explain how to do that using for example a limit parameter (optional) and a last parameter (optional) to express which is the maximum number of element to return and which was the last element to see.
These operations will have to cope with the possibility to have over limit fault (413) or item not found fault (404).

5.2.8 Limits

We can manage the capacity of the system in order to prevent the abuse of the system through some limitations. These limitations will be configured by the operator and may differ from one implementation to other of the GE implementation.

5.2.8.1 *Rate Limits*

These limits are specified both in human readable wild-card and in regular expressions and will indicate for each HTTP verb which will be the maximum number of operations per time unit that a user can request. After each unit time the counter is initialized again. In the event a request exceeds the thresholds established for your account, a 413 HTTP response will be returned with a Retry-After header to notify the client when they can attempt to try again.

5.2.9 ETag Handling

For standard caching an ETag HTTP header is provided for `GET` and `PUT` requests. If a `GET` requests has a "If-None-Match" header, than the content is only delivered if the stored ETag of the object matches the requested ETag. HTTP status code 304 (not changed) is responded otherwise.
For `PUT` requests the ETag header can be used to ensure integrity of the repository. The `PUT` operation will only be executed if the "If-Match" header matches the stored ETag of the resource in the repository. If no "If-Match" header is given for an existing resource or the "If-Match" header does not match the existing ETag of the resource, status code 409 (Conflict)will be returned. If the resource was changed, then a new ETag header will be returned in the response header.

5.2.10 Extensions

The Marketplace could be extended in the future. At the moment, we foresee the following resource to indicate a method that will be used in order to allow the extensibility of the API. This allow the introduction of new features in the API without requiring an update of the version, for instance, or to allow the introduction of vendor specific functionality.

Verb	URI	Description
GET	/extensions	List of all available extensions

5.2.11 Faults

5.2.11.1 *Synchronous Faults*

Error codes are returned in the body of the response. The description section returns a human-readable message for displaing end users.

Example:

```
<exception>
	<description>Resource Not found</description>
	<errorCode>404</errorCode>
	<reasonPhrase>Not Found</reasonPhrase>
</exception>
```

Fault Element	Associated Error Codes	Expected in All Requests?
Unauthorized	403	YES
Not Found	404	YES
Limit Fault	413	YES
Internal Server error	50X	YES

5.3 API Operations

5.3.1 Managing Stores

Here we start with the description of the operation following the next table:

Verb	URI	Additional Path Parameters	Description

GET	/registration/stores/	filter, index, limit	Get a list of all registered stores
GET	/registration/store/{StoreName}	-	Get a specific store
PUT	/registration/store/{StoreName}	-	Create a store
POST	/registration/store/{StoreName}	-	Update store information
DELETE	/registration/store/{StoreName}	-	Unregister a store

A Filter expression, a limit and a starting index are supported for the */registration/stores/* operation to reduce the number of results. If no filter expression is given then all users are returned.

- *filter* - Optional filter expression to reduce the number of delivered results.
- *index* - Index of the first rating to be returned.
- *limit* - Maximal number of results to be returned.

Example:

```
http://[SERVER_URL]?filter=name:Simth*&index=20&limit=10
```

5.3.2 Managing Marketplace Participants

5.3.2.1 *Marketplace Participant*

Verb	URI	Additional Path Parameters	Description
GET	/registration/userManagement/users/	filter, index, limit	Get a list of all registered marketplace participants
GET	/registration/userManagement/user/{username}	-	Get a specific marketplace participant
PUT	/registration/userManagement/user/{username}	-	Create a marketplace participant
POST	/registration/userManagement/user/{username}	-	Update a marketplace participant
DELETE	/registration/userManagement/user/{username}	-	Unregister a marketplace participant

A Filter expression, a limit and a starting index are supported for the */userManagement/users/* operation to reduce the number of results. If no filter expression is given then all users are returned.

- *filter* - Optional filter expression to reduce the number of delivered results.

- *index* - Index of the first rating to be returned.
- *limit* - Maximal number of results to be returned.

Example:

```
http://[SERVER_URL]?filter=name:Simth*&index=20&limit=10
```

5.3.2.2 *Marketplace Participants by Role*

Verb	URI	Additional Path Parameters	Description
GET	/registration/userManagement/roles/	filter, index, limit	Get a list of all marketplace participant roles
GET	/registration/userManagement/roles?role=guest	filter, index, limit	Get all marketplace participants with the role guest
GET	/registration/userManagement/roles?role=consumer	filter, index, limit	Get all marketplace participants with the role consumer
GET	/registration/userManagement/roles?role=provider	filter, index, limit	Get all marketplace participants with the role provider
GET	/registration/userManagement/roles?role=reseller	filter, index, limit	Get all marketplace participants with the role reseller

A Filter expression, a limit and a starting index are supported for all *Marketplace Participants by Role* operations to reduce the number of results. If no filter expression is given then all users are returned.

- *filter* - Optional filter expression to reduce the number of delivered results.
- *index* - Index of the first rating to be returned.
- *limit* - Maximal number of results to be returned.

Example:

```
http://[SERVER_URL]?filter=name:Simth*&index=20&limit=10
```

5.3.3 Status Codes

200 OK

The request was handled successfully and transmitted in response message.

201 Created

The request has been fulfilled and resulted in a new resource being created.

204 No Content

The server successfully processed the request, but is not returning any content.

304 Not Modified

Indicates the resource has not been modified since last requested. Typically, the HTTP client provides a header like the If-Modified-Since header to provide a time against which to compare. Using this saves bandwidth and reprocessing on both the server and client, as only the header data must be sent and received in comparison to the entirety of the page being re-processed by the server, then sent again using more bandwidth of the server and client.

400 Bad Request

The request cannot be fulfilled due to bad syntax.

404 Not Found

The requested resource could not be found but may be available again in the future. Subsequent requests by the client are permissible.

409 Conflict

Indicates that the request could not be processed because of conflict in the request, such as an edit conflict.

500 Internal Server Error

A generic error message, given when no more specific message is suitable.

6 FIWARE OpenSpecification Apps Marketplace Offerings REST

You can find the content of this chapter as well in the wiki of fi-ware.

6.1 Introduction to the *Marketplace Offering* API

Please check the following **FI-WARE Open Specification Legal Notice (essential patents license)** to understand the rights to use this open specification. As all other FI-WARE members, SAP has chosen one of the two FI-WARE license schemes for open specifications.

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6.1.1 Marketplace Offering Core

The Marketplace Offering API is a RESTful, resource-oriented API accessed via HTTP that uses various representations for information interchange. The Marketplace Offerings Component is responsible for exchanging service offerings with stores and making them public to potential customers.

6.1.2 Intended Audience

This specification is intended for both software developers and reimplementers of this API. For the former, this document provides a full specification of how to interoperate with products that implement the Repository API. For the latter, this specification indicates the interface to be implemented and provided to clients.

To use this information, the reader should firstly have a general understanding of the Generic Enabler service Marketplace. You should also be familiar with:

- RESTful web services
- HTTP/1.1
- JSON and/or XML data serialization formats.
- RDF, TURTLE and Atom

6.1.3 API Change History

This version of the Marketplace Offering API Guide replaces and obsoletes all previous versions. The most recent changes are described in the table below:

Revision Date	Changes Summary
Apr 25, 2012	• Initial version
Apr 21, 2014	• Final version

6.1.4 How to Read This Document

It is assumed that the reader is familiar with the REST architecture style. Within the document, some special notations are applied to differentiate some special words or concepts. The following list summarizes these special notations.

- A bold, mono-spaced font is used to represent code or logical entities, e.g., HTTP method (`GET, PUT, POST, DELETE`).
- An italic font is used to represent document titles or some other kind of special text, e.g., *URI*.
- Variables are represented between brackets, e.g. {id} and in italic font. The reader can replace the id with an appropriate value.

For a description of some terms used along this document, see Marketplace.

6.1.5 Additional Resources

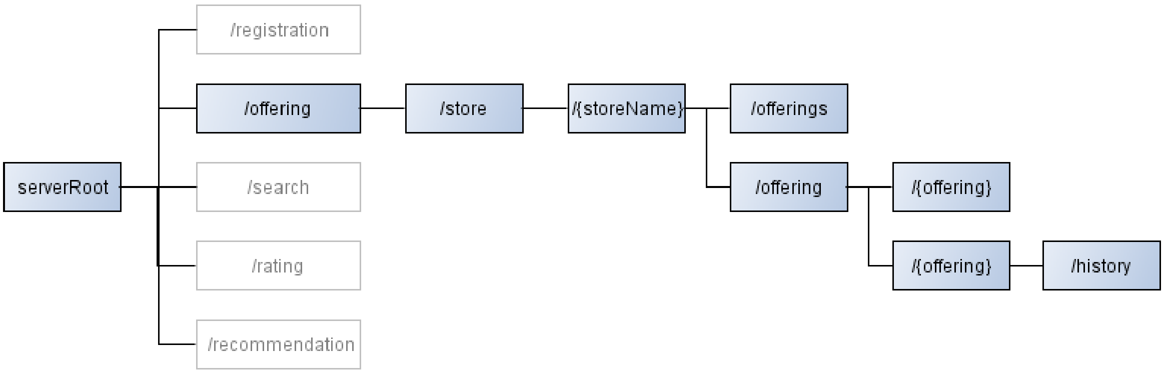
You can download the most current version of this document from the FI-WARE API specification website at **Marketplace Offerings API** . For more details about the Marketplace GE that this API is based upon, please refer to High Level Description. Related documents, including an Architectural Description, are available at the same site.

6.2 General *Marketplace Offering* API Information

The Marketplace GE is structured into five core components. These components are Registry & Directory, Offering & Demand, Discovery & Matching, Recommendation, and the Review and Rating component. The API for the Offering & Demand component is described in this document.

6.2.1 Resources Summary

A service offering consists of a link to a concrete USDL description, a pricing model and the classification of the service. The Offering component is responsible for exchanging service offerings with stores and version handling/archiving of out-dated offerings. Symmetrically to offerings also the demand side of the marktet need to be represented. A service demand according to expected functionality, pricing and service levels might be expressed, classified and published to the marketplace.



6.2.2 Authentication

Each HTTP request against the *Marketplace Offering API* requires the inclusion of specific authentication credentials. The specific implementation of this API may support multiple authentication schemes (OAuth, Basic Auth, Token) and will be determined by the specific provider that implements the GE. Please contact with it to determine the best way to authenticate against this API. Remember that some authentication schemes may require that the API operate using SSL over HTTP (HTTPS).

6.2.3 Representation Format

The *Marketplace Offering* API supports at least XML and JSON for delivering any kind of resources, it may also support simple text and HTML output format. The request format is specified using the Content-Type header and is required for operations that have a request body. The response format can be specified in requests using the Accept header. Note that it is possible for a response to be serialized using a format different from the request (see example below).

If no Content-Type is specified, the content is delivered in the format that was chosen to upload the resource.

The interfaces should support data exchange through multiple formats:

- *text/plain* - A linefeed separated list of elements for easy mashup and scripting.
- *text/html* - An human-readable HTML rendering of the results of the operation as output format.
- *application/json* - A JSON representation of the input and output for mashups or JavaScript-based Web Apps
- *application/xml* - A XML description of the input and output.

In a concrete implementation of this GE other formats like RSS, Atom, etc. may also be possible.

6.2.4 Representation Transport

Resource representation is transmitted between client and server by using HTTP 1.1 protocol, as defined by IETF RFC-2616. Each time an HTTP request contains payload, a

Content-Type header shall be used to specify the MIME type of wrapped representation. In addition, both client and server may use as many HTTP headers as they consider necessary.

6.2.5 Resource Identification

The resource identification for HTTP transport is made using the mechanisms described by HTTP protocol specification as defined by IETF RFC-2616.

6.2.6 Links and References

6.2.6.1 *Web citizen*

The Marketplace Offering is relying on Web principles:

- URI to identify resources
- consistent URI structure based on REST style protocol
- HTTP content negotiation to allow the client to choose the appropriate data format supporting HTML, RDF, XML, RSS, JSON, Turtle, ...
- Human readable output format using HTML rendering ('text/html' accept header) including hyperlinked representation
- Use of HTTP response codes including ETags (proper caching)
- Linked Data enablement supporting RDF input and output types

6.2.6.2 *Linked Open Data*

Publishing data as linked data requires every resource to be directly resolvable given their URL. The basic idea of Linked Data is simple. Tim Berners-Lee's note on Linked Data describes four rules for publishing data on the Web:

- Use URIs as names for things
- Use HTTP URIs so that people can look up those names.
- When someone looks up a URI, provide useful information, using the standards (RDF*, SPARQL)
- Include links to other URIs, so that they can discover more things.

This can actually achieved by different approaches. One is the use of a special resolver similar to URL shorteners.

So the authoring environment has to ensure that every URI (actually IRI - Internationalized Resource Identifiers - RFC 3987) can be resolved by a HTTP `GET` request. For example: If a resource is maintained in a Marketplace Offering under the URL http://marketplaceOffering.acme.com/service/xyz but the IRI used in service descriptions is actually http://fi-ware.org/service/xyz, we need a resolver at this location which redirects the request to the actual Marketplace Offering.

Setting up resolvers is more complex task. Therefore we try to follow a simpler approach for the USDLMarketplace OfferingRest. The API is designed to be directly used for Linked Data publishing without the need for a resolver.

6.2.7 Paginated Result Lists

In order to reduce the load on the service, we can decide to limit the number of elements to return when it is too big. This section explain how to do that using for example a limit parameter (optional) and a last parameter (optional) to express which is the maximum number of element to return and which was the last element to see.
These operations will have to cope with the possibility to have over limit fault (413) or item not found fault (404).

6.2.8 Limits

We can manage the capacity of the system in order to prevent the abuse of the system through some limitations. These limitations will be configured by the operator and may differ from one implementation to other of the GE implementation.

6.2.8.1 *Rate Limits*

These limits are specified both in human readable wild-card and in regular expressions and will indicate for each HTTP verb which will be the maximum number of operations per time unit that a user can request. After each unit time the counter is initialized again. In the event a request exceeds the thresholds established for your account, a 413 HTTP response will be returned with a Retry-After header to notify the client when they can attempt to try again.

6.2.9 ETag Handling

For standard caching an ETag HTTP header is provided for `GET` and `PUT` requests. If a `GET` requests has a "If-None-Match" header, than the content is only delivered if the stored ETag of the object matches the requested ETag. HTTP status code 304 (not changed) is responded otherwise.
For `PUT` requests the ETag header can be used to ensure integrity of the repository. The `PUT` operation will only be executed if the "If-Match" header matches the stored ETag of the resource in the repository. If no "If-Match" header is given for an existing resource or the "If-Match" header does not match the existing ETag of the resource, status code 409 (Conflict)will be returned. If the resource was changed, then a new ETag header will be returned in the response header.

6.2.10 Extensions

The Marketplace could be extended in the future. At the moment, we foresee the following resource to indicate a method that will be used in order to allow the extensibility of the API. This will allow the introduction of new features in the API without requiring an update of the version, for instance, or to allow the introduction of vendor specific functionality.

Verb	URI	Description
GET	/extensions	List of all available extensions

6.2.11 Faults

6.2.11.1 *Synchronous Faults*

Error codes are returned in the body of the response. The description section returns a human-readable message for displaing end users.
Example:

```
<exception>
        <description>Resource Not found</description>
        <errorCode>404</errorCode>
        <reasonPhrase>Not Found</reasonPhrase>
</exception>
```

Fault Element	Associated Error Codes	Expected in All Requests?
Unauthorized	403	YES
Not Found	404	YES
Limit Fault	413	YES
Internal Server error	50X	YES

6.3 API Operations

6.3.1 Managing Offerings

Here we start with the description of the operation following the next table:

Verb	URI	Additional Path Parameters	Description
GET	/offering/	filter, index, limit	Get a list of all offerings
GET	/offering/store/{storeName}/offerings	filter, index, limit	Get a list of all offerings from a specific store
GET	/offering/store/{storeName}/offering/{offering}	-	Get a specific offering
GET	/offering/store/{storeName}/offering/{offering}/history	version	Get the history of a specific offering

PUT	/offering/store/{storeName}/offering/{offering}	-	Create a new offering (offering information in body)
POST	/offering/store/{storeName}/offering/{offering}	-	Update offering information, creates a new version
DELETE	/offering/store/{storeName}/offering/{offering}	-	disables an offering

A Filter expression, a limit and a starting index are supported for the */offerings/* and the */offerings/store/{storeName}/offerings* operation to reduce the number of results. If no filter expression is given then all users are returned.

- *filter* - Optional filter expression to reduce the number of delivered results.
- *index* - Index of the first rating to be returned.
- *limit* - Maximal number of results to be returned.

Example:

```
http://[SERVER_URL]?filter=name:Simth*&index=20&limit=10
```

6.3.2 Status Codes

200 OK

The request was handled successfully and transmitted in response message.

201 Created

The request has been fulfilled and resulted in a new resource being created.

204 No Content

The server successfully processed the request, but is not returning any content.

304 Not Modified

Indicates the resource has not been modified since last requested. Typically, the HTTP client provides a header like the If-Modified-Since header to provide a time against which to compare. Using this saves bandwidth and reprocessing on both the server and client, as only the header data must be sent and received in comparison to the entirety of the page being re-processed by the server, then sent again using more bandwidth of the server and client.

400 Bad Request

The request cannot be fulfilled due to bad syntax.

404 Not Found

The requested resource could not be found but may be available again in the future. Subsequent requests by the client are permissible.

409 Conflict

Indicates that the request could not be processed because of conflict in the request, such as an edit conflict.

500 Internal Server Error

A generic error message, given when no more specific message is suitable.

7 FIWARE OpenSpecification Apps Marketplace Search REST

You can find the content of this chapter as well in the wiki of fi-ware.

7.1 Introduction to the *Marketplace Search* API

Please check the following **FI-WARE Open Specification Legal Notice (essential patents license)** to understand the rights to use this open specification. As all other FI-WARE members, SAP has chosen one of the two FI-WARE license schemes for open specifications.

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- If the owner (SAP) of this GE spec holds a patent that is essential to create a conforming implementation of the GE spec (i.e. it is impossible to write a conforming implementation without violating the patent) then a license to that patent is deemed granted to the implementation.

7.1.1 Marketplace Search Core

The Marketplace Search API is a RESTful, resource-oriented API accessed via HTTP that uses various representations for information interchange. The Marketplace Search Component provides functionality to search the marketplace for concrete offerings.

7.1.2 Intended Audience

This specification is intended for both software developers and reimplementers of this API. For the former, this document provides a full specification of how to interoperate with products that implement the Repository API. For the latter, this specification indicates the interface to be implemented and provided to clients.

To use RESTful information, the reader should firstly have a general understanding of the Generic Enabler service Marketplace. You should also be familiar with:

- ReSTful web services
- HTTP/1.1
- JSON and/or XML data serialization formats.
- RDF, TURTLE and Atom

7.1.3 API Change History

This version of the Marketplace Search API Guide replaces and obsoletes all previous versions. The most recent changes are described in the table below:

Revision Date	Changes Summary
Apr 25, 2012	• Initial version
Apr 03, 2014	• Final version

7.1.4 How to Read This Document

It is assumed that the reader is familiar with the REST architecture style. Within the document, some special notations are applied to differentiate some special words or concepts. The following list summarizes these special notations.

- A bold, mono-spaced font is used to represent code or logical entities, e.g., HTTP method (`GET, PUT, POST, DELETE`).
- An italic font is used to represent document titles or some other kind of special text, e.g., *URI*.
- Variables are represented between brackets, e.g. {id} and in italic font. The reader can replace the id with an appropriate value.

For a description of some terms used along this document, see Marketplace.

7.1.5 Additional Resources

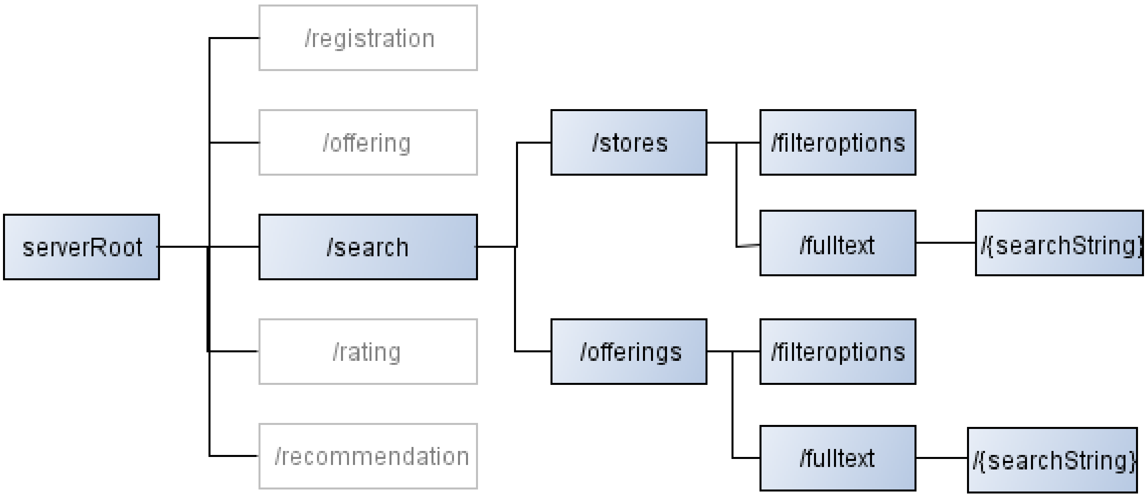
You can download the most current version of this document from the FI-WARE API specification website at **Marketplace Search API** . For more details about the Marketplace GE that this API is based upon, please refer to High Level Description. Related documents, including an Architectural Description, are available at the same site.

7.2 General *Marketplace Search* API Information

The Marketplace GE is structured into five core components. These components are Registry & Directory, Offering & Demand, Discovery & Matching, Recommendation, and the Review and Rating component. The API for the Discovery & Matching component is described in this document.

7.2.1 Resources Summary

The Discovery and Matching component primarily supports customers finding offerings and storing their matched needs. In both cases the *Marketplace Search* API supports freetext search as well as attributed search.



7.2.2 Authentication

Each HTTP request against the *Marketplace Search API* requires the inclusion of specific authentication credentials. The specific implementation of this API may support multiple authentication schemes (OAuth, Basic Auth, Token) and will be determined by the specific provider that implements the GE. Please contact with it to determine the best way to authenticate against this API. Remember that some authentication schemes may require that the API operate using SSL over HTTP (HTTPS).

7.2.3 Representation Format

The *Marketplace Offering* API supports at least XML and JSON for delivering any kind of resources, it may also support simple text and HTML output format. The request format is specified using the Content-Type header and is required for operations that have a request body. The response format can be specified in requests using the Accept header. Note that it is possible for a response to be serialized using a format different from the request (see example below).

If no Content-Type is specified, the content is delivered in the format that was chosen to upload the resource.

The interfaces should support data exchange through multiple formats:

- *text/plain* - A linefeed separated list of elements for easy mashup and scripting.
- *text/html* - An human-readable HTML rendering of the results of the operation as output format.
- *application/json* - A JSON representation of the input and output for mashups or JavaScript-based Web Apps
- *application/xml* - A XML description of the input and output.

In a concrete implementation of this GE other formats like RSS, Atom, etc. may also be possible.

7.2.4 Representation Transport

Resource representation is transmitted between client and server by using HTTP 1.1 protocol, as defined by IETF RFC-2616. Each time an HTTP request contains payload, a Content-Type header shall be used to specify the MIME type of wrapped representation. In addition, both client and server may use as many HTTP headers as they consider necessary.

7.2.5 Resource Identification

The resource identification for HTTP transport is made using the mechanisms described by HTTP protocol specification as defined by IETF RFC-2616.

7.2.6 Links and References

7.2.6.1 *Web citizen*

The Marketplace Search is relying on Web principles:

- URI to identify resources
- consistent URI structure based on REST style protocol
- HTTP content negotiation to allow the client to choose the appropriate data format supporting HTML, RDF, XML, RSS, JSON, Turtle, ...
- Human readable output format using HTML rendering ('text/html' accept header) including hyperlinked representation
- Use of HTTP response codes including ETags (proper caching)
- Linked Data enablement supporting RDF input and output types

7.2.6.2 *Linked Open Data*

Publishing data as linked data requires every resource to be directly resolvable given their URL. The basic idea of Linked Data is simple. Tim Berners-Lee's note on Linked Data describes four rules for publishing data on the Web:

- Use URIs as names for things
- Use HTTP URIs so that people can look up those names.
- When someone looks up a URI, provide useful information, using the standards (RDF*, SPARQL)
- Include links to other URIs, so that they can discover more things.

This can actually achieved by different approaches. One is the use of a special resolver similar to URL shorteners.

So the authorizing environment has to ensure that every URI (actually IRI - Internationalized Resource Identifiers - [RFC 3987](RFC 3987)) can be resolved by a HTTP `GET` request. For example: If a resource is maintained in a Marketplace Search under the URL http://marketplaceSearch.acme.com/service/xyz but the IRI used in service descriptions is actually http://fi-ware.org/service/xyz, we need a resolver at this location which redirects the request to the actual Marketplace Search.

Setting up resolvers is a more complex task. Therefore we try to follow a simpler approach for the USDLMarketplace SearchRest. The API is designed to be directly used for Linked Data publishing without the need for a resolver.

7.2.7 Paginated Result Lists

In order to reduce the load on the service, we can decide to limit the number of elements to return when it is too big. This section explain how to do that using for example a limit parameter (optional) and a last parameter (optional) to express which is the maximum number of element to return and which was the last element to see. These operations will have to cope with the possibility to have over limit fault (413) or item not found fault (404).

7.2.8 Limits

We can manage the capacity of the system in order to prevent the abuse of the system through some limitations. These limitations will be configured by the operator and may differ from one implementation to other of the GE implementation.

7.2.8.1 *Rate Limits*

These limits are specified both in human readable wild-card and in regular expressions and will indicate for each HTTP verb which will be the maximum number of operations per time unit that a user can request. After each unit time the counter is initialized again. In the event a request exceeds the thresholds established for your account, a 413 HTTP response will be returned with a Retry-After header to notify the client when they can attempt to try again.

7.2.9 ETag Handling

For standard caching an ETag HTTP header is provided for `GET` and `PUT` requests. If a `GET` requests has a "If-None-Match" header, than the content is only delivered if the stored ETag of the object matches the requested ETag. HTTP status code 304 (not changed) is responded otherwise.

For `PUT` requests the ETag header can be used to ensure integrity of the repository. The `PUT` operation will only be executed if the "If-Match" header matches the stored ETag of the resource in the repository. If no "If-Match" header is given for an existing resource or the "If-Match" header does not match the existing ETag of the resource, status code 409 (Conflict)will be returned. If the resource was changed, then a new ETag header will be returned in the response header.

7.2.10 Extensions

The Marketplace could be extended in the future. At the moment, we foresee the following resource to indicate a method that will be used in order to allow the extensibility of the API. This will allow the introduction of new features in the API without requiring an update of the version, for instance, or to allow the introduction of vendor specific functionality.

Verb	URI	Description
GET	/extensions	List of all available extensions

7.2.11 Faults

7.2.11.1 *Synchronous Faults*

Error codes are returned in the body of the response. The description section returns a human-readable message for displaing end users.
Example:

```
<exception>
	<description>Resource Not found</description>
	<errorCode>404</errorCode>
	<reasonPhrase>Not Found</reasonPhrase>
</exception>
```

Fault Element	Associated Error Codes	Expected in All Requests?
Unauthorized	403	YES
Not Found	404	YES
Limit Fault	413	YES
Internal Server error	50X	YES

7.3 API Operations

7.3.1 Search for Offerings

Here we start with the description of the operation following the next table:

Verb	URI	Additional Path Parameters	Description
GET	/search/offerings/fulltext/{searchString}	filter, index, limit, sortBy, order, minScore	search for offerings where the services description matches the specified search string
GET	/search/offerings/filteroptions		returns a list of possible filter options for offering search

A Filter expression, a limit and a starting index are supported for the fulltext search operation to reduce the number of results. Each search result entry has a score value, a minimum threshold score value can be defined to reduce the number of results.

- *filter* - Optional filter expression to reduce the number of delivered results.

- *index* - Index of the first rating to be returned.
- *limit* - Maximal number of results to be returned.
- *order* - Either ascending (asc) or descending (desc).
- *sortBy* - Comma separated list of sort options, sorted by application order. The sort options for this operation are *score*, *storeName*, *serviceName* or *date*.
- *minScore* - Minimum threshold score value of results to be returned.

Example:

```
http://[SERVER_URL]?filter=name:Simth*&index=20&limit=10&order=asc&s
ortBy=name,storeName&minScore=0.75
```

7.3.2 Search for Stores

Here we start with the description of the operation following the next table:

Verb	URI	Additional Path Parameters	Description
GET	/search/stores/fulltext/{searchString}	filter, index, limit, sortBy, order, minScore	search for stores where the store description matches the specified search string
GET	/search/stores/filteroptions		returns a list of possible filter options for store search

A Filter expression, a limit and a starting index are supported for the fulltext search operation to reduce the number of results. Each search result entry has a score value, a minimum threshold score value can be defined to reduce the number of results.

- *filter* - Optional filter expression to reduce the number of delivered results.
- *index* - Index of the first rating to be returned.
- *limit* - Maximal number of results to be returned.
- *order* - Either ascending (asc) or descending (desc).
- *sortBy* - Comma separated list of sort options, sorted by application order. The sort options for this operation are *score*, *storeName* or *registrationDate*.
- *minScore* - Minimum threshold score value of results to be returned.

Example:

```
http://[SERVER_URL]?filter=name:Simth*&index=20&limit=10&order=asc&s
ortBy=name,storeName&minScore=0.75
```

7.3.3 Status Codes

200 OK

The request was handled successfully and transmitted in response message.

201 Created

The request has been fulfilled and resulted in a new resource being created.

204 No Content

The server successfully processed the request, but is not returning any content.

304 Not Modified

Indicates the resource has not been modified since last requested. Typically, the HTTP client provides a header like the If-Modified-Since header to provide a time against which to compare. Using this saves bandwidth and reprocessing on both the server and client, as only the header data must be sent and received in comparison to the entirety of the page being re-processed by the server, then sent again using more bandwidth of the server and client.

400 Bad Request

The request cannot be fulfilled due to bad syntax.

404 Not Found

The requested resource could not be found but may be available again in the future. Subsequent requests by the client are permissible.

409 Conflict

Indicates that the request could not be processed because of conflict in the request, such as an edit conflict.

500 Internal Server Error

A generic error message, given when no more specific message is suitable.

8 FIWARE OpenSpecification Apps Marketplace Review and Rating REST

You can find the content of this chapter as well in the wiki of fi-ware.

8.1 Introduction to the *Marketplace Review and Rating* API

Please check the following **FI-WARE Open Specification Legal Notice (essential patents license)** to understand the rights to use this open specification. As all other FI-WARE members, SAP has chosen one of the two FI-WARE license schemes for open specifications.

To illustrate this open specification license from our SAP perspective:

- SAP provides the specifications of this Generic Enabler available under IPR rules that allow for a exploitation and sustainable usage both in Open Source as well as proprietary, closed source products to maximize adoption.
- This Open Specification is exploitable for proprietary 3rd party products and is exploitable for open source 3rd party products, including open source licenses that require patent pledges.
- If the owner (SAP) of this GE spec holds a patent that is essential to create a conforming implementation of the GE spec (i.e. it is impossible to write a conforming implementation without violating the patent) then a license to that patent is deemed granted to the implementation.

8.1.1 Marketplace Review and Rating Core

The Marketplace Review and Rating Component is a RESTful, resource-oriented API accessed via HTTP that uses various representations for information interchange. The Review and Rating component allows users of the marketplace to give textual and star-rating feedback for user defined objects. These objects are not necessarily, but may be also a part of the marketplace itself (e.g. stores or services). Reviews of users and their ratings are being used to improve the quality of the recommendation component.

8.1.2 Intended Audience

This specification is intended for both software developers and reimplementers of this API. For the former, this document provides a full specification of how to interoperate with products that implement the Repository API. For the latter, this specification indicates the interface to be implemented and provided to clients.

To use this information, the reader should firstly have a general understanding of the Generic Enabler service Marketplace. You should also be familiar with:

- RESTful web services
- HTTP/1.1
- JSON and/or XML data serialization formats.
- RDF, TURTLE and Atom

8.1.3 API Change History

This version of the Marketplace Review and Rating API Guide replaces and obsoletes all previous versions. The most recent changes are described in the table below:

Revision Date	Changes Summary
Nov 11, 2013	• Initial version
Apr 03, 2014	• Final version

8.1.4 How to Read This Document

It is assumed that the reader is familiar with the REST architecture style. Within the document, some special notations are applied to differentiate some special words or concepts. The following list summarizes these special notations.

- A bold, mono-spaced font is used to represent code or logical entities, e.g., HTTP method (`GET, PUT, POST, DELETE`).
- An italic font is used to represent document titles or some other kind of special text, e.g., *URI*.
- Variables are represented between brackets, e.g. {id} and in italic font. The reader can replace the id with an appropriate value.

For a description of some terms used along this document, see Marketplace.

8.1.5 Additional Resources

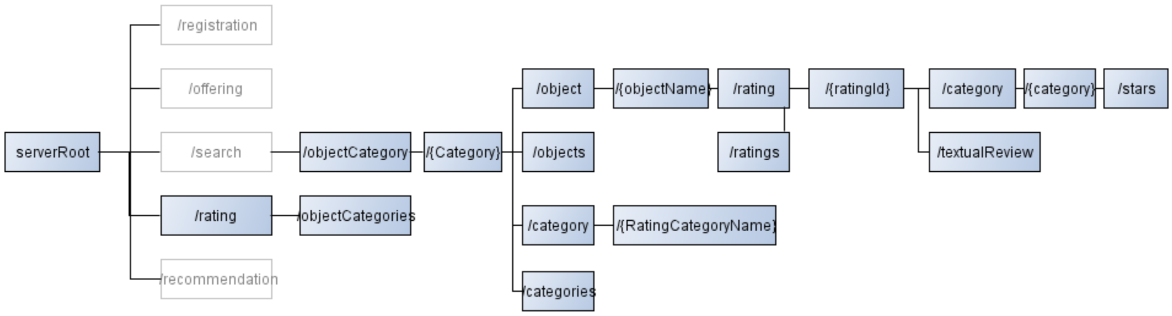
You can download the most current version of this document from the FI-WARE API specification website at **Marketplace Review and Rating API** . For more details about the Marketplace GE that this API is based upon, please refer to High Level Description. Related documents, including an Architectural Description, are available at the same site.

8.2 General *Marketplace Review and Rating* API Information

The Marketplace GE is structured into five core components. These components are Registry & Directory, Offering & Demand, Discovery & Matching, Recommendation, and the Review and Rating component. The API for the Review and Rating component is described in this document.

8.2.1 Resources Summary

The Review and Rating component allows users of the marketplace to give textual and star-rating feedback for services and stores along defined categories. Reviews of users and their overall rating about applications and services can be used to improve the quality of the recommendation.



- Object Categories are used to cluster user review and ratings
- Rating Categories are always tight to a Object Category and are used to allow users to rate opbjects along different categories.
- Rating Objects are concrete objects which can be rated. A Rating Object is tight to exacty one Object Category.

8.2.2 Authentication

Each HTTP request against the *Marketplace Review and Rating API* requires the inclusion of specific authentication credentials. The specific implementation of this API may support multiple authentication schemes (OAuth, Basic Auth, Token) and will be determined by the specific provider that implements the GE. Please contact with it to determine the best way to authenticate against this API. Remember that some authentication schemes may require that the API operate using SSL over HTTP (HTTPS).

8.2.3 Representation Format

The *Marketplace Review and Rating* API supports at least XML and JSON for delivering any kind of resources, it may also support simple text and HTML output format. The request format is specified using the Content-Type header and is required for operations that have a request body. The response format can be specified in requests using the Accept header. Note that it is possible for a response to be serialized using a format different from the request (see example below).
If no Content-Type is specified, the content is delivered in the format that was choosen to upload the resource.
The interfaces should support data exchange through multiple formats:

- *text/plain* - A linefeed separated list of elements for easy mashup and scripting.
- *text/html* - An human-readable HTML rendering of the results of the operation as output format.
- *application/json* - A JSON representation of the input and output for mashups or JavaScript-based Web Apps
- *application/xml* - A XML description of the input and output.

In a concrete implementation of this GE other formats like RSS, Atom, etc. may also be possible.

8.2.4 Representation Transport

Resource representation is transmitted between client and server by using HTTP 1.1 protocol, as defined by IETF RFC-2616. Each time an HTTP request contains payload, a Content-Type header shall be used to specify the MIME type of wrapped representation. In addition, both client and server may use as many HTTP headers as they consider necessary.

8.2.5 Resource Identification

The resource identification for HTTP transport is made using the mechanisms described by HTTP protocol specification as defined by IETF RFC-2616.

8.2.6 Links and References

8.2.6.1 *Web citizen*

The Marketplace Review and Rating is relying on Web principles:

- URI to identify resources
- consistent URI structure based on REST style protocol
- HTTP content negotiation to allow the client to choose the appropriate data format supporting HTML, RDF, XML, RSS, JSON, Turtle, ...
- Human readable output format using HTML rendering ('text/html' accept header) including hyperlinked representation
- Use of HTTP response codes including ETags (proper caching)
- Linked Data enablement supporting RDF input and output types

8.2.6.2 *Linked Open Data*

Publishing data as linked data requires every resource to be directly resolvable given their URL. The basic idea of Linked Data is simple. Tim Berners-Lee’s note on Linked Data describes four rules for publishing data on the Web:

- Use URIs as names for things
- Use HTTP URIs so that people can look up those names.
- When someone looks up a URI, provide useful information, using the standards (RDF*, SPARQL)
- Include links to other URIs, so that they can discover more things.

This can actually achieved by different approaches. One is the use of a special resolver similar to URL shorteners.

So the authoring environment has to ensure that every URI (actually IRI - Internationalized Resource Identifiers - RFC 3987) can be resolved by a HTTP `GET` request. For example: If a resource is maintained in a Marketplace under the URL http://marketplaceRegistration.acme.com/service/xyz but the IRI used in service descriptions is actually http://fi-ware.org/service/xyz, we need a resolver at this location which redirects the request to the actual Marketplace Registration.

Setting up resolvers is more complex task. Therefore we try to follow a simpler approach for the USDLMarketplace RegistrationRest. The API is designed to be directly used for Linked Data publishing without the need for a resolver.

8.2.7 Paginated Result Lists

In order to reduce the load on the service, we can decide to limit the number of elements to return when it is too big. This section explain how to do that using for example a limit parameter (optional) and a last parameter (optional) to express which is the maximum number of element to return and which was the last element to see.
These operations will have to cope with the possibility to have over limit fault (413) or item not found fault (404).

8.2.8 Limits

We can manage the capacity of the system in order to prevent the abuse of the system through some limitations. These limitations will be configured by the operator and may differ from one implementation to other of the GE implementation.

8.2.8.1 *Rate Limits*

These limits are specified both in human readable wild-card and in regular expressions and will indicate for each HTTP verb which will be the maximum number of operations per time unit that a user can request. After each unit time the counter is initialized again. In the event a request exceeds the thresholds established for your account, a 413 HTTP response will be returned with a Retry-After header to notify the client when they can attempt to try again.

8.2.9 ETag Handling

For standard caching an ETag HTTP header is provided for `GET` and `PUT` requests. If a `GET` requests has a "If-None-Match" header, than the content is only delivered if the stored ETag of the object matches the requested ETag. HTTP status code 304 (not changed) is responded otherwise.
For `PUT` requests the ETag header can be used to ensure integrity of the repository. The `PUT` operation will only be executed if the "If-Match" header matches the stored ETag of the resource in the repository. If no "If-Match" header is given for an existing resource or the "If-Match" header does not match the existing ETag of the resource, status code 409 (Conflict)will be returned. If the resource was changed, then a new ETag header will be returned in the response header.

8.2.10 Extensions

The Marketplace could be extended in the future. At the moment, we foresee the following resource to indicate a method that will be used in order to allow the extensibility of the API. This allow the introduction of new features in the API without requiring an update of the version, for instance, or to allow the introduction of vendor specific functionality.

Verb	**URI**	**Description**
GET	/extensions	List of all available extensions

8.2.11 Faults

8.2.11.1 *Synchronous Faults*

Error codes are returned in the body of the response. The description section returns a human-readable message for displaing end users.
Example:

```
<exception>
       <description>Resource Not found</description>
       <errorCode>404</errorCode>
       <reasonPhrase>Not Found</reasonPhrase>
</exception>
```

Fault Element	**Associated Error Codes**	**Expected in All Requests?**
Unauthorized	403	YES
Not Found	404	YES
Not Found	406	Not Acceptable
Not Found	412	Precondition Failed
Limit Fault	413	YES
Internal Server error	50X	YES

8.3 API Operations

8.3.1 Creating Rating Objects

In this section we describe how to create reviews, ratings, categories, object categories and rating objects.

Verb	URI	Description
POST/PUT	/rating/objectCategory/{ObjectCategoryName}	Create a new Rating Object Category
POST/PUT	/rating/objectCategory/{ObjectCategoryName}/category	Create a new Rating Category

	/{RatingCategoryName}	
POST/PUT	/rating/objectCategory/{ObjectCategoryName}/object /{ObjectName}	Create a new Rating Object
POST/PUT	/rating/objectCategory/{ObjectCategoryName}/object /{ObjectName}/rating/	Create a new Rating, Rating ID needs to be returned in the result
POST/PUT	/rating/objectCategory/{ObjectCategoryName}/object /{ObjectName}/rating/{RatingId}/category/{RatingCategoryName}/stars/{STARS}	Create Rating for Category
POST/PUT	/rating/objectCategory/{ObjectCategoryName}/object /{ObjectName}/rating/{RatingId}/textualReview/{Review_Message}	Create Textual Review

8.3.2 Receiving Rating Objects

In this section we describe how to get reviews, ratings, categories, object categories and rating objects.

Verb	URI	Description
GET	/rating/objectCategory/{ObjectCategoryName} /object/{ObjectName}/rating/{RatingId}	Get a Rating
GET	/rating/objectCategory/{ObjectCategoryName} /category/{RatingCategoryName}/Quality	Get a Category
GET	/rating/objectCategory/{ObjectCategoryName} /object/{ObjectName}	Get a Rating Object
GET	/rating/objectCategory/{ObjectCategoryName}	Get a Rating Object Category
GET	/rating/objectCategory/{ObjectCategoryName} /object/{ObjectName}/ratings	Get all Ratings for an Object
GET	/rating/objectCategory/{ObjectCategoryName}/objects	Get all Objects for an Object Category
GET	/rating/objectCategory/{ObjectCategoryName}/catego	Get all Categories for an Object

	ries	Category
GET	/rating/objectCategories	Get all Available Object Categories

8.3.3 Deleting Rating Objects

In this section we describe how to delete reviews, ratings, categories, object categories and rating objects. All deletion operations must be cascading.

Verb	URI	Description
DELETE	/rating/objectCategory/{ObjectCategoryName} /object/{ObjectName}/rating/{RatingId}	Delete a Rating
DELETE	/rating/objectCategory/{ObjectCategoryName} /{RatingCategoryName}/Quality	Delete a Rating Category
DELETE	/rating/objectCategory/{ObjectCategoryName} /object/{ObjectName}	Delete a new Rating Object
DELETE	/rating/objectCategory/{ObjectCategoryName}	Delete a new Rating Object Category

8.3.4 Status Codes

200 OK

The request was handled successfully and transmitted in response message.

201 Created

The request has been fulfilled and resulted in a new resource being created.

204 No Content

The server successfully processed the request, but is not returning any content.

304 Not Modified

Indicates the resource has not been modified since last requested. Typically, the HTTP client provides a header like the If-Modified-Since header to provide a time against which to compare. Using this saves bandwidth and reprocessing on both the server and client, as only the header data must be sent and received in comparison to the entirety of the page being re-processed by the server, then sent again using more bandwidth of the server and client.

400 Bad Request

The request cannot be fulfilled due to bad syntax.

404 Not Found

The requested resource could not be found but may be available again in the future. Subsequent requests by the client are permissible.

406: Not Acceptable

The requested resource is only capable of generating content not acceptable according to the Accept headers sent in the request.

409 Conflict

Indicates that the request could not be processed because of conflict in the request, such as an edit conflict.

412: Precondition Failed

The server does not meet one of the preconditions that the requester put on the request.

500 Internal Server Error

A generic error message, given when no more specific message is suitable.

9 FIWARE OpenSpecification Apps Marketplace Recommendation REST

You can find the content of this chapter as well in the wiki of fi-ware.

9.1 Introduction to the *Marketplace Recommendation* API

Please check the following **FI-WARE Open Specification Legal Notice (essential patents license)** to understand the rights to use this open specification. As all other FI-WARE members, SAP has chosen one of the two FI-WARE license schemes for open specifications.

To illustrate this open specification license from our SAP perspective:

- SAP provides the specifications of this Generic Enabler available under IPR rules that allow for a exploitation and sustainable usage both in Open Source as well as proprietary, closed source products to maximize adoption.
- This Open Specification is exploitable for proprietary 3rd party products and is exploitable for open source 3rd party products, including open source licenses that require patent pledges.
- If the owner (SAP) of this GE spec holds a patent that is essential to create a conforming implementation of the GE spec (i.e. it is impossible to write a conforming implementation without violating the patent) then a license to that patent is deemed granted to the implementation.

9.1.1 Marketplace Recommendation Core

The Marketplace Recommendation Component is a RESTful, resource-oriented API accessed via HTTP that uses various representations for information interchange. The Recommendation component allows users of the marketplace to get recommendation for objects. These objects are not necessarily, but may be also a part of the marketplace itself (e.g. stores or services). In this first Release of the Marketplace Recommendation Component, basic recommendation functionality based on user ratings will be supported.

9.1.2 Intended Audience

This specification is intended for both software developers and reimplementers of this API. For the former, this document provides a full specification of how to interoperate with products that implement the Repository API. For the latter, this specification indicates the interface to be implemented and provided to clients.

To use this information, the reader should firstly have a general understanding of the Generic Enabler service Marketplace. You should also be familiar with:

- RESTful web services
- HTTP/1.1
- JSON and/or XML data serialization formats.
- RDF, TURTLE and Atom

9.1.3 API Change History

This version of the Marketplace Recommendation API Guide replaces and obsoletes all previous versions. The most recent changes are described in the table below:

Revision Date	Changes Summary
Nov 11, 2013	• Initial version
Apr 03, 2014	• Final version

9.1.4 How to Read This Document

It is assumed that the reader is familiar with the REST architecture style. Within the document, some special notations are applied to differentiate some special words or concepts. The following list summarizes these special notations.

- A bold, mono-spaced font is used to represent code or logical entities, e.g., HTTP method (`GET, PUT, POST, DELETE`).
- An italic font is used to represent document titles or some other kind of special text, e.g., *URI*.
- Variables are represented between brackets, e.g. {id} and in italic font. The reader can replace the id with an appropriate value.

For a description of some terms used along this document, see Marketplace.

9.1.5 Additional Resources

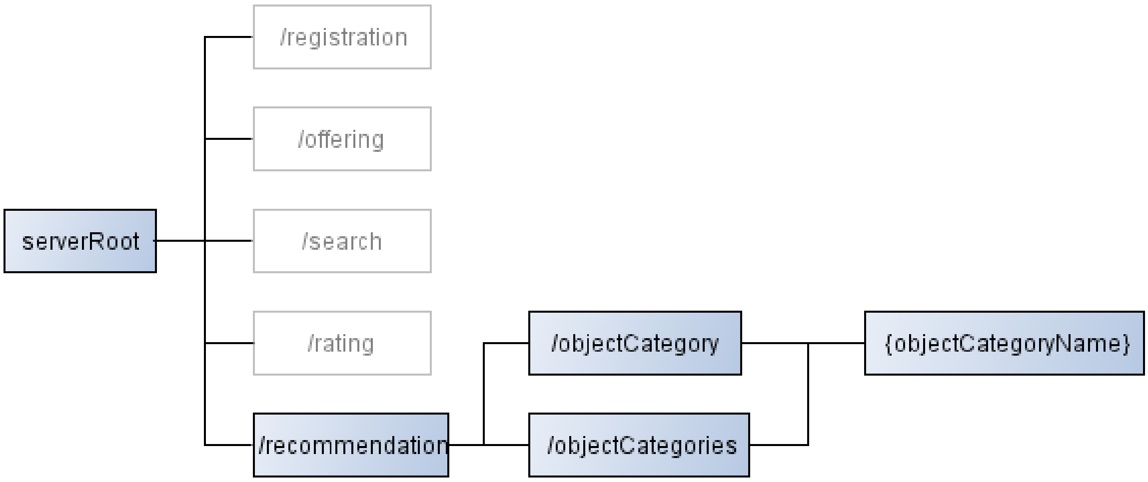
You can download the most current version of this document from the FI-WARE API specification website at **Marketplace Recommendation API** . For more details about the Marketplace GE that this API is based upon, please refer to High Level Description. Related documents, including an Architectural Description, are available at the same site.

9.2 General *Marketplace Recommendation* API Information

The Marketplace GE is structured into five core components. These components are Registry & Directory, Offering & Demand, Discovery & Matching, Recommendation, and the Review and Rating component. The API for the Recommendation component is described in this document.

9.2.1 Resources Summary

The Recommendation component allows users of the marketplace to get recommendation for objects. In this first version the recommendations are based on user ratings



9.2.2 Authentication

Each HTTP request against the *Marketplace Recommendation API* requires the inclusion of specific authentication credentials. The specific implementation of this API may support multiple authentication schemes (OAuth, Basic Auth, Token) and will be determined by the specific provider that implements the GE. Please contact with it to determine the best way to authenticate against this API. Remember that some authentication schemes may require that the API operate using SSL over HTTP (HTTPS).

9.2.3 Representation Format

The *Marketplace Recommendation* API supports at least XML and JSON for delivering any kind of resources, it may also support simple text and HTML output format. The request format is specified using the Content-Type header and is required for operations that have a request body. The response format can be specified in requests using the Accept header. Note that it is possible for a response to be serialized using a format different from the request (see example below).
If no Content-Type is specified, the content is delivered in the format that was choosen to upload the resource.
The interfaces should support data exchange through multiple formats:

- *text/plain* - A linefeed separated list of elements for easy mashup and scripting.
- *text/html* - An human-readable HTML rendering of the results of the operation as output format.
- *application/json* - A JSON representation of the input and output for mashups or JavaScript-based Web Apps
- *application/xml* - A XML description of the input and output.

In a concrete implementation of this GE other formats like RSS, Atom, etc. may also be possible.

9.2.4 Representation Transport

Resource representation is transmitted between client and server by using HTTP 1.1 protocol, as defined by IETF RFC-2616. Each time an HTTP request contains payload, a Content-Type header shall be used to specify the MIME type of wrapped representation. In addition, both client and server may use as many HTTP headers as they consider necessary.

9.2.5 Resource Identification

The resource identification for HTTP transport is made using the mechanisms described by HTTP protocol specification as defined by IETF RFC-2616.

9.2.6 Links and References

9.2.6.1 *Web citizen*

The Marketplace Recommendation Component is relying on Web principles:

- URI to identify resources
- consistent URI structure based on REST style protocol
- HTTP content negotiation to allow the client to choose the appropriate data format supporting HTML, RDF, XML, RSS, JSON, Turtle, ...
- Human readable output format using HTML rendering ('text/html' accept header) including hyperlinked representation
- Use of HTTP response codes including ETags (proper caching)
- Linked Data enablement supporting RDF input and output types

9.2.6.2 *Linked Open Data*

Publishing data as linked data requires every resource to be directly resolvable given their URL. The basic idea of Linked Data is simple. Tim Berners-Lee's note on Linked Data describes four rules for publishing data on the Web:

- Use URIs as names for things
- Use HTTP URIs so that people can look up those names.
- When someone looks up a URI, provide useful information, using the standards (RDF*, SPARQL)
- Include links to other URIs, so that they can discover more things.

This can actually achieved by different approaches. One is the use of a special resolver similar to URL shorteners.

So the authoring environment has to ensure that every URI (actually IRI - Internationalized Resource Identifiers - RFC 3987) can be resolved by a HTTP `GET` request. For example: If a resource is maintained in a Marketplace under the URL http://marketplaceRegistration.acme.com/service/xyz but the IRI used in service descriptions is actually http://fi-ware.org/service/xyz, we need a resolver at this location which redirects the request to the actual Marketplace Registration.

Setting up resolvers is more complex task. Therefore we try to follow a simpler approach for the USDLMarketplace RegistrationRest. The API is designed to be directly used for Linked Data publishing without the need for a resolver.

9.2.7 Paginated Result Lists

In order to reduce the load on the service, we can decide to limit the number of elements to return when it is too big. This section explain how to do that using for example a limit parameter (optional) and a last parameter (optional) to express which is the maximum number of element to return and which was the last element to see.

These operations will have to cope with the possibility to have over limit fault (413) or item not found fault (404).

9.2.8 Limits

We can manage the capacity of the system in order to prevent the abuse of the system through some limitations. These limitations will be configured by the operator and may differ from one implementation to other of the GE implementation.

9.2.8.1 *Rate Limits*

These limits are specified both in human readable wild-card and in regular expressions and will indicate for each HTTP verb which will be the maximum number of operations per time unit that a user can request. After each unit time the counter is initialized again. In the event a request exceeds the thresholds established for your account, a 413 HTTP response will be returned with a Retry-After header to notify the client when they can attempt to try again.

9.2.9 ETag Handling

For standard caching an ETag HTTP header is provided for `GET` and `PUT` requests. If a `GET` requests has a "If-None-Match" header, than the content is only delivered if the stored ETag of the object matches the requested ETag. HTTP status code 304 (not changed) is responded otherwise.

For `PUT` requests the ETag header can be used to ensure integrity of the repository. The `PUT` operation will only be executed if the "If-Match" header matches the stored ETag of the resource in the repository. If no "If-Match" header is given for an existing resource or the "If-Match" header does not match the existing ETag of the resource, status code 409 (Conflict)will be returned. If the resource was changed, then a new ETag header will be returned in the response header.

9.2.10 Extensions

The Marketplace could be extended in the future. At the moment, we foresee the following resource to indicate a method that will be used in order to allow the extensibility of the API. This allow the introduction of new features in the API without requiring an update of the version, for instance, or to allow the introduction of vendor specific functionality.

Verb	**URI**	**Description**
GET	/extensions	List of all available extensions

9.2.11 Faults

9.2.11.1 *Synchronous Faults*

Error codes are returned in the body of the response. The description section returns a human-readable message for displaing end users.
Example:

```
<exception>
        <description>Resource Not found</description>
        <errorCode>404</errorCode>
        <reasonPhrase>Not Found</reasonPhrase>
</exception>
```

Fault Element	Associated Error Codes	Expected in All Requests?
Unauthorized	403	YES
Not Found	404	YES
Not Found	406	Not Acceptable
Not Found	412	Precondition Failed
Limit Fault	413	YES
Internal Server error	50X	YES

9.3 API Operations

9.3.1 Getting Recommendations based on Ratings

In this section we describe how to get recommendations based on ratings provided by the Marketplace Review and Rating Component.

Verb	URI	Description
GET	/recommendation/objectCategories	Get available Object Categories:
GET	recommendation/objectCategory/{objectCategory Name}/	Get Recommendations for an Object Category

9.3.2 Status Codes

200 OK

The request was handled successfully and transmitted in response message.

201 Created

The request has been fulfilled and resulted in a new resource being created.

204 No Content

The server successfully processed the request, but is not returning any content.

304 Not Modified

Indicates the resource has not been modified since last requested. Typically, the HTTP client provides a header like the If-Modified-Since header to provide a time against which to compare. Using this saves bandwidth and reprocessing on both the server and client, as only the header data must be sent and received in comparison to the entirety of the page being re-processed by the server, then sent again using more bandwidth of the server and client.

400 Bad Request

The request cannot be fulfilled due to bad syntax.

404 Not Found

The requested resource could not be found but may be available again in the future. Subsequent requests by the client are permissible.

406: Not Acceptable

The requested resource is only capable of generating content not acceptable according to the Accept headers sent in the request.

409 Conflict

Indicates that the request could not be processed because of conflict in the request, such as an edit conflict.

412: Precondition Failed

The server does not meet one of the preconditions that the requester put on the request.

500 Internal Server Error

A generic error message, given when no more specific message is suitable.

10 FIWARE OpenSpecification Apps Registry

You can find the content of this chapter as well in the wiki of fi-ware.

Name	FIWARE.OpenSpecification.Apps.Registry
Chapter	Apps,
Catalogue-Link to Implementation	FI-WARE Registry
Owner	SAP, Torsten Leidig

10.1 Preface

Within this document you find a self-contained open specification of a FI-WARE generic enabler, please consult as well the FI-WARE Product Vision, the website on http://www.fi-ware.org and similar pages in order to understand the complete context of the FI-WARE project.

10.2 Copyright

- Copyright © 2014 by SAP

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- SAP provides the specifications of this Generic Enabler available under IPR rules that allow for a exploitation and sustainable usage both in Open Source as well as proprietary, closed source products to maximize adoption.
- This Open Specification is exploitable for proprietary 3rd party products and is exploitable for open source 3rd party products, including open source licenses that require patent pledges.
- If the owner (SAP) of this GE spec holds a patent that is essential to create a conforming implementation of the GE spec (i.e. it is impossible to write a conforming implementation without violating the patent) then a license to that patent is deemed granted to the implementation.

Note: SAP provides the software associated to the Registry - RI as open source under the **BSD License**. Please check the specific terms and conditions linked to this BSD open source license at https://github.com/service-business-framework/Registry-RI/blob/master/license.txt. You can also obtain the Registry GE software using the FI-WARE Catalogue at http://catalogue.fi-ware.org/enablers/registry-sap-ri

10.4 Overview

While the Repository Enabler is used to store complete service descriptions, which are more or less static and change only rarely, the Registry Enabler is used to store information on service instances necessary for run-time execution. Discovering entities and their description in an open distributed system often is achieved via registries, which have a well-known address. The registry serves as a kind of directory and for example can store detailed settings for concrete infrastructure components as well as information about human or computing agents. The information can range from stable to extremely volatile and is needed to make specific settings for and adjustments to other components in the platform. For example, the Registry can be used by the Marketplace in order to register stores, providers, persons, infrastructure components and more. The functionality and purpose of the Registry GE is comparable to the Microsoft Windows Registry [REG3] or the Light-weight Directory Access Protocol LDAP [REG1] or the UDDI Business Registry [REG4]. The main difference is that the Registry GE is fully relying on standard Web protocols and has a simpler data model.

10.4.1 Target usage

The Registry acts as a universal directory of information used for the maintenance, administration, deployment and retrieval of services. Existing (running) service endpoints as well as information to create an actual service instance and endpoint are registered. This GE will be used by potentially all GE in the Apps Chapter in order to build a common database of run-time configuration options and properties. It can also be used by GE of other chapters, such as the Cloud, Security, Data or IoT to announce their instance specific information to the rest of the platform components. In a FI-WARE instance there could be multiple instances of the Registry for different purposes and usage domains, which are accessed uniformly according the Repository RESTful interface specification.

10.4.2 Rationale

The Registry has specific requirements according to scalability and performance. Highly volatile information about runtime aspects are to be handled with quick response times. On the other hand, the number of clients and the amount of data is usually small.

10.4.3 Background

Registries are quite a common pattern in software architectures. With in the internet protocol stack defined by the IETF RFC, LDAP (Light-weight Directory Access Protocol) [REG1] is a common technical realization of the registry functionality. Other examples of registry implementations are UDDI [REG4]and the Windows Registry database [REG3].

10.5 Basic Concepts

10.5.1 Register and Deregister Entries

This function is used by resource providers to register and deregister their resources as entries in the Registry. This information can be used by other components in the FI-WARE instance. E.g. the Application Mashup component can use the Registry to find out Marketplaces and their respective endpoint information.

10.5.2 Retrieving Registry Entries

The Retrieving Registry Entries component is responsible for read access of entries. A client service can ask for specific settings and options of the operating environment. The retrieval is either controlled by giving the entry key, which identifies the entry in a unique way. Or the retrieval is based on a filter expression, which is referring to concrete entry values. In this case a list of matching entries is returned. Using a selector expression, the user can limit the number of property values to be returned.

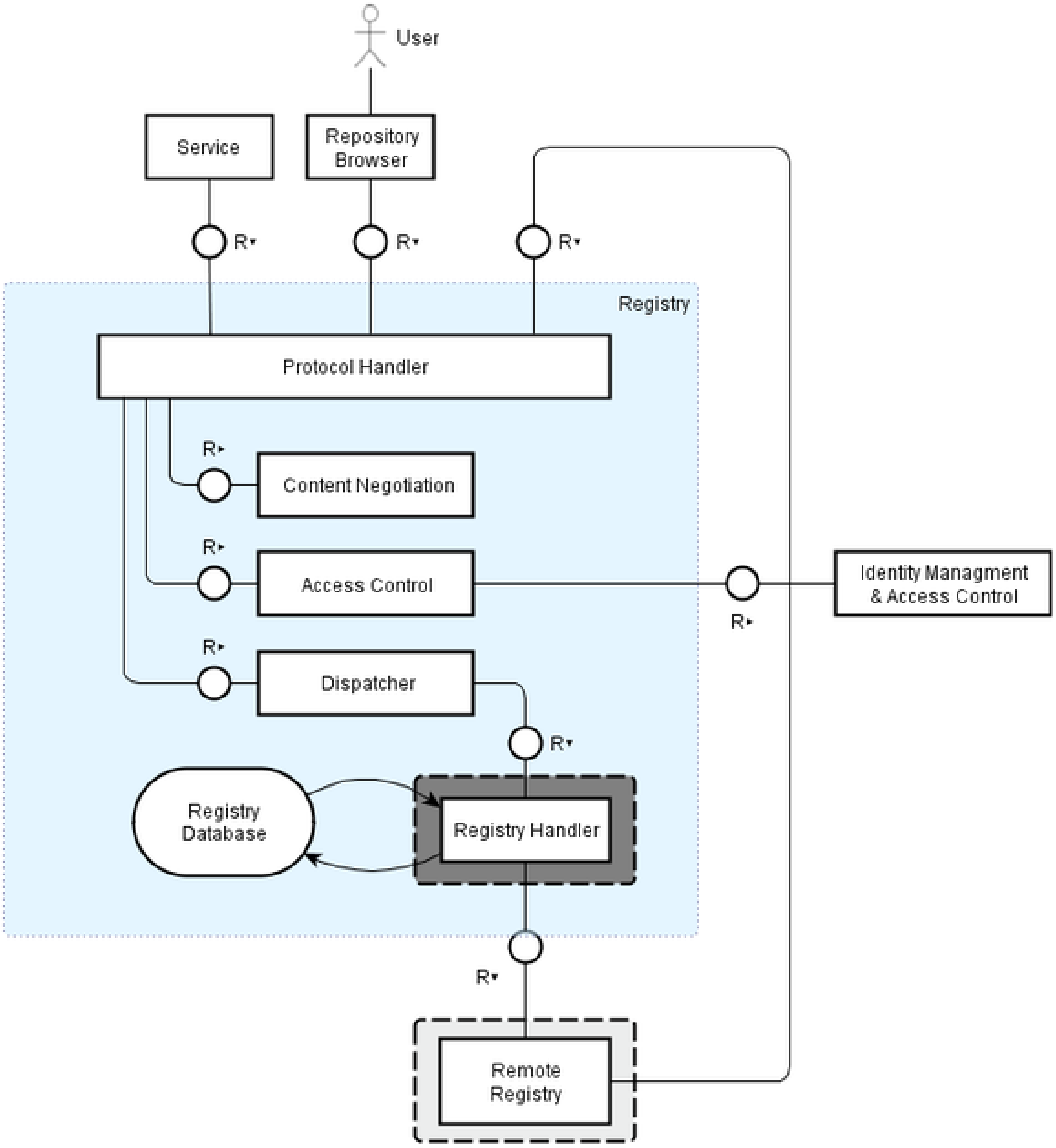
10.5.3 Data Model

The basic data elements of the registry are the ***Registry Entry*** containing the actual information and the ***Registry Key*** to access the data entries in the Registry. A registry entry can be a single atomic piece of data or a structured data such as a record of named properties (name/value pairs). The exact data model and its encoding will be defined in the interface specification. The schema (the exact names of properties and their value encoding) is the matter of the application developer or the community of developers in a respective application domain.

The Registry Key is used for accessing individual entries or a collection of entries is often organized as path into an underlying registry internal organization such as a tree.

10.6 Registry Architecture

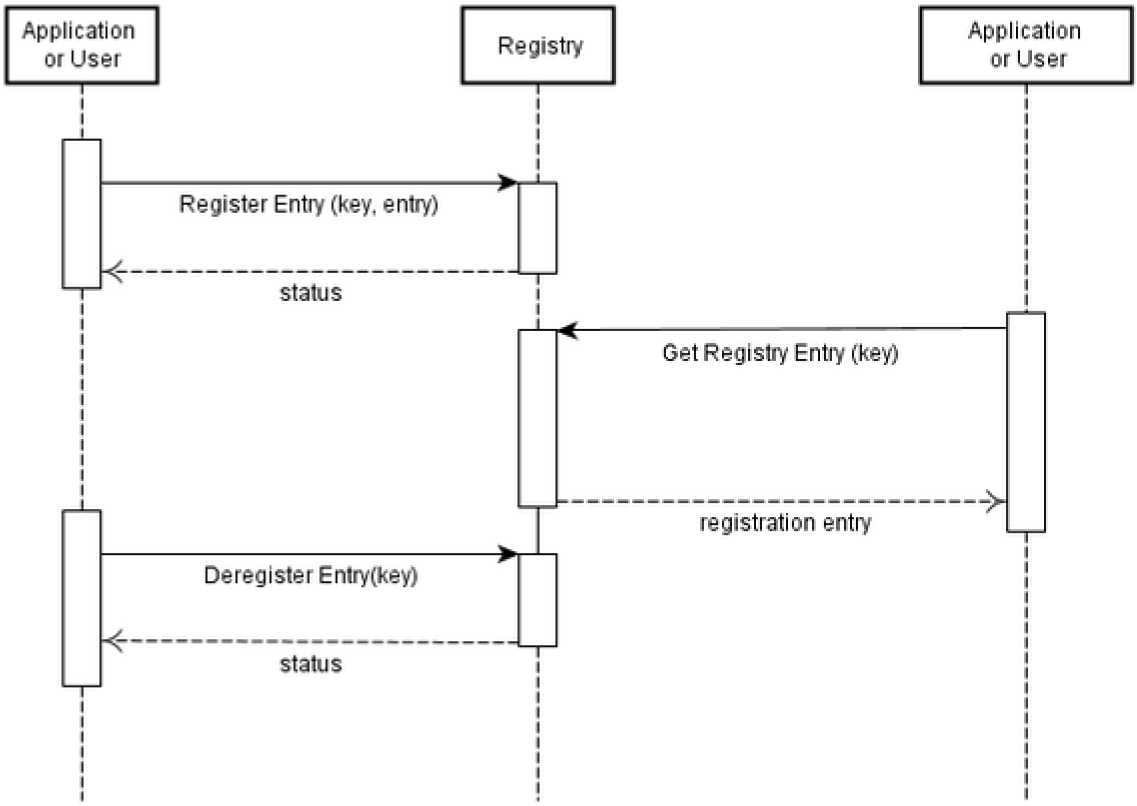
The Registry is a searchable index of the Repository GE. The following picture shows the schematic architecture of the Repository GE. A protocol handler is responsible for the realization of the RESTful HTTP protocol. Content negotiation is used to deliver the results of the operations in different formats convenient for various client environments. An access control adapter is responsible to check access rights according to the FI-WARE Identity Management & Access Control Enabler. The dispatcher calls different handlers for the registry functions. The registry entries and index is stored in a registry database. The registry handlers can call remote registries if the registry is distributed over multiple servers.



Registry architecture (schematic)

10.7 Main Interactions

The following diagram shows an example sequence how a user or other GEs can register, retrieve, and deregister a registry entry.



Example sequence of Registry operations

10.7.1 Register and Deregister Entries

The ***Register Entry*** operation is used to write or update a register information entry into the Registry. Two parameters are essentially needed:

- *key* - The Registry Key of the entry to be registered. A key can exhibit an organizational structure such as a tree. The Registry Key is usually given by the client and is chosen according to a published naming scheme.
- *entry* - The Register Entry to be registered. The entry is usually a list of name/value pairs.

A registry key is returned.

For the ***Deregister Entry*** operation only the Registry Key of the Registry Entry is needed:

- *key* - Registry Key of the entry to be de-registered

10.7.2 Retrieving Registry Entries

It must be possible to directly retrieve a Registry Entry using a unique Key using the ***Get Registry Entry*** operation. In this case one parameter is sufficient:

- *key* - Registry Key of the entry to be retrieved

The ***Query Registry Entries*** operation allows the retrieval of Registry Entries matching a filter expression:

- *filter* - A filter expression to select entries to be retrieved.

10.8 Basic Design Principles

An implementation for the Registry might take different design decisions and technological approaches, depending on the non-functional requirements of the repository. A registry implementation might be highly distributed and scalable if it is used by many parties on a global scale. Also the database schema might be of different complexity depending on the data requirements of the use case. Prominent example technologies which have a distributed nature are LDAP, UDDI, or distributed key/value stores for large amounts of records such as MongoDB, CouchDB, or Cassandra. The Registry specification follows the separation of concerns principle. So it is possible to supplement it with an authentication and authorization system such as OAuth [REG2].

10.9 Detailed Open Specifications

- **FIWARE.OpenSpecification.Apps.Registry**

10.9.1 Open API Specifications

- Registry Open RESTful API Specification

10.10 References

REG1 LDAP protocol specifications(RFCs 4510,4512,4514,4516,4517)

REG2 OAuth2 protocol (http://tools.ietf.org/html/draft-ietf-oauth-v2-30)

REG3 Microsoft Windows Registry (http://msdn.microsoft.com/msdnmag/issues/1100/Registry/)

REG4 UDDI Business Registry (http://en.wikipedia.org/wiki/Universal_Description_Discovery_and_Integration)

10.11 Detailed Specifications

10.11.1 Open API Specifications

- Repository Open RESTful API Specification (PRELIMINARY)

10.11.2 Other Relevant Specifications

none

10.12 Re-utilised Technologies/Specifications

Because the registry can be used to provide central consistent information base of run-time information it might require authentication and authorization in order to safeguard the content. For this reasons it need to be combined with a pluggable authenticaton/authentication provider.
FI-Ware for example offers an Identity GE providing API authorization with bearer tokens of the OAuth2 protocol (http://tools.ietf.org/html/draft-ietf-oauth-v2-30).

10.13 Terms and definitions

This section comprises a summary of terms and definitions introduced during the previous sections. It intends to establish a vocabulary that will be help to carry out discussions internally and with third parties (e.g., Use Case projects in the EU FP7 Future Internet PPP). For a summary of terms and definitions managed at overall FI-WARE level, please refer to FIWARE Global Terms and Definitions

- **Aggregator (Role):** A Role that supports domain specialists and third-parties in aggregating services and apps for new and unforeseen opportunities and needs. It does so by providing the dedicated tooling for aggregating services at different levels: UI, service operation, business process or business object levels.
- **Application:** Applications in FI-WARE are composite services that have a IT supported interaction interface (user interface). In most cases consumers do not buy the application, instead they buy the right to use the application (user license).
- **Broker (Role):** The business network's central point of service access, being used to expose services from providers that are delivered through the Broker's service delivery functionality. The broker is the central instance for enabling monetization.
- **Business Element:** Core element of a business model, such as pricing models, revenue sharing models, promotions, SLAs, etc.
- **Business Framework:** Set of concepts and assets responsible for supporting the implementation of innovative business models in a flexible way.
- **Business Model:** Strategy and approach that defines how a particular service/application is supposed to generate revenue and profit. Therefore, a Business Model can be implemented as a set of business elements which can be combined and customized in a flexible way and in accordance to business and market requirements and other characteristics.
- **Business Process:** Set of related and structured activities producing a specific service or product, thereby achieving one or more business objectives. An operational business process clearly defines the roles and tasks of all involved parties inside an organization to achieve one specific goal.
- **Business Role:** Set of responsibilities and tasks that can be assigned to concrete business role owners, such as a human being or a software component.
- **Channel:** Resources through which services are accessed by end users. Examples for well-known channels are Web sites/portals, web-based brokers (like iTunes, eBay

and Amazon), social networks (like Facebook, LinkedIn and MySpace), mobile channels (Android, iOS) and work centers. The access mode to these channels is governed by technical channels like the Web, mobile devices and voice response, where each of these channels requires its own specific workflow.

- **Channel Maker (Role):** Supports parties in creating outlets (the Channels) through which services are consumed, i.e. Web sites, social networks or mobile platforms. The Channel Maker interacts with the Broker for discovery of services during the process of creating or updating channel specifications as well as for storing channel specifications and channeled service constraints in the Broker.
- **Composite Service (composition):** Executable composition of business back-end MACs (see MAC definition later in this list). Common composite services are either orchestrated or choreographed. Orchestrated compositions are defined by a centralized control flow managed by a unique process that orchestrates all the interactions (according to the control flow) between the external services that participate in the composition. Choreographed compositions do not have a centralized process, thus the services participating in the composition autonomously coordinate each other according to some specified coordination rules. Backend compositions are executed in dedicated process execution engines. Target users of tools for creating Composites Services are technical users with algorithmic and process management skills.
- **Consumer (Role):** Actor who searches for and consumes particular business functionality exposed on the Web as a service/application that satisfies her own needs.
- **Desktop Environment:** Multi-channel client platform enabling users to access and use their applications and services.
- **Event-driven Composition:** Components concerned with the composition of business logic, which is driven by asynchronous events. This implies run-time selection of MACs and the creation/modification of orchestration workflows based on composition logic defined at design-time and adapted to context and the state of the communication at run-time.
- **Front-end/Back-end Composition:** Front-end compositions define a front-end application as an aggregation of visual mashable application pieces (named as widgets, gadgets, portlets, etc.) and back-end services. Front-end compositions interact with end-users, in the sense that front-end compositions consume data provided by the end-users and provide data to them. Thus the front-end composition (or mashup) will have a direct influence on the application look and feel; every component will add a new user interaction feature. Back-end compositions define a back-end business service (also known as process) as an aggregation of backend services as defined for service composition term, the end-user being oblivious to the composition process. While back-end components represent atomization of business logic and information processing, front-end components represent atomization of information presentation and user interaction.
- **Gateway (Role):** The Gateway role enables linking between separate systems and services, allowing them to exchange information in a controlled way despite different technologies and authoritative realms. A Gateway provides interoperability solutions for other applications, including data mapping as well as run-time data store-forward

and message translation. Gateway services are advertised through the Broker, allowing providers and aggregators to search for candidate gateway services for interface adaptation to particular message standards. The Mediation is the central generic enabler. Other important functionalities are eventing, dispatching, security, connectors and integration adaptors, configuration, and change propagation.

- **Hoster (Role):** Allows the various infrastructure services in cloud environments to be leveraged as part of provisioning an application in a business network. A service can be deployed onto a specific cloud using the Hoster's interface. This enables service providers to re-host services and applications from their on-premise environments to cloud-based, on-demand environments to attract new users at much lower cost.
- **Marketplace:** Part of the business framework providing means for service providers, to publish their service offerings, and means for service consumers, to compare and select a specific service implementation. A marketplace can offer services from different stores and thus different service providers. The actual buying of a specific service is handled by the related service store.
- **Mashup:** Executable composition of front-end MACs. There are several kinds of mashups, depending on the technique of composition (spatial rearrangement, wiring, piping, etc.) and the MACs used. They are called application mashups when applications are composed to build new applications and services/data mash-ups if services are composed to generate new services. While composite service is a common term in backend services implementing business processes, the term 'mashup' is widely adopted when referring to Web resources (data, services and applications). Front-end compositions heavily depend on the available device environment (including the chosen presentation channels). Target users of mashup platforms are typically users without technical or programming expertise.
- **Mashable Application Component (MAC):** Functional entity able to be consumed executed or combined. Usually this applies to components that will offer not only their main behaviour but also the necessary functionality to allow further compositions with other components. It is envisioned that MACs will offer access, through applications and/or services, to any available FI-WARE resource or functionality, including gadgets, services, data sources, content, and things. Alternatively, it can be denoted as 'service component' or 'application component'.
- **Mediator:** A mediator can facilitate proper communication and interaction amongst components whenever a composed service or application is utilized. There are three major mediation area: Data Mediation (adapting syntactic and/or semantic data formats), Protocol Mediation (adapting the communication protocol), and Process Mediation (adapting the process implementing the business logic of a composed service).
- **Monetization:** Process or activity to provide a product (in this context: a service) in exchange for money. The Provider publishes certain functionality and makes it available through the Broker. The service access by the Consumer is being accounted, according to the underlying business model, and the resulting revenue is shared across the involved service providers.
- **Premise (Role):** On-Premise operators provide in-house or on-site solutions, which are used within a company (such as ERP) or are offered to business partners under specific terms and conditions. These systems and services are to be regarded as

external and legacy to the FI-Ware platform, because they do not conform to the architecture and API specifications of FI-WARE. They will only be accessible to FI-WARE services and applications through the Gateway.

- **Prosumer:** A user role able to produce, share and consume their own products and modify/adapt products made by others.
- **Provider (Role):** Actor who publishes and offers (provides) certain business functionality on the Web through a service/application endpoint. This role also takes care of maintaining this business functionality.
- **Registry and Repository:** Generic enablers that able to store models and configuration information along with all the necessary meta-information to enable searching, social search, recommendation and browsing, so end users as well as services are able to easily find what they need.
- **Revenue Settlement:** Process of transferring the actual charges for specific service consumption from the consumer to the service provider.
- **Revenue Sharing:** Process of splitting the charges of particular service consumption between the parties providing the specific service (composition) according to a specified revenue sharing model.
- **Service:** We use the term service in a very general sense. A service is a means of delivering value to customers by facilitating outcomes customers want to achieve without the ownership of specific costs and risks. Services could be supported by IT. In this case we say that the interaction with the service provider is through a technical interface (for instance a mobile app user interface or a Web service). Applications could be seen as such IT supported Services that often are also composite services.
- **Service Composition:** in SOA domain, a service composition is an added value service created by aggregation of existing third party services, according to some predefined work and data flow. Aggregated services provide specialized business functionality, on which the service composition functionality has been split down.
- **Service Delivery Framework:** Service Delivery Framework (or Service Delivery Platform (SDP)) refers to a set of components that provide service delivery functionality (such as service creation, session control & protocols) for a type of service. In the context of FI-WARE, it is defined as a set of functional building blocks and tools to (1) manage the lifecycle of software services, (2) creating new services by creating service compositions and mashups, (3) providing means for publishing services through different channels on different platforms, (4) offering marketplaces and stores for monetizing available services and (5) sharing the service revenues between the involved service providers.
- **Service Level Agreement (SLA):** A service level agreement is a legally binding and formally defined service contract, between a service provider and a service consumer, specifying the contracted qualitative aspects of a specific service (e.g. performance, security, privacy, availability or redundancy). In other words, SLAs not only specify that the provider will just deliver some service, but that this service will also be delivered on time, at a given price, and with money back if the pledge is broken.
- **Service Orchestration:** in SOA domain, a service orchestration is a particular architectural choice for service composition where a central orchestrated process manages the service composition work and data flow invocations of the external third

party services in the order determined by the work flow. Service orchestrations are specified by suitable orchestration languages and deployed in execution engines who interpret these specifications.

- **Store:** An external component integrated with the business framework, offering a set of services that are published to a selected set of marketplaces. The store thereby holds the service portfolio of a specific service provider. In case a specific service is purchased on a service marketplace, the service store handles the actual buying of a specific service (as a financial business transaction).
- **Unified Service Description Language (USDL):** USDL is a platform-neutral language for describing services, covering a variety of service types, such as purely human services, transactional services, informational services, software components, digital media, platform services and infrastructure services. The core set of language modules offers the specification of functional and technical service properties, legal and financial aspects, service levels, interaction information and corresponding participants. USDL is offering extension points for the derivation of domain-specific service description languages by extending or changing the available language modules.

- **Registry Key:** A unique identifier for accessing entries in the Registry. The Registry is often given as a hierarchical naming schema or path.
- **Registry Entry:** Data that is stored for a specific Registry Key. This data is usually a record of key, value pairs defining a property and its value.

11 FIWARE OpenSpecification Apps Registry REST

You can find the content of this chapter as well in the wiki of fi-ware.

11.1 Introduction to the *Registry* API

11.1.1 Registry API Core

The Registry API is a RESTful, resource-oriented API accessed via HTTP that uses various representations for information interchange.
Overall description of the API with its functionalities.

11.1.2 Intended Audience

This specification is intended for both software developers and Cloud Providers. For the former, this document provides a full specification of how to interoperate with Cloud Platforms that implements the Registry API. For the latter, this specification indicates the interface to be provided in order to clients to inter-operate with Cloud Platform to provide the described functionality. To use this information, the reader should firstly have a general understanding of the Generic Enabler service FIWARE.ArchitectureDescription.Apps.Registry. You should also be familiar with:

- ReSTful web services
- HTTP/1.1
- JSON and/or XML data serialization formats.
- LDAP

11.1.3 API Change History

This version of the Registry API Guide replaces and obsoletes all previous versions. The most recent changes are described in the table below:

Revision Date	Changes Summary
Apr 20, 2012	• Initial version

11.1.4 How to Read This Document

In the whole document it is taken the assumption that reader is familiarized with REST architecture style. Along the document, some special notations are applied to differentiate some special words or concepts. The following list summarizes these special notations.

- A bold, mono-spaced font is used to represent code or logical entities, e.g., HTTP method (GET, PUT, POST, DELETE).
- An italic font is used to represent document titles or some other kind of special text, e.g., URI.
- The variables are represented between brackets, e.g. {id} and in italic font. When the reader find it, can change it by any value.
- <add any other content that you think that it is relevant>

For a description of some terms used along this document, see FIWARE.ArchitectureDescription.Apps.Registry.

11.1.5 Additional Resources

You can download the most current version of this document from the FIWARE API specification website at https://forge.fi-ware.eu/plugins/mediawiki/wiki/fi-ware-private/index.php?title=FIWARE.OpenSpecification.Apps.RegistryREST . For more details about the Registry GE that this API is based upon, please refer to <link to the High Level Description>. Related documents, including an Architectural Description, are available at the same site.

11.2 General *Registry* API Information

11.2.1 Resources Summary

The registry is structured into core objects, which are called *registry entries*. These objects constitute also the granularity of access control. A registry entry, uniquely identified by its *distinguished name*, can hold a number of *attributes*.

11.2.2 Authentication

Each HTTP request against the *Registry GE* requires the inclusion of specific authentication credentials. The specific implementation of this API may support multiple authentication schemes (OAuth, Basic Auth, Token) and will be determined by the specific provider that implements the GE. Please contact with it to determine the best way to authenticate against this API. Remember that some authentication schemes may require that the API operate using SSL over HTTP (HTTPS).

11.2.3 Authorization

It is assumed that access to the registry is controlled by a authorization mechanisms in order to ensure that only authorized clients can read/modify/write specific information.

The FI-WARE configuration requires OAuth2 API authorization with Bearer tokens, which have to be sent with each request. The token will be validated against the FI-WARE Identity Management Generic Enabler running in the FI-WARE Lab.

Example request header:

```
Authorization: Bearer AbCdEf123456
```

11.2.4 Representation Format

The *Registry* API supports XML/RDF, Turtle, JSON, Atom HTML for delivering information for registry entries. The request format is specified using the Content-Type header and is required for operations that have a request body. The response format can be specified in requests using the Accept header. Note that it is possible for a response to be serialized using a format different from the request (see example below).

If no Content-Type is specified, the content is delivered in the format that was choosen to upload the resource.
The interfaces should support data exchange through multiple formats:

- *text/plain* - A linefeed separated list of elements for easy mashup and scripting.
- *text/html* - An human-readable HTML rendering of the results of the operation as output format.
- *application/json* - A JSON representation of the input and output for mashups or JavaScript-based Web Apps
- *application/rdf+xml* - A RDF description of the input and output.

Other formats such as XML, RSS, Atom, etc. are possible.

11.2.5 Representation Transport

Resource representation is transmitted between client and server by using HTTP 1.1 protocol, as defined by IETF RFC-2616. Each time an HTTP request contains payload, a Content-Type header shall be used to specify the MIME type of wrapped representation. In addition, both client and server may use as many HTTP headers as they consider necessary.

11.2.6 Resource Identification

This section must explain which would be the resource identification used by the API in order to identify unambiguously the resource. For HTTP transport, this is made using the mechanisms described by HTTP protocol specification as defined by IETF RFC-2616.
The Distinguished Entry Name (DEN) is used to unambiguously identify registry entries. In analogy to the LDAP protocol (RFCs 4510,4512,4514,4516,4517) we assume distinguished entry names can be expressed in a hierarchical way.
Example:
/c=de/o=University%20of%20Michigan - is a DEN similar to an LDAP DN
/de/University%20of%20Michigan - is an alternative representation of the DEN assuming that there is a default hierarchy

11.2.7 Links and References

11.2.7.1 ***Web citizen***

The registry is relying on Web principles:

- URI to identify resources
- consistent URI structure based on REST style protocol
- HTTP content negotiation to allow the client to choose the appropriate data format supporting HTML, RDF, XML, RSS, JSON, Turtle, ...
- Human readable output format using HTML rendering ('text/html' accept header) including hyperlinked representation
- Use of HTTP response codes including ETags (proper caching)
- Linked Data enablement supporting RDF input and output types

11.2.8 Paginated Collections

In order to reduce the load on the service, we can decide to limit the number of elements to return when it is too big. This section explain how to do that using for example a limit parameter (optional) and a last parameter (optional) to express which is the maximum number of element to return and which was the last element to see.
These operations will have to cope with the possibility to have over limit fault (413) or item not found fault (404).

11.2.9 Limits

We can manage the capacity of the system in order to prevent the abuse of the system through some limitations. These limitations will be configured by the operator and may differ from one implementation to other of the GE implementation.

11.2.9.1 *Rate Limits*

These limits are specified both in human readable wild-card and in regular expressions and will indicate for each HTTP verb which will be the maximum number of operations per time unit that a user can request. After each unit time the counter is initialized again. In the event a request exceeds the thresholds established for your account, a 413 HTTP response will be returned with a Retry-After header to notify the client when they can attempt to try again.

11.2.10 Faults

11.2.10.1 *Synchronous Faults*

In this section, we provide the complete list of possible fault elements and error code, and if it is expected in all request or not following this table.

Fault Element	Associated Error Codes	Expected in All Requests?
GET	/limits	[YES]

We must indicate which will be the fault response in XML and/or JSON format and it would be nice if we can provide some type of information associated to the specific error including a message and details.

11.3 API Operations

In this section we go in depth for each operation. In order to provide good comprehensive of the API operations, we would suggest to group them into similar functionalities within subsections. e.g. operations related to VM management in the Cloud Chapter or Context Entity Management in IoT.

11.3.1 Retrieving Registry Information

11.3.1.1 *Read registry entry*

Here we start with the description of the operation following the next table:

Verb	URI	Description
GET	/{DistinguishedEntryName}?filter={FilterExpression}&attributes={AttributeList}&scope={Scope}	Get registry entry information:

(1)Paramters

FilterExpression - Expression for filtering registered entries under a relative distinguished entry name.

AttributeList - Comma-separated list of attribute names which should be returned.

Scope - Return entries of the DEN only or in the whole sub-tree (one of "base" / "one" / "sub")

(2)Example

GET /de/service/stores/?attributes=Name,serviceResource,endpoint

Returns the name, service description URL, and service endpoint URL for all services registered under "/de/service/stores".

(3)Result Format

Accept: application/json:

```
[ { DEN: "/de/service/stores/store1",
    Name: "Store1 Name",
    service: "http://fiware.org/usdl/servicestorexyz",
    endpoint:                                        "http://fiware-
platform.org/service/store1/instance4711"
  },
  ...
]
```

(4)Error Codes

200 OK

The request was handled successfully and transmitted in response message.

400 Bad Request

The request cannot be fulfilled due to bad syntax.

404 Not Found

The requested resource could not be found but may be available again in the future. Subsequent requests by the client are permissible.

500 Internal Server Error

A generic error message, given when no more specific message is suitable.

11.3.2 Modifying Entries

11.3.2.1 *Creating and Updating*

Verb	URI	Description
PUT	/{DistinuguishedEntryName}	Create or update a resource or a number of resources

(1)Request Body

The request body of a PUT operation should contain the set of attributes of the entry. E.g. if Content-type was "application/json":

```
{
  "{attributeName1}": "AttributeValue1",
  "{attributeName2}": "AttributeValue2",
  ...
}
```

or for a number of resources

```
[{
  "RDN": "{RelativeDistinguishedName",
  "{attributeName1}": "AttributeValue1",
  "{attributeName2}": "AttributeValue2",
  ...
 },
 ...
]
```

respectively.

(2)Error Codes

201 Created

The request has been fulfilled and resulted in a new resource being created.

204 No Content

The server successfully processed the request, but is not returning any content.

400 Bad Request

The request cannot be fulfilled due to bad syntax.

404 Not Found

The requested resource could not be found but may be available again in the future. Subsequent requests by the client are permissible.

409 Conflict

Indicates that the request could not be processed because of conflict in the request, such as an edit conflict.

500 Internal Server Error

A generic error message, given when no more specific message is suitable.

(3)Adding Information

Verb	URI	Description
POST	/{DistinguishedEntryName}	Add attributes to a registry entry

(4)Request Body

The request body contains the attributes to be added to an entry:

```
{
  "{attributeName1}": "AttributeValue1",
  "{attributeName2}": "AttributeValue2",
  ...
}
```

(5)Error Codes

201 Created

The request has been fulfilled and resulted in a new resource being created.

204 No Content

The server successfully processed the request, but is not returning any content.

400 Bad Request

The request cannot be fulfilled due to bad syntax.

404 Not Found

The requested resource could not be found but may be available again in the future. Subsequent requests by the client are permissible.

409 Conflict

Indicates that the request could not be processed because of conflict in the request, such as an edit conflict.

500 Internal Server Error

A generic error message, given when no more specific message is suitable.

11.3.3 Deleting Registry Information

11.3.3.1 *Deleting Entries*

Verb	URI	Description
DELETE	/{DistinuguishedEntryName}	Delete a registry entry

(1)Error Codes

200 OK

The request was handled successfully and transmitted in response message.

400 Bad Request

The request cannot be fulfilled due to bad syntax.

404 Not Found

The requested resource could not be found but may be available again in the future. Subsequent requests by the client are permissible.

500 Internal Server Error

A generic error message, given when no more specific message is suitable.

11.3.3.2 *Delete Attributes of an Entry*

Verb	URI	Description
DELETE	/{DistinguishedEntryName}?attributes={AttributeNames}	Delete attributes of a registry entry

(1)Parameters

{AttributeNames} contains a comma-separated list of attribute names to be deleted from the entry.

(2)Error Codes

200 OK

The request was handled successfully and transmitted in response message.

400 Bad Request

The request cannot be fulfilled due to bad syntax.

404 Not Found

The requested resource could not be found but may be available again in the future. Subsequent requests by the client are permissible.

500 Internal Server Error

A generic error message, given when no more specific message is suitable.

12 FIWARE OpenSpecification Apps Mediator

You can find the content of this chapter as well in the wiki of fi-ware.

Name	FIWARE.OpenSpecification.Apps.Mediator
Chapter	Apps,
Catalogue-Link to Implementation	Mediator
Owner	Telecom Italia, THALES, Marco Ughetti, Pierre Chatel

12.1 Preface

Within this document you find a self-contained open specification of a FI-WARE generic enabler, please consult as well the FI-WARE Product Vision, the website on http://www.fi-ware.org and similar pages in order to understand the complete context of the FI-WARE project.

12.2 Copyright

12.3 Legal Notice

Please check the following **FI-WARE Open Specification Legal Notice (essential patents license)** to understand the rights to use this open specification. As all other FI-WARE members, Telecom Italia has chosen one of the two FI-WARE license schemes for open specifications.

Telecom Italia provides the software associated to the Mediator as as Open and Free Access to PPP partners during the FI-WARE/PPP duration and under a FRAND (Fair, Reasonable And Non-Discriminatory) licensing terms afterwards. This means that it is accessible by the partners of the FIWARE-PPP Projects, and in particular by the Use Case Projects, as share-ware but it is not available for public distribution. In particular the usage of the Mediator under the following circumstances is defined: Projects being part of the FI-PPP program can use the Mediator product under the conditions established in the FI-PPP Collaboration Agreement that they should have signed as beneficiaries of the program.

12.4 Overview

Providing interoperability solutions is the main functionality of the Mediator. The heterogeneity that exists among the ways to represent data (i.e. to represent syntactically and semantically the information items that are requested or provided by an application or a service), and to represent the communication pattern and the protocol or the public process needed to request a functionality (executing a composition in a different execution environment or implementing dynamic run-time changes might require a process mediation function), are problems that arise in many Future Internet applications. Acknowledging the necessity to deal with these heterogeneities, mediation solutions are provided in FIWARE.

The Mediator is basically a middleware application responsible for providing interoperability among different communication protocols and among different data models. For example it can convert ASCII delimited message payloads from older protocols such as FTP into an XML message payload submitted to a web service (both soap over http or rest over http). Thus the main capabilities of the mediator are protocol and data transformations. Another example of data transformation is the transformation of an XML payload into another XML payload through XSLT or XQuery.

The Mediator provides data mediation and protocol mediation capabilities to enable clients playing the role of Mediation Service Creators to compose different kinds of target service, and to enable clients playing the role of Mediation Service Clients to invoke the mediated services (see figure 1.1).

The Composition Engine GEs can play both the roles of Mediation Service Creator and Mediation Service Client.

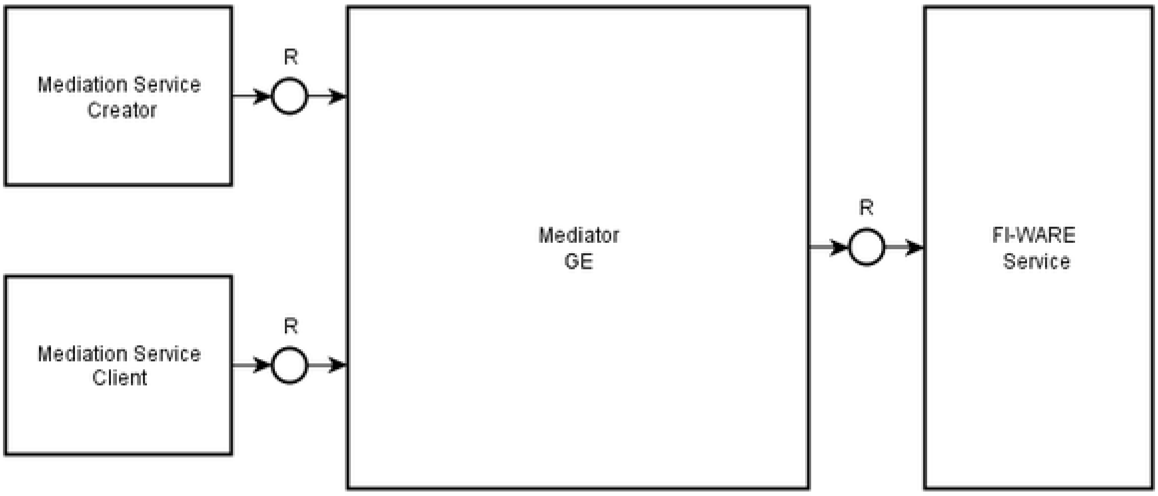


Figure 1.1: Mediator Role in FI-WARE

The Mediator provides an Administrator GUI and APIs allowing mediation services to be constructed given a target service and to be used in a service composition.

12.5 Basic Concepts

FI-WARE platform should be able to support services exposed through different protocols and technologies and enable the creation of new composed services. The mediator shall provide the "glue" between the service layer and the composition layer in order to enhance the composition capabilities of the composing GEs.

Within FI-WARE we abstract this functionality into a Generic Enabler called Mediator. The API abstracts the concrete implementation technology. Implementations using various kinds of platforms and frameworks should be possible. The main goal of the Mediator is to provide a virtual proxy of the target service to be used by the Composition Engine GE instead of the target service. The Virtual Proxy is configured with *Mediation Tasks* and *Dynamic Mediation Tasks* that provide data mediation and protocol mediation capabilities in order to make the target service suitable for composition. The first release of this GE will provide an Administration GUI for the configuration of such Virtual Proxies. The final release will provide remote generic APIs to allow the configuration of the Mediator directly by the other GEs

12.5.1 Data Model

The Mediator offers a set of available *mediation tasks* and *dynamic mediation tasks*: the set of mediation capabilities that can be used via the mediator. The mediator allows users to create and manage their *mediation services*: a *mediation service* is a virtual proxy towards a web service that executes a chain of *mediation tasks* and/or *dynamic mediation tasks* between the caller and the target service. The *mediation tasks* and *dynamic mediation tasks* must be chosen from the set of available task types and the concrete implementation of the mediation tasks to be chained are potentially provided by different mediator implementations. Each mediator implementation (asset) will provide its own set of addressable *mediation tasks* and/or *dynamic mediation tasks*. How to build a concrete *mediation task* or *dynamic mediation task* depends on the specific mediator implementation.

12.5.1.1 *Mediation Task*

Mediation tasks are the mediation capabilities that can be used via the Mediator. The Mediator maintains a set of the available mediation tasks.
The concrete implementation of a mediation task is provided by a specific mediator implementation (asset).

Examples of provided mediation tasks include:

- SOAP2REST: allows a REST Service to be called from the SOAP protocol
- SOAP2POX: allows a service that is expecting a POX Payload (Plain Old XML) to be called from the SOAP protocol
- TCP2HTTP: allows a service exposed via HTTP to be called using TCP transport

The mediation tasks exposed by the Mediation GE are a chain of the built-in low level mediation capabilities provided by WSO2 ESB and Apache Camel.
A short list of these **mediation capabilities**:

Name	Description
Send	Sends a message out
Log	Logs a message
Property	Sets or removes properties associated with the message
Sequence	Refers to a sequence

Event	Sends event notifications to an event source
Drop	Drops a message
Enrich	Enriches a message
Enqueue	Creates an enqueue mediator
Filter	Filters a message using Xpath (if else logic)
Out	Inbuilt filter for choosing messages in ESB out path
In	Inbuilt filter for choosing messages in ESB path
Switch	Filters a message using Xpath (switch logic)
Router	Routes messages based on XPath filtering
Conditional Router	Routes messages based on 'Condition'
Validate	Schema validation for messages
XSLT	XSLT Transformations
XQuery	XQuery Transformations
Header	Sets or removes SOAP Headers
Fault	Creates or removes SOAP Faults
Rewrite	Creates a rewrites mediator

We provide some examples of the configuration of these mediation tasks.

Example 1: WS-Security

Virtual proxy configuration that adds WS-Security to the unsecured target service "ServiceExample"

```
<proxy xmlns="http://ws.apache.org/ns/synapse" name="SecuredServiceExampleProxy" transports="https" startOnLoad="true">
 <target>
    <inSequence>
       <header xmlns:wsse="http://docs.oasis-open.org/wss/2004/01/oasis-200401-wss-wssecurity-secext-1.0.xsd" name="wsse:Security" action="remove" />
```

```
    </inSequence>
    <endpoint>
       <address uri="http://<ServiceExample URL>" />
    </endpoint>
    <outSequence>
       <send />
    </outSequence>
 </target>
 <enableSec />
 <policy                        key="conf:/repository/axis2/service-
groups/SecuredServiceExampleProxy/services/SecuredServiceExampleProx
y/policies/UTOverTransport" />
</proxy>
```

Example 2: Protocol Transformation TCP2HTTP

```
<proxy                        xmlns="http://ws.apache.org/ns/synapse"
name="TCPServiceExample" transports="tcp" startOnLoad="true">
  <target>
     <endpoint>
        <address uri="http://<ServiceExample URL>" />
     </endpoint>
     <outSequence>
        <send />
     </outSequence>
  </target>
</proxy>
```

12.5.1.2 *Dynamic Mediation Task*

In the current vision of the Mediator GE, this enabler allows users to create and manage mediation services “offline”, at design time. A mediation service is a chain of *mediation tasks* and *dynamic mediation tasks* between a service producer and consumer that can be accessed through a Web service interface. This chain deals with all the mediation problems that may arise between these two protagonists.

To cope with some limitations in this current pragmatic vision of how mediation is made – limitations related to potential missing information at design time – the mediator GE offers specific *mediation tasks* called *“Dynamic mediation tasks”*. These tasks may be needed because, at design time (when the chain of tasks is defined), all the needed data and/or information is not necessarily available to be able to solve mediation issues between the caller request (“service consumer”) and the target service (“service provider”).

We postulate that these data and information will become available at runtime and that the *dynamic mediation tasks* will then dynamically solve the remaining mediation issues. This approach is the first step toward a fully dynamic mediation.

The concrete implementation of a *dynamic mediation task* is provided through features provided by an existing asset called *SETHA2* that deals with data, protocol and process mediation in a SOA context. In using semantics to replace the information that are not known, SETHA2 bridges the gap between a consumer and a service provider.

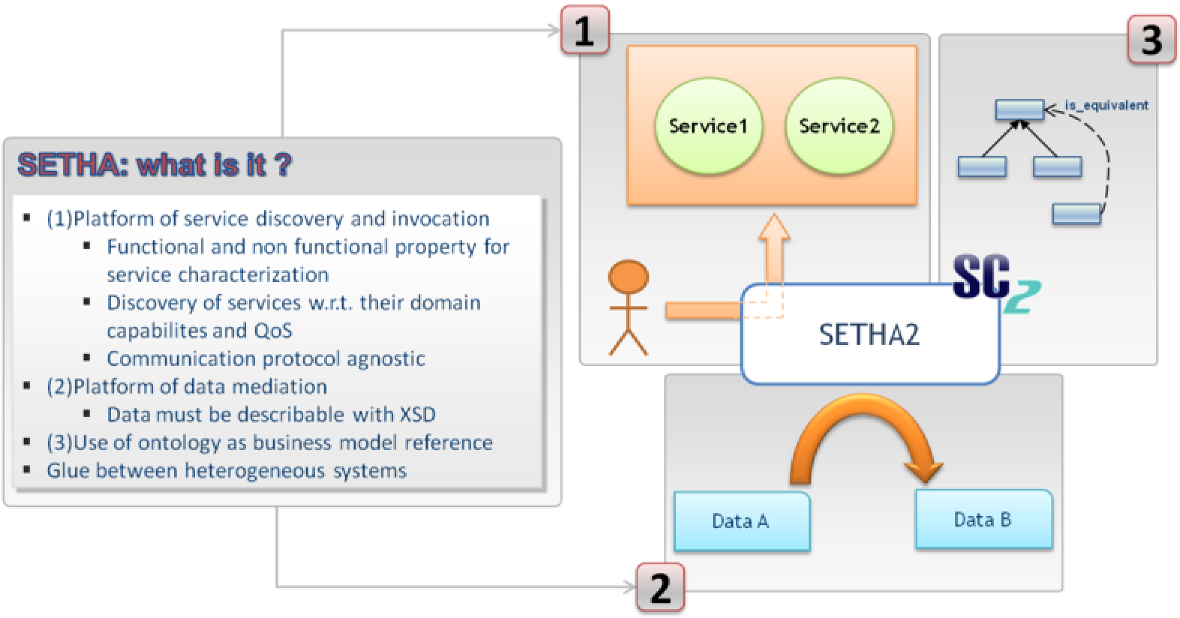


Figure 4.1: SETHA2 dynamic mediation engine

We identify multiple *dynamic mediation tasks* types that are detailed hereafter:

- Data *dynamic mediation tasks*

The data dynamic mediation tasks can be used to solve the following issues:

- Consumer knows the target service and the operation to invoke but not its parameters (e.g. order of parameters, exact type of parameter to use, …). So consumer provides his data, with their semantic description, and the semantic description of the target service. Then the dynamic mediation task builds the payload to provide to the target service.

- Consumer knows the target service but not exactly the operation to invoke (e.g. the precise name of the target operation is not known). So consumer provides his data with their semantic description and the semantic description of the target service. The dynamic task finds the correct semantic matching operation in the target service and builds the payload to provide.

- Protocol *dynamic mediation tasks*

If the target service protocol is not known at design time, the protocol dynamic mediation task will be used to bridge the protocol gap between service consumer and producer (e.g. SOAP/HTTP service consumer and DDS service).

- Process *dynamic mediation tasks*

To be used if there is a potential process mismatch at runtime between the consumer and the producer in the case where one of the processes (either from consumer or producer) is not known at design time.

A second step toward fully dynamic mediation in FI-WARE would be to rely directly on the dynamic mediation SETHA2 engine to deal with extreme cases where only consumer's side requirements are known at design time and all mediation must be automatically defined and invoked at runtime.

12.5.1.3 *Mediation Service*

The mediation service represents the final mediation capability exposed by the Mediator to the external word. A mediation service can be composed by a single mediation task (the simplest case) or by a chain of mediation tasks that can be provided by different Mediator implementations The mediation service is configured with a chain of *mediation tasks* and/or *dynamic mediation tasks*: they are the mediation tasks that the mediation service will execute between the caller and the service.

The *Mediation service URL* is the URL that allows the invocation of the target service with the mediation logic included in the chain of mediation tasks/dynamic mediation tasks configured.

To configure the mediation service the *Target service endpoint* must be specified: it is the URL of the target web service that will be invoked via the mediation service.

12.6 Mediator Architecture

The Mediator GE is used mainly by the Composition Engine GEs within the FI-WARE platform. It provides a layer of virtual proxies to be used by the composer instead of the target services in order to allow the composer support various kinds of target services. Besides the FI-WARE platform, Future Internet applications or composed services on top of the FI-WARE platform can use the mediator as a service for their own purpose.

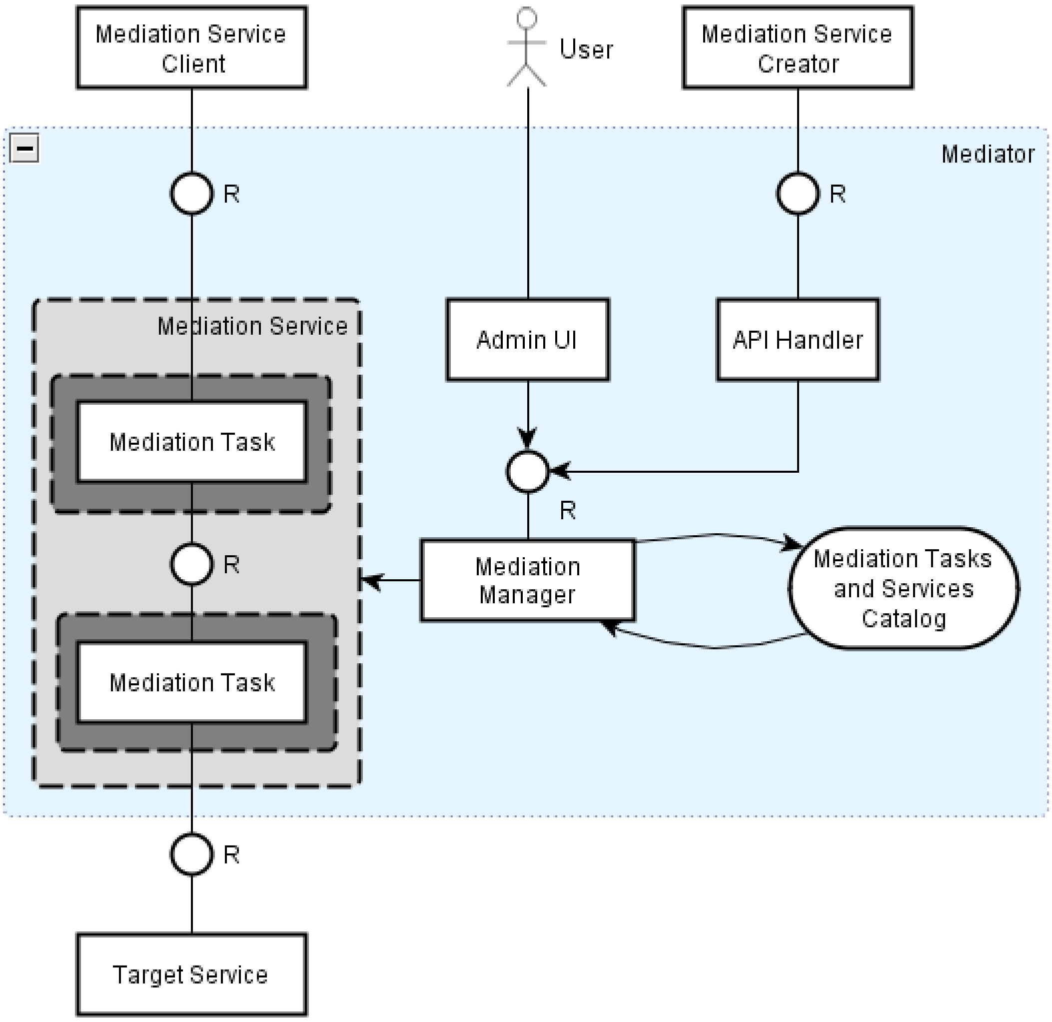


Figure 4.2: Mediator Architecture

12.7 Main Interactions

There are two main interactions provided by the mediator:

- at design time there are interactions in order to create and handle virtual proxies
- at execution time the mediator provides the virtual proxy, whose URL has to be invoked in order to mediate the target service

The design time interaction occurs between a client that plays the role of the Mediation Service Creator and the Mediator.
The execution time interaction occurs between the Mediation Service Clients and the Mediation Services exposed by the Mediator. The mediated services are invoked by the Mediation Service Clients just like any other service.
As regards the current release, all design time interaction needed to manage mediation tasks and services is performed through the Web GUI of the various Mediator Implementations (assets). Refer to the User guide of the specific asset.
The main interaction at execution time will be:

- invocation of the mediation service, exposed by the mediator

The main interactions at design time will be (remote APIs that will be provided by the final release of the mediator):

- create a mediation service (mandatory operation)
- delete a mediation service (mandatory operation)
- get a specific mediation service configuration (mandatory operation)
- get available mediation tasks (mandatory operation)
- get available dynamic mediation tasks (mandatory operation)

12.7.1 Invocation of the Mediation Service

At execution time the mediation capabilities are provided through services that can be invoked by the client GE using the mediation service URL. The mediation services can be exposed using various technologies, for example through soap web services and rest web services.

12.7.2 Mediation Service Management

The design time API will be designed for future releases of the FIWARE platform taking into account the available implementations (assets) of the Mediator GE

12.8 Basic Design Principles

- **API Technology independence**

  The API abstracts the concrete implementation technology. Implementations using various kinds of platforms and frameworks are possible.

- **Modularity**

  Mediation Tasks can be composed, creating Mediation Task chains that realize complex mediation logic.

12.9 Detailed Open Specifications

- **FIWARE.OpenSpecification.Apps.Mediator**

12.10 Concrete Implementation Documentation

12.10.1 Static mediation engine

In order to learn how to create mediation tasks refer to our presentation Mediator-doc and to understand in deep detail the concept of Virtual proxy see apache-synapse project mediation catalog (http://synapse.apache.org/userguide/mediators.html).
In order to have an understanding of the Administration GUI of the static mediation engine see the User guide of Wso2 ESB Wso2-ESB-UserGuide

12.10.2 Dynamic mediation engine

The *setha2* engine offers to FI-WARE a set of dynamic mediation tasks. SETHA2 is a software framework that deals with dynamicity and heterogeneity concerns in the SOA context and is composed of several components/tools that can be deployed independently, depending on the targeted needs of FI-WARE. A major part of SETHA2 is about providing libraries/facilities dedicated to data mediation. A brief description is available at SETHA2_DESCRIPTION.

Examples of dynamic mediation tasks provided by the dynamic mediation engine ("SETHA2"):

- Data *dynamic mediation tasks*
- Protocol *dynamic mediation tasks*
- Process *dynamic mediation tasks*

12.11 Detailed Specifications

12.11.1 Open API Specifications

- FIWARE.OpenSpecification.Apps.MediatorREST

12.11.2 Other Relevant Specifications

None

12.12 Re-utilised Technologies/Specifications

- RESTful web services
- HTTP/1.1
- W3C WS-*
- XML data serialization format

12.13 Terms and definitions

This section comprises a summary of terms and definitions introduced during the previous sections. It intends to establish a vocabulary that will be help to carry out discussions internally and with third parties (e.g., Use Case projects in the EU FP7 Future Internet PPP). For a summary of terms and definitions managed at overall FI-WARE level, please refer to FIWARE Global Terms and Definitions

- **Aggregator (Role):** A Role that supports domain specialists and third-parties in aggregating services and apps for new and unforeseen opportunities and needs. It does so by providing the dedicated tooling for aggregating services at different levels: UI, service operation, business process or business object levels.
- **Application:** Applications in FI-WARE are composite services that have a IT supported interaction interface (user interface). In most cases consumers do not buy the application, instead they buy the right to use the application (user license).
- **Broker (Role):** The business network's central point of service access, being used to

expose services from providers that are delivered through the Broker's service delivery functionality. The broker is the central instance for enabling monetization.

- **Business Element:** Core element of a business model, such as pricing models, revenue sharing models, promotions, SLAs, etc.
- **Business Framework:** Set of concepts and assets responsible for supporting the implementation of innovative business models in a flexible way.
- **Business Model:** Strategy and approach that defines how a particular service/application is supposed to generate revenue and profit. Therefore, a Business Model can be implemented as a set of business elements which can be combined and customized in a flexible way and in accordance to business and market requirements and other characteristics.
- **Business Process:** Set of related and structured activities producing a specific service or product, thereby achieving one or more business objectives. An operational business process clearly defines the roles and tasks of all involved parties inside an organization to achieve one specific goal.
- **Business Role:** Set of responsibilities and tasks that can be assigned to concrete business role owners, such as a human being or a software component.
- **Channel:** Resources through which services are accessed by end users. Examples for well-known channels are Web sites/portals, web-based brokers (like iTunes, eBay and Amazon), social networks (like Facebook, LinkedIn and MySpace), mobile channels (Android, iOS) and work centers. The access mode to these channels is governed by technical channels like the Web, mobile devices and voice response, where each of these channels requires its own specific workflow.
- **Channel Maker (Role):** Supports parties in creating outlets (the Channels) through which services are consumed, i.e. Web sites, social networks or mobile platforms. The Channel Maker interacts with the Broker for discovery of services during the process of creating or updating channel specifications as well as for storing channel specifications and channeled service constraints in the Broker.
- **Composite Service (composition):** Executable composition of business back-end MACs (see MAC definition later in this list). Common composite services are either orchestrated or choreographed. Orchestrated compositions are defined by a centralized control flow managed by a unique process that orchestrates all the interactions (according to the control flow) between the external services that participate in the composition. Choreographed compositions do not have a centralized process, thus the services participating in the composition autonomously coordinate each other according to some specified coordination rules. Backend compositions are executed in dedicated process execution engines. Target users of tools for creating Composites Services are technical users with algorithmic and process management skills.
- **Consumer (Role):** Actor who searches for and consumes particular business functionality exposed on the Web as a service/application that satisfies her own needs.
- **Desktop Environment:** Multi-channel client platform enabling users to access and use their applications and services.
- **Event-driven Composition:** Components concerned with the composition of business logic, which is driven by asynchronous events. This implies run-time

selection of MACs and the creation/modification of orchestration workflows based on composition logic defined at design-time and adapted to context and the state of the communication at run-time.

- **Front-end/Back-end Composition:** Front-end compositions define a front-end application as an aggregation of visual mashable application pieces (named as widgets, gadgets, portlets, etc.) and back-end services. Front-end compositions interact with end-users, in the sense that front-end compositions consume data provided by the end-users and provide data to them. Thus the front-end composition (or mashup) will have a direct influence on the application look and feel; every component will add a new user interaction feature. Back-end compositions define a back-end business service (also known as process) as an aggregation of backend services as defined for service composition term, the end-user being oblivious to the composition process. While back-end components represent atomization of business logic and information processing, front-end components represent atomization of information presentation and user interaction.
- **Gateway (Role):** The Gateway role enables linking between separate systems and services, allowing them to exchange information in a controlled way despite different technologies and authoritative realms. A Gateway provides interoperability solutions for other applications, including data mapping as well as run-time data store-forward and message translation. Gateway services are advertised through the Broker, allowing providers and aggregators to search for candidate gateway services for interface adaptation to particular message standards. The Mediation is the central generic enabler. Other important functionalities are eventing, dispatching, security, connectors and integration adaptors, configuration, and change propagation.
- **Hoster (Role):** Allows the various infrastructure services in cloud environments to be leveraged as part of provisioning an application in a business network. A service can be deployed onto a specific cloud using the Hoster's interface. This enables service providers to re-host services and applications from their on-premise environments to cloud-based, on-demand environments to attract new users at much lower cost.
- **Marketplace:** Part of the business framework providing means for service providers, to publish their service offerings, and means for service consumers, to compare and select a specific service implementation. A marketplace can offer services from different stores and thus different service providers. The actual buying of a specific service is handled by the related service store.
- **Mashup:** Executable composition of front-end MACs. There are several kinds of mashups, depending on the technique of composition (spatial rearrangement, wiring, piping, etc.) and the MACs used. They are called application mashups when applications are composed to build new applications and services/data mash-ups if services are composed to generate new services. While composite service is a common term in backend services implementing business processes, the term 'mashup' is widely adopted when referring to Web resources (data, services and applications). Front-end compositions heavily depend on the available device environment (including the chosen presentation channels). Target users of mashup platforms are typically users without technical or programming expertise.
- **Mashable Application Component (MAC):** Functional entity able to be consumed executed or combined. Usually this applies to components that will offer not only their

main behaviour but also the necessary functionality to allow further compositions with other components. It is envisioned that MACs will offer access, through applications and/or services, to any available FI-WARE resource or functionality, including gadgets, services, data sources, content, and things. Alternatively, it can be denoted as ‘service component’ or ‘application component’.

- **Mediator:** A mediator can facilitate proper communication and interaction amongst components whenever a composed service or application is utilized. There are three major mediation area: Data Mediation (adapting syntactic and/or semantic data formats), Protocol Mediation (adapting the communication protocol), and Process Mediation (adapting the process implementing the business logic of a composed service).
- **Monetization:** Process or activity to provide a product (in this context: a service) in exchange for money. The Provider publishes certain functionality and makes it available through the Broker. The service access by the Consumer is being accounted, according to the underlying business model, and the resulting revenue is shared across the involved service providers.
- **Premise (Role):** On-Premise operators provide in-house or on-site solutions, which are used within a company (such as ERP) or are offered to business partners under specific terms and conditions. These systems and services are to be regarded as external and legacy to the FI-Ware platform, because they do not conform to the architecture and API specifications of FI-WARE. They will only be accessible to FI-WARE services and applications through the Gateway.
- **Prosumer:** A user role able to produce, share and consume their own products and modify/adapt products made by others.
- **Provider (Role):** Actor who publishes and offers (provides) certain business functionality on the Web through a service/application endpoint. This role also takes care of maintaining this business functionality.
- **Registry and Repository:** Generic enablers that able to store models and configuration information along with all the necessary meta-information to enable searching, social search, recommendation and browsing, so end users as well as services are able to easily find what they need.
- **Revenue Settlement:** Process of transferring the actual charges for specific service consumption from the consumer to the service provider.
- **Revenue Sharing:** Process of splitting the charges of particular service consumption between the parties providing the specific service (composition) according to a specified revenue sharing model.
- **Service:** We use the term service in a very general sense. A service is a means of delivering value to customers by facilitating outcomes customers want to achieve without the ownership of specific costs and risks. Services could be supported by IT. In this case we say that the interaction with the service provider is through a technical interface (for instance a mobile app user interface or a Web service). Applications could be seen as such IT supported Services that often are also composite services.
- **Service Composition:** in SOA domain, a service composition is an added value service created by aggregation of existing third party services, according to some predefined work and data flow. Aggregated services provide specialized business functionality, on which the service composition functionality has been split down.

- **Service Delivery Framework:** Service Delivery Framework (or Service Delivery Platform (SDP)) refers to a set of components that provide service delivery functionality (such as service creation, session control & protocols) for a type of service. In the context of FI-WARE, it is defined as a set of functional building blocks and tools to (1) manage the lifecycle of software services, (2) creating new services by creating service compositions and mashups, (3) providing means for publishing services through different channels on different platforms, (4) offering marketplaces and stores for monetizing available services and (5) sharing the service revenues between the involved service providers.
- **Service Level Agreement (SLA):** A service level agreement is a legally binding and formally defined service contract, between a service provider and a service consumer, specifying the contracted qualitative aspects of a specific service (e.g. performance, security, privacy, availability or redundancy). In other words, SLAs not only specify that the provider will just deliver some service, but that this service will also be delivered on time, at a given price, and with money back if the pledge is broken.
- **Service Orchestration:** in SOA domain, a service orchestration is a particular architectural choice for service composition where a central orchestrated process manages the service composition work and data flow invocations of the external third party services in the order determined by the work flow. Service orchestrations are specified by suitable orchestration languages and deployed in execution engines who interpret these specifications.
- **Store:** An external component integrated with the business framework, offering a set of services that are published to a selected set of marketplaces. The store thereby holds the service portfolio of a specific service provider. In case a specific service is purchased on a service marketplace, the service store handles the actual buying of a specific service (as a financial business transaction).
- **Unified Service Description Language (USDL):** USDL is a platform-neutral language for describing services, covering a variety of service types, such as purely human services, transactional services, informational services, software components, digital media, platform services and infrastructure services. The core set of language modules offers the specification of functional and technical service properties, legal and financial aspects, service levels, interaction information and corresponding participants. USDL is offering extension points for the derivation of domain-specific service description languages by extending or changing the available language modules.

- **Mediation Task:** Mediation tasks are the mediation capabilities that can be used via the mediator. The mediator maintains a set of the available mediation tasks.
- **Dynamic Mediation Task**: Mediation Tasks that can handle scenarios where all the needed data and/or information is not necessarily available at design time, but will became available at runtime.
- **Mediation Service**: The mediation service represent the final mediation capability exposed by Mediator GE to the external word. A mediation service can be composed by a single mediation task (the simplest case) or by a chain of mediation tasks that can be provided by different Mediator implementations.

13 FIWARE OpenSpecification Apps Mediator REST

You can find the content of this chapter as well in the wiki of fi-ware.

13.1 Introduction to the *Mediator* API

13.1.1 Mediator API Core

The Mediator API is a RESTful, resource-oriented API accessed via HTTP that uses XML representation for information interchange.
Overall description of the API with its functionalities.

13.1.2 Intended Audience

This specification is intended for both software developers and Cloud Providers. For the former, this document provides a full specification of how to interoperate with Cloud Platforms that implements Mediator API. For the latter, this specification indicates the interface to be provided in order to clients to interoperate with Cloud Platform to provide the described functionalities. To use this information, the reader should firstly have a general understanding of the Generic Enabler service FIWARE.OpenSpecification.Apps.Mediator.
You should also be familiar with:

- ReSTful web services
- HTTP/1.1
- XML data serialization formats.

13.1.3 API Change History

This version of the Mediator API Guide replaces and obsoletes all previous versions. The most recent changes are described in the table below:

Revision Date	Changes Summary
Apr 30, 2012	• Initial version

13.1.4 How to Read This Document

In the whole document it is taken the assumption that reader is familiarized with REST architecture style. Along the document, some special notations are applied to differentiate some special words or concepts. The following list summarizes these special notations.

- A bold, mono-spaced font is used to represent code or logical entities, e.g., HTTP method (GET, PUT, POST, DELETE).
- An italic font is used to represent document titles or some other kind of special text, e.g., URI.
- The variables are represented between brackets, e.g. {id} and in italic font. When the reader find it, can change it by any value.

For a description of some terms used along this document, see FIWARE.OpenSpecification.Apps.Mediator.

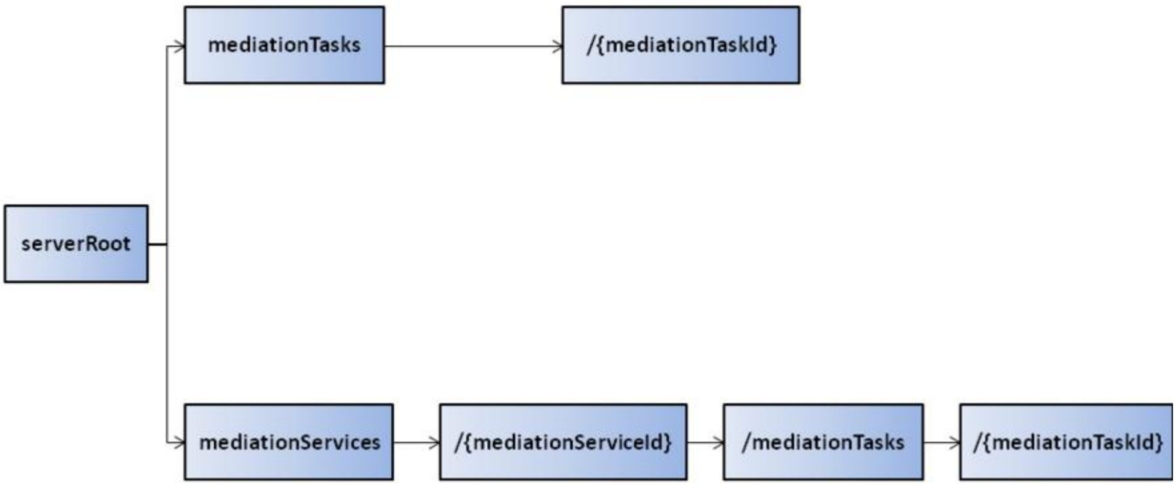
13.1.5 Additional Resources

You can download the most current version of this document from the FIWARE API specification website at <link to the url>. For more details about the Mediator GE that this API is based upon, please refer to <link to the High Level Description>. Related documents, including an Architectural Description, are available at the same site.

13.2 General *Mediator* API Information

13.2.1 Resources Summary

The mediator is structured into mediationServices and mediationTasks.



13.2.1.1 ***MediationService***

13.2.1.2 ***MediationTask***

13.2.2 Authentication

Each HTTP request against the *Mediator GE* requires the inclusion of specific authentication credentials. The specific implementation of this API may support multiple authentication schemes (OAuth, Basic Auth, Token) and will be determined by the specific provider that implements the GE. Please contact with it to determine the best way to authenticate against this API. Remember that some authentication schemes may require that the API operate using SSL over HTTP (HTTPS).

13.2.3 Representation Format

The *Mediator* API supports XML for delivering metadata resources . The request format is specified using the Content-Type header and is required for operations that have a request body. The response format can be specified in requests using the Accept header (application/xml).

The interfaces should support data exchange through XML format:

- *application/xml* - A XML description of the input and output.

13.2.4 Representation Transport

Resource representation is transmitted between client and server by using HTTP 1.1 protocol, as defined by IETF RFC-2616. Each time an HTTP request contains payload, a Content-Type header shall be used to specify the MIME type of wrapped representation. In addition, both client and server may use as many HTTP headers as they consider necessary.

13.2.5 Resource Identification

This section must explain which would be the resource identification used by the API in order to identify unambiguously the resource. For HTTP transport, this is made using the mechanisms described by HTTP protocol specification as defined by IETF RFC-2616.

13.2.6 Links and References

13.2.6.1 *Web citizen*

The mediator is relying on Web principles:

- URI to identify resources
- consistent URI structure based on REST style protocol
- HTTP content negotiation to allow the client to choose the appropriate data format supporting HTML, RDF, XML, RSS, JSON, Turtle, ...
- Human readable output format using HTML rendering ('text/html' accept header) including hyperlinked representation
- Use of HTTP response codes including ETags (proper caching)
- Linked Data enablement supporting RDF input and output types

13.2.6.2 *Linked Open Data*

Publishing data as linked data requires every resource to be directly resolvable given their URL. The basic idea of Linked Data is simple. Tim Berners-Leeâ€™s note on Linked Data describes four rules for publishing data on the Web:

- Use URIs as names for things
- Use HTTP URIs so that people can look up those names.
- When someone looks up a URI, provide useful information, using the standards (RDF*, SPARQL)
- Include links to other URIs, so that they can discover more things.

This can actually achieved by different approaches. One is the use of a special resolver similar to URL shorteners.

So the authoring environment has to ensure that every URI (actually IRI) can be resolved by a HTTP GET request. For example: If a resource is maintained under the URL http://mediator.acme.com/service/xyz but the IRI used in service descriptions is actually http://fi-ware.org/service/xyz, we need a resolver at this location which redirects the request to the actual resource.
Setting up resolvers is more complex task. Therefore we try to follow a simpler approach for the USDLMediatorRest. The API is designed to be directly used for Linked Data publishing without the need for a resolver.

13.2.7 Paginated Collections

In order to reduce the load on the service, we can decide to limit the number of elements to return when it is too big. This section explain how to do that using for example a limit parameter (optional) and a last parameter (optional) to express which is the maximum number of element to return and which was the last element to see.
These operations will have to cope with the possibility to have over limit fault (413) or item not found fault (404).

13.2.8 Limits

We can manage the capacity of the system in order to prevent the abuse of the system through some limitations. These limitations will be configured by the operator and may differ from one implementation to other of the GE implementation.

13.2.8.1 *Rate Limits*

These limits are specified both in human readable wild-card and in regular expressions and will indicate for each HTTP verb which will be the maximum number of operations per time unit that a user can request. After each unit time the counter is initialized again. In the event a request exceeds the thresholds established for your account, a 413 HTTP response will be returned with a Retry-After header to notify the client when they can attempt to try again.

13.2.9 ETag Handling

For standard caching an ETag HTTP header is provided for GET and PUT requests. If a GET requests has a "If-None-Match" header, than the content is only delivered if the stored ETag of the object matches the requested ETag. HTTP status code 304 (not changed) is responded otherwise.
For PUT requests the ETag header can be used to ensure integrity of the repository. The PUT operation will only be executed if the "If-Match" header matches the stored ETag of the resource in the repository. If no "If-Match" header is given for an existing resource or the "If-Match" header does not match the existing ETag of the resource, status code 409 will be returned. If the resource was changed, then a new ETag header will be returned in the response header.

13.2.10 Extensions

In this section we should indicate which are the extension that we could use in the API in order to allow the extensibility of our API. This allow the introduction of new features in the API without requiring an update of the version and also allow the introduction of vendor specific functionality. Applications could recover this information through the following request.

Verb	URI	Description
GET	/extensions	List of all available extensions

We should provide the list of normal response code(s) and the list of error response code(s) together with example in appropriate representation format (XML and/or JSON) about the response of this operation.

13.2.11 Faults

13.2.11.1 *Synchronous Faults*

In this section, we provide the complete list of possible fault elements and error code, and if it is expected in all request or not following this table.

Fault Element	Associated Error Codes	Expected in All Requests?
GET	/limits	[YES]

We must indicate which will be the fault response in XML and/or JSON format and it would be nice if we can provide some type of information associated to the specific error including a message and details.

13.3 API Operations

In this section we go in depth for each operation. In order to provide good comprehensive of the API operations, we would suggest to group them into similar functionalities within subsections. e.g. operations related to VM management in the Cloud Chapter or Context Entity Management in IoT.

13.3.1 Managing MediationServices

13.3.1.1 <*Operation*>

Here we start with the description of the operation following the next table:

Verb	URI	Description
GET	/MediationServices	Get the list of available mediationServices
GET	/MediationServices/{mediationServiceID}	Get the mediationService

PUT	/MediationServices/{mediationServiceID}	Create or update a mediationService
DELETE	/MediationServices/{mediationServiceID}	Delete the mediationService

In addition, we must specify which are the normal response code(s) and the error response code(s) that we obtain in the response to the HTTP Verb. Furthermore, wee provide a description of the functionality and provide some example in XML-based and/or JSON-based representation format both for the Request and the Response.

13.3.1.2 *Error Codes*

200 OK

The request was handled successfully and transmitted in response message.

201 Created

The request has been fulfilled and resulted in a new resource being created.

204 No Content

The server successfully processed the request, but is not returning any content.

304 Not Modified

Indicates the resource has not been modified since last requested. Typically, the HTTP client provides a header like the If-Modified-Since header to provide a time against which to compare. Using this saves bandwidth and reprocessing on both the server and client, as only the header data must be sent and received in comparison to the entirety of the page being re-processed by the server, then sent again using more bandwidth of the server and client.

400 Bad Request

The request cannot be fulfilled due to bad syntax.

404 Not Found

The requested resource could not be found but may be available again in the future. Subsequent requests by the client are permissible.

409 Conflict

Indicates that the request could not be processed because of conflict in the request, such as an edit conflict.

500 Internal Server Error

A generic error message, given when no more specific message is suitable.

13.3.2 Managing MediationTasks

13.3.2.1 <*Operation*>

Verb	URI	Description
GET	/MediationTasks/	Get the list of available mediationTasks
GET	/MediationTasks/{mediationTaskID}	Get the mediationTask

GET	/MediationServices/{mediationServiceID}/MediationTasks	Get the list of mediationTasks set on the mediationService
GET	/MediationServices/{mediationServiceID}/MediationTasks/{mediationTaskID}	Get the mediationTask set on the mediationService

In addition, we must specify which are the normal response code(s) and the error response code(s) that we obtain in the response to the HTTP Verb. Furthermore, wee provide a description of the functionality and provide some example in XML-based and/or JSON-based representation format both for the Request and the Response.

13.3.2.2 *Error Codes*

200 OK

The request was handled successfully and transmitted in response message.

204 No Content

The server successfully processed the request, but is not returning any content.

400 Bad Request

The request cannot be fulfilled due to bad syntax.

404 Not Found

The requested resource could not be found but may be available again in the future. Subsequent requests by the client are permissible.

500 Internal Server Error

A generic error message, given when no more specific message is suitable.

14 FIWARE OpenSpecification Apps ServiceMashup

You can find the content of this chapter as well in the wiki of fi-ware.

Name	FIWARE.OpenSpecification.Apps.ServiceMashup
Chapter	Apps,
Catalogue-Link to Implementation	Mashup Factory
Owner	DT, Horst Stein

14.1 Preface

Within this document you find a self-contained open specification of a FI-WARE generic enabler, please consult as well the FI-WARE Product Vision, the website on http://www.fi-ware.org and similar pages in order to understand the complete context of the FI-WARE project.

14.2 Copyright

14.3 Legal Notice

Please check the following **FI-WARE Open Specification Legal Notice (essential patents license)** to understand the rights to use this open specification. As all other FI-WARE members, DT has chosen one of the two FI-WARE license schemes for open specifications.

To illustrate this open specification license from our DT perspective:

- DT provides the specifications of this Generic Enabler available under IPR rules that allow for a exploitation and sustainable usage both in Open Source as well as proprietary, closed source products to maximize adoption.
- This Open Specification is exploitable for proprietary 3rd party products and is exploitable for open source 3rd party products, including open source licenses that require patent pledges.
- If the owner (DT) of this GE spec holds a patent that is essential to create a conforming implementation of the GE spec (i.e. it is impossible to write a conforming implementation without violating the patent) then a license to that patent is deemed granted to the implementation.

Note: DT provides an instance of Mashup Factory for FIWARE associated Use Case projects under specific terms.

14.4 Overview

Mashups are web applications which combine content and services from various sources in a value-adding manner. This composition of services and content can become a crucial business enabler in combination with the Internet of Services.
Mashups often focus on a very specific situational need and typically use web technologies (e.g. SOAP or RESTful services, or RSS feeds). For the mashup development, expert programming know-how and development environments have been required until now.
Web, telco, media services and content often are accessable via APIs (Application Programming Interface). APIs cover a set of functions that one computer program makes available to other programs so they can talk to the APIs directly. www.programmableweb.de lists more than 4200 APIs. Very popular APIs are google maps, twitter microblogging service, flickr photo sharing service, youtube video sharing and Google search.
The Service Mashup GE is implemented as a tool called Mashup Factory. Mashup Factory is an experimental toolset of DT, which allows end users without programming know-how to compose their own services for their immediate needs in communication, organization and information.
The Mashup Factory toolset supports a graphical composition style, which allows the combination of services and content from several areas (e.g. communication, multimedia, geolocation). It supports integrated APIs from developergarden.com (e.g. SMS, Conference Call) by Deutsche Telekom and external sources (e.g. Google geo data, translator, weather forecast). Note that the Service Mashup GE Open Specifications would allow alternative implementations of this GE.

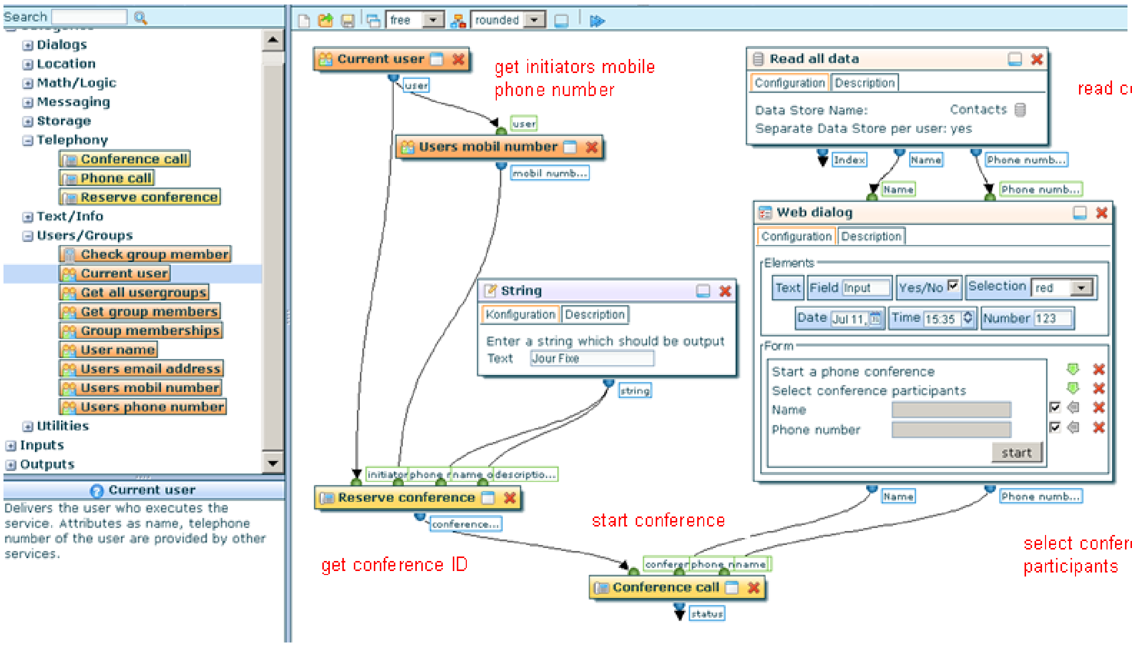
14.5 Basic Concepts

Mashup Factory is an experimental web-based application which supports a user to compose and execute mashups in an intuitive workflow. During the composition of the mashup, user activities like design, creation, configuration and simulation are enabled. After the mashup is designed, it can be activated, executed and monitored by the user. The mashup can be exposed to different consumer environments (e.g. portal, social network) where authentication and invocation can be performed. Technically speaking, the communication between the separated tasks are realized by dedicated service descriptions and service lists.

14.5.1 Build-in Service Repository

During the composition and design process the user can discover and use services from a repository.
Also we envision a large number of repositories containing service descriptions, which also might refer to descriptions in other repositories. Repositories can be hosted by the provider or a provider may use repository services of platform providers. The latter might be an alternative for small sized providers, which don't want to provide an own infrastructure. The

figure below shows a screenshot of an example mashup which allows a user to initiate a phone conference with friends, whose phone numbers are provided from a data store. The service composition consists of basic services for conference call, data retrieval and a web dialog for the selection of conference participants from a user list.



Composition editor of Mashup Factory

The services can be categorized into three categories: application logic (e.g. sending SMS), data (e.g. storing data) and user interface (e.g. creating web dialog). Each service has a dedicated interface, i.e. input and output parameters of particular types. The repository can be extended by other services.

For experimentation purposes we have included services of different areas in the repository:

- a click-to-call (1-1) and a click-to-conference call for telephony
- email and SMS for messaging
- store, retrieve, modify and remove data for structured data storage
- a design-time based editor to configure user interaction structures with input and output parameters
- content services: weather, bible verse, and translation services
- geo position, geo distance, Google Places and displaying geo positions within Google Maps
- several services to support supplementary functions (e.g. text concatenation), logical functions (e.g. filter), user data functions (e.g. phone number).

14.5.2 Composition Editor

The services are graphically represented as boxes; input and output parameters are represented as ports. The user designs connections between services by linking equivalent input and output ports, represented by links. This allows the service creator to develop the mashup in a dataflow oriented composition style by combining services.

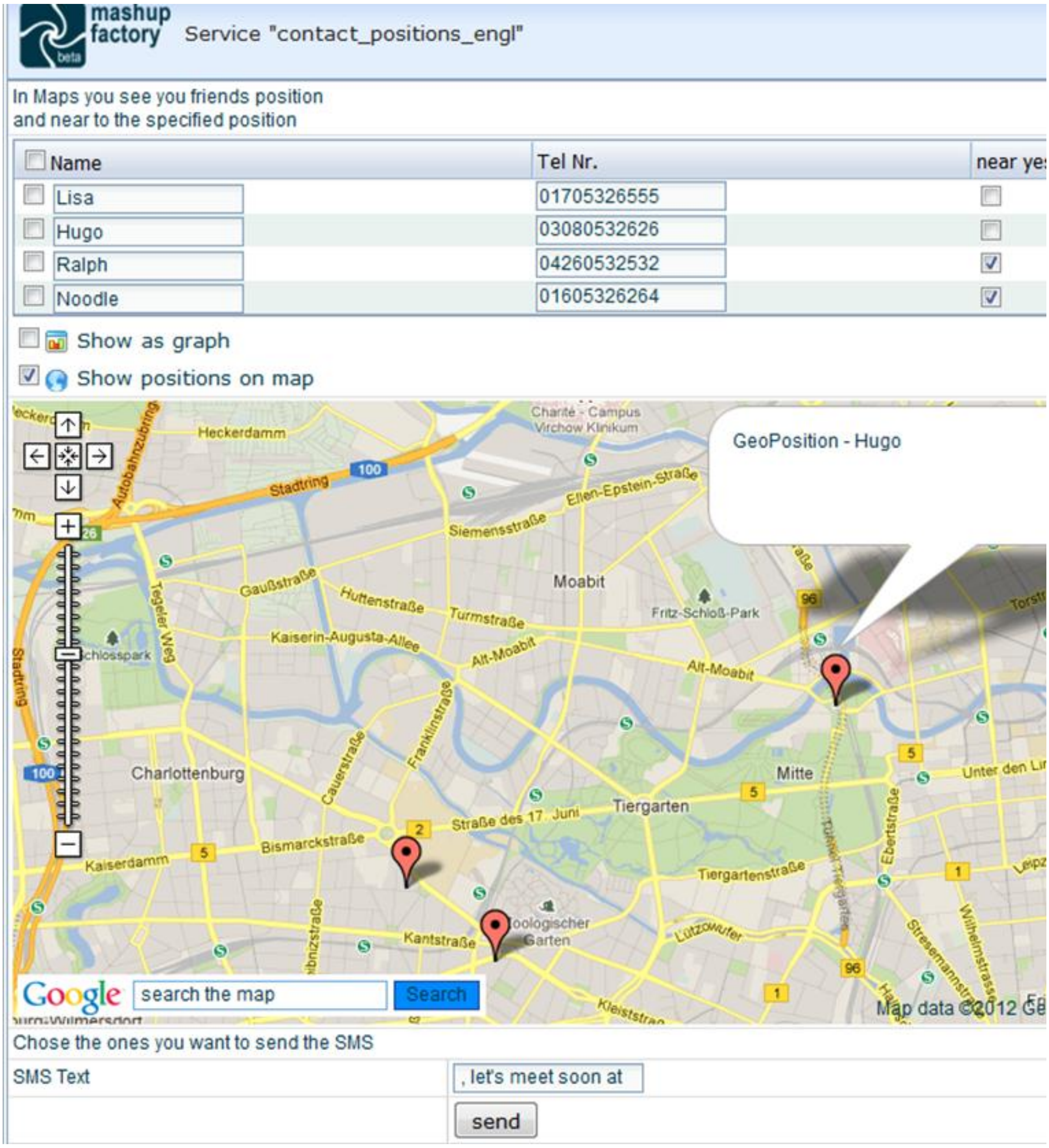
The user interface combines drag-and-drop features for services and simple textual editing functions for configuration purposes. Simple control constructs (e.g. filters, logical operations) are also available. Services are added via drag & drop from the repository to the work surface. A short service description is given in the left corner. Services have input and output ports, services are connected via linking input and output ports. There is a type checker which allows to connect only correct data types, e.g. date with date. Certain services are parameterized with configuration data, e.g. the web dialog. This service adds support for communication with an end-user in a web browser and transfer the user data to other services.

The composition determines which services are integrated in the mashup, and which output is produced. The output (see figure below) of a mashup composition can be

1. a web user interface (e.g. a digital diary)
2. an executed application (e.g. a telephone conference) or
3. a mixture of both (e.g. a web-based poll distributed by SMS).

When a service is composed (i.e. all input ports are connected with an output port), it can be saved as a composition by giving it a name. Service can be debugged by going step by step through the service watching the parameters transferred between the services.

The figure below shows a screenshot of a service output with the geo position of users displayed in Google Maps, with the option to send an SMS.



Output of a mashup

14.5.3 Service Execution

During the execution of a mashup the services are orchestrated in a data flow style, i.e. a service is executed when all input parameters are available.

The lifecycle of service execution can be managed by activating, stopping, renaming or removing services. The status of a service can be monitored and the period of activation defined. Dedicated users and user groups can be given permissions to consume the services.

The execution is performed by a (standard) BPEL (Business Process Execution Language) engine. The services are called via SOAP requests and executed under the responsibility of the service provider. Thus, QoS of the services and the mashups cannot be guaranteed by Mashup Factory.

14.5.4 Users and Groups

Mashup Factory allows the management of users and groups. Some attributes (e.g. email address, phone number, login name) of the users can be edited and they can be organized into groups. User attributes can be retrieved by a service composition at run time. Every service composition can be given permissions determining which users and groups (and their respective users) are allowed to execute it.
Caution: The users of Mashup Factory are responsible for the data of test users, keeping legal constraints concerning data security.

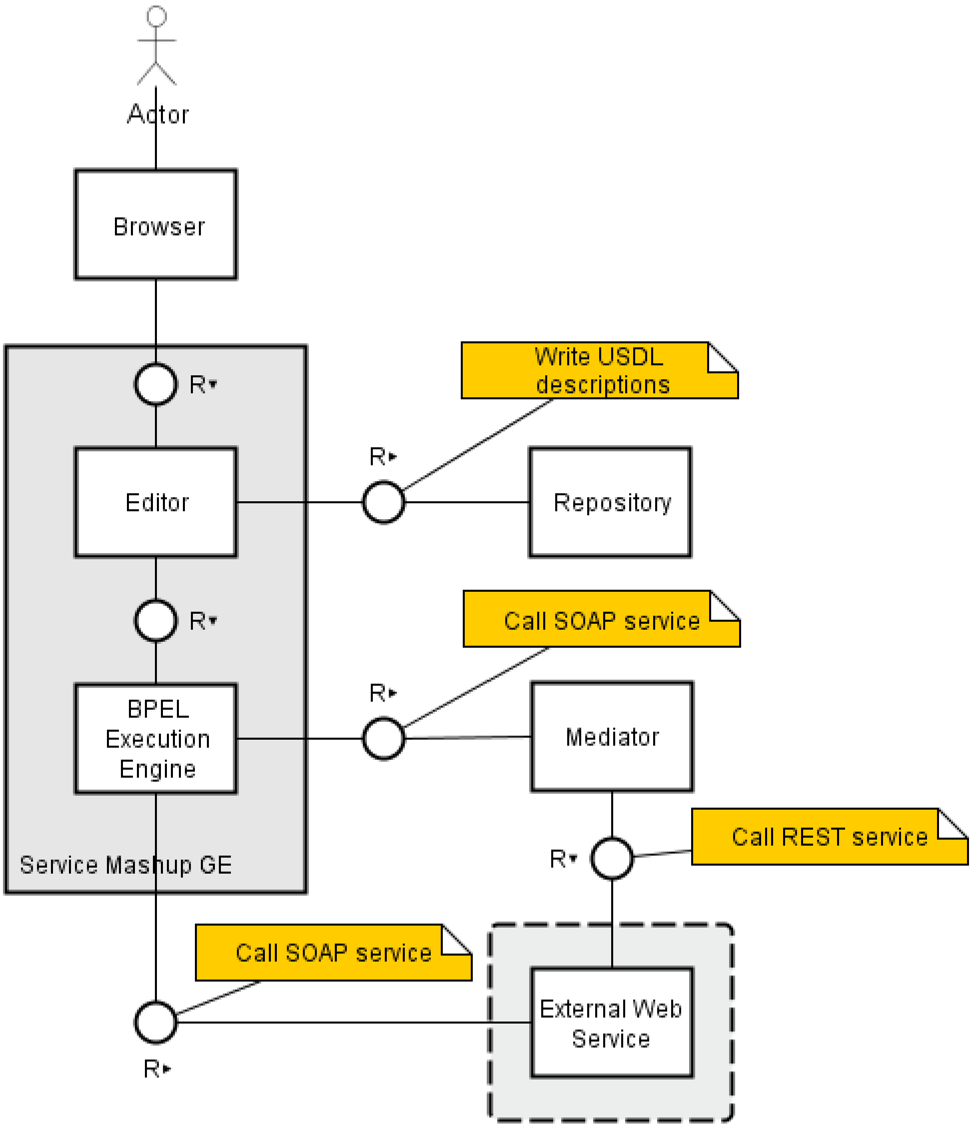
14.5.5 Example Scenarios

In the following section the composition process and some illustrative application scenarios will be described. Imagine a person who frequently organizes (trekking) tours of a group of friends. He wants to reduce his effort to contact his friends for finding adequate dates and notify the group with relevant information. He builds a mashup by using Mashup Factory, which in turn uses a weather service, SMS and a web based survey.
Other possible scenarios for supporting immediate needs in communication, organization and information are

- providing a digital diary for monitoring health data with weight, blood pressure data where an SMS will be sent to a supervising person in case of exceeding a threshold
- conducting a web based survey for a (sports) club
- sending SMS to customers if they are close (related to a geo position) to a defined place (e.g. special offers in shop)
- inviting club members via voice mail to a day of an open door
- distributing particular content (e.g. bible verses, pollen information) to an interested audience
- performing video transmissions to selected persons, e.g. for health training, education, team meetings

For realizing the scenarios, appropriate services must be integrated and perform their services with an adequate level of quality.

14.6 ServiceMashup Architecture



Service Mashup Architecture

The Mashup Factory follows the architecture of a Rich Internet Application. All user interaction takes place using a Web browser as user agent, all application logic is implemented on a Web server. There are no software components to be installed on the client side except for the Web browser.

14.6.1 Technical Interfaces

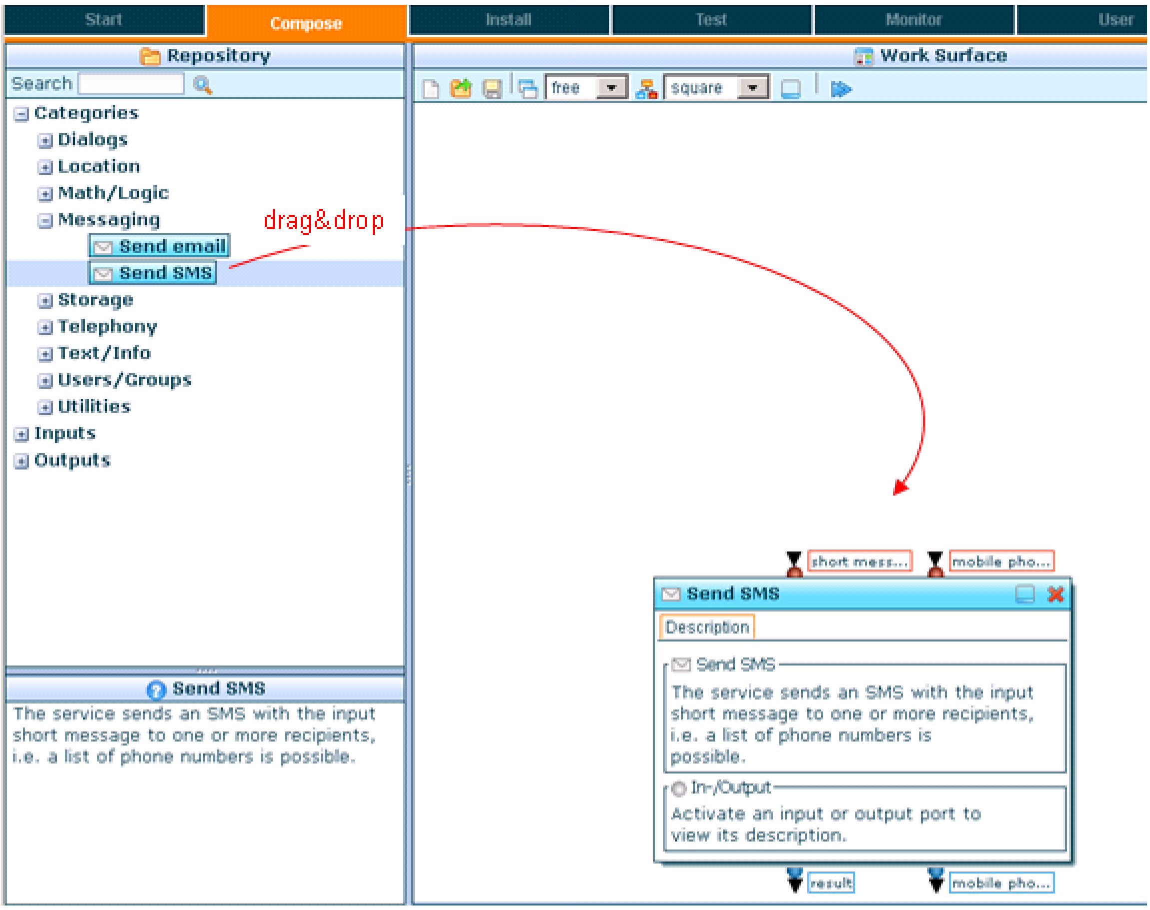
The Web browser communicates with the Mashup Factory server using HTML and Ajax technologies. The Web server needs to comply with the Java EE servlet container specification. The Editor communicates to the BPEL Execution Engine and the Repository GE via REST interfaces, the Mediator GE and all other external Web services are called from the BPEL Execution Engine via SOAP protocol. For the purpose of storing the BPEL service descriptions and other internal data an XML database is used that is also hosted in the servlet container.

14.7 Main Interactions

To give an idea how to use and interact with the Mashup Factory to create Service Mashups this section provides a step-by-step introduction to compose exemplary services.

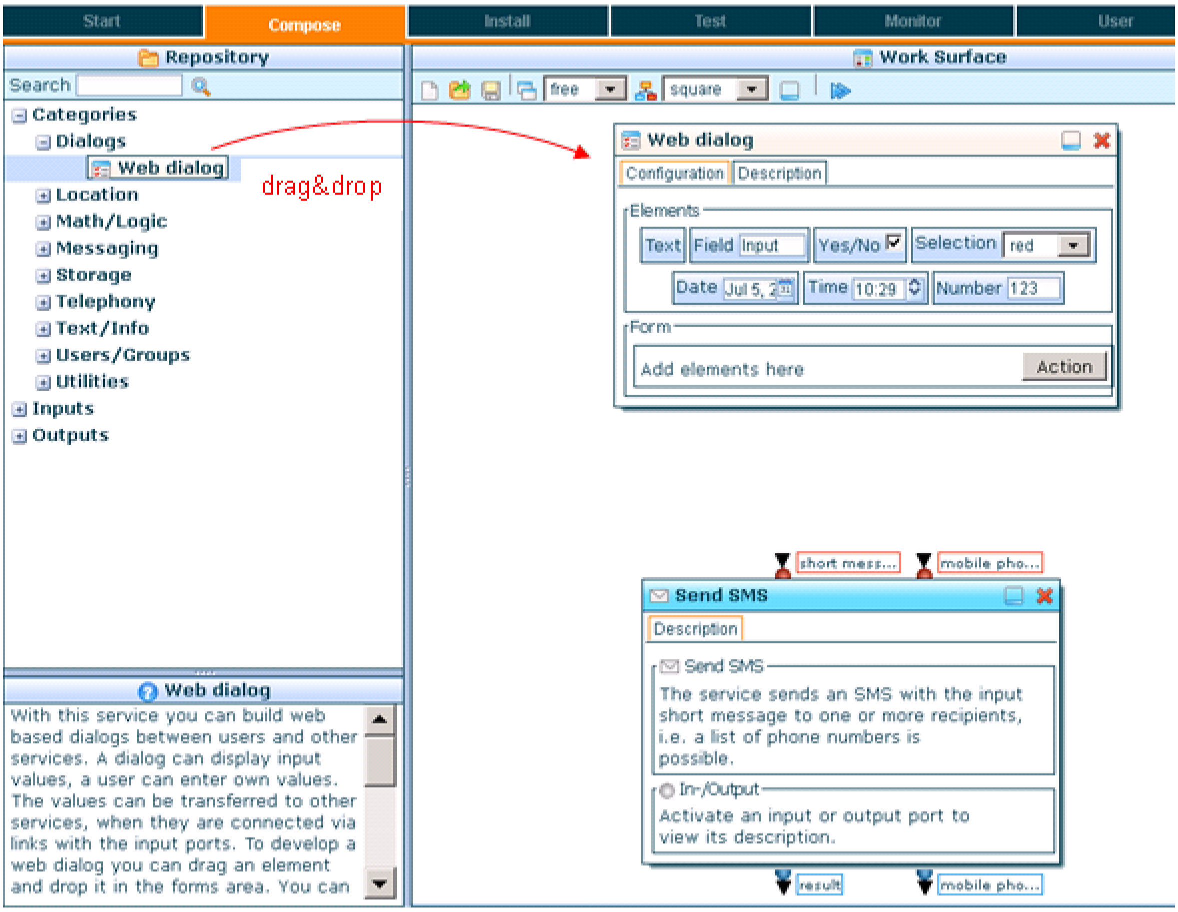
14.7.1 Send SMS Service

A "send SMS" service composition depicts the easy composition process with Mashup Factory and illustrates the functions and components. Purpose of the service is a web dialog to send a SMS, which can be used by an authorized user by entering the message text and the phone number. In the Compose section you browse the repository for “Send SMS”. Drag this box with the mouse and drop it on the work surface.



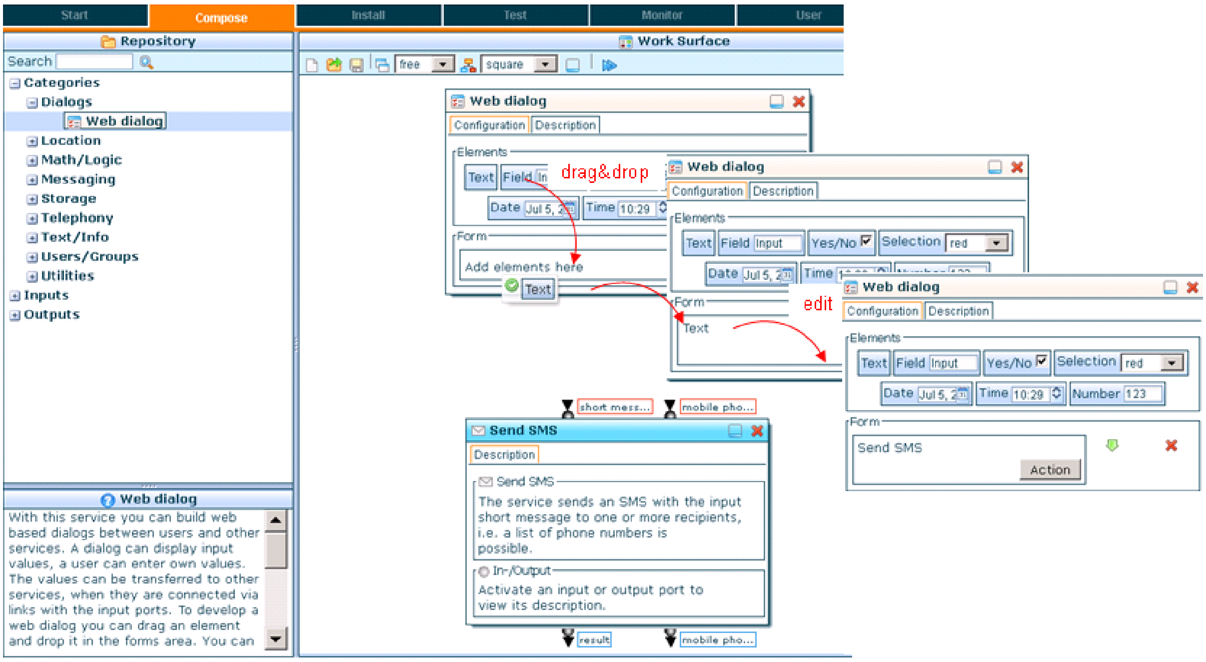
Send SMS Service - Step 1

The “Send SMS” service has two input ports which have to be connected with other services. Thus, fetch the Web Dialog from the repository and drag it on the work surface.



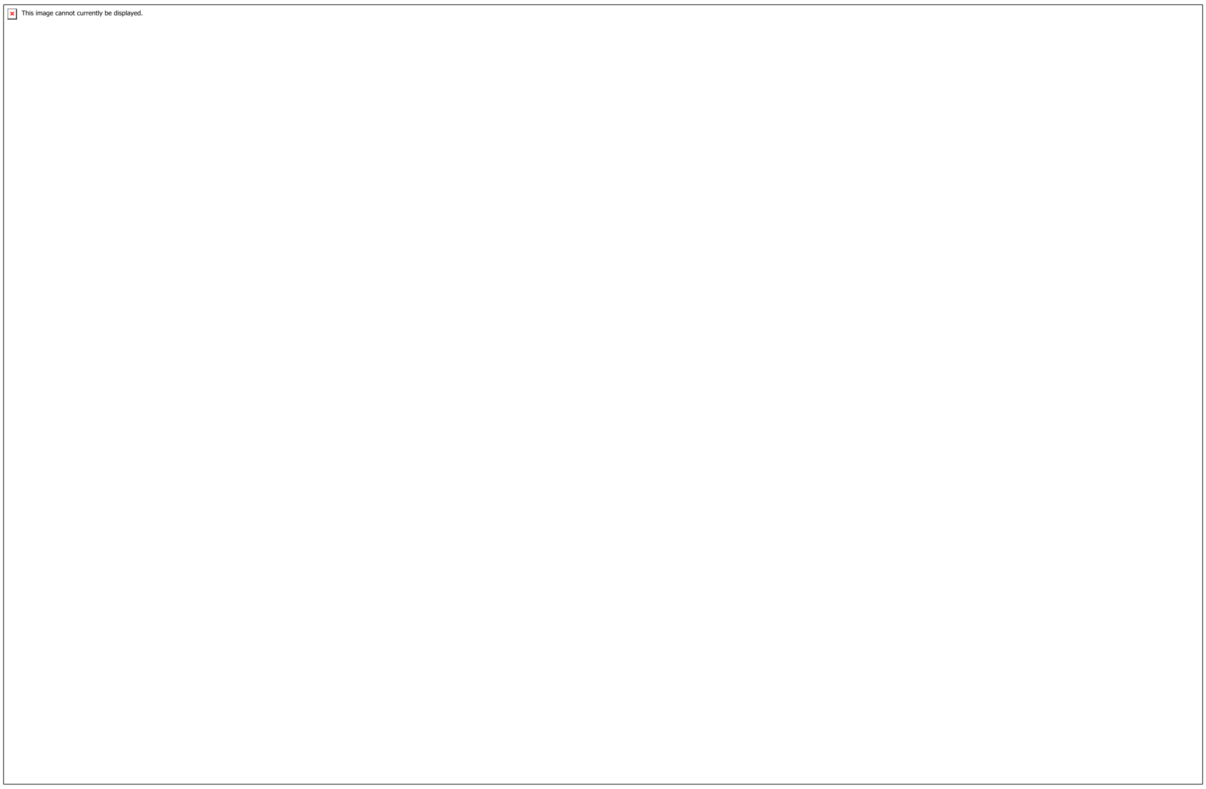
Send SMS Service - Step 2

In the Web dialog you can edit the user interface which later is displayed in the web browser. Relevant data fields of the user who consumes the service, are added herein. To create the appropriate dialog you can drag an element from the Elements area of the Web dialog and drop it in the Form space. Start with dragging a text element, position it, and edit it by double clicking on the Text field. Enter “Send SMS” and press return.



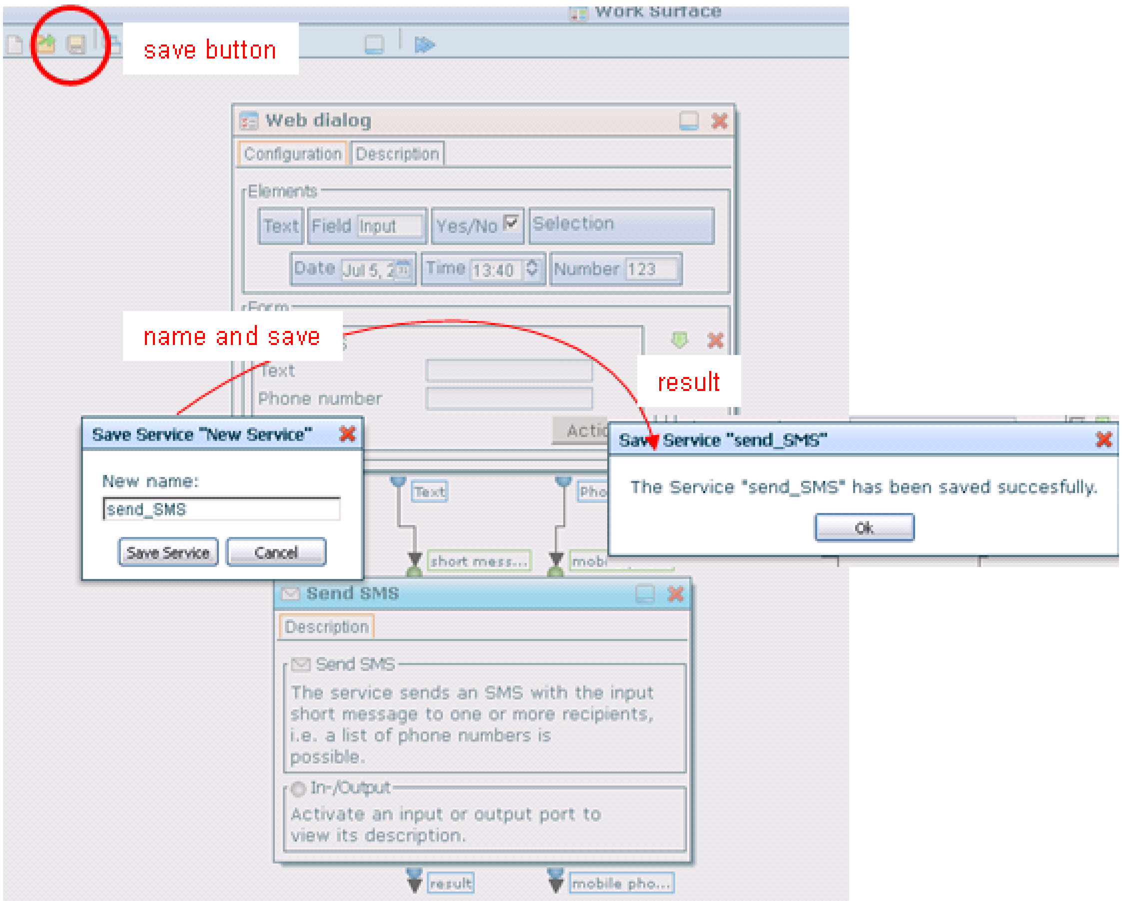
Send SMS Service - Step 3

Next, enter the message text and the phone number by using the field Element. You find two new output ports below the Web dialog box Connect the output ports with the corresponding input ports of the Send SMS.



Send SMS Service - Step 4

That's it! Your first service composition is created. Now you save it by giving it a name. You get a result message in case of storage.

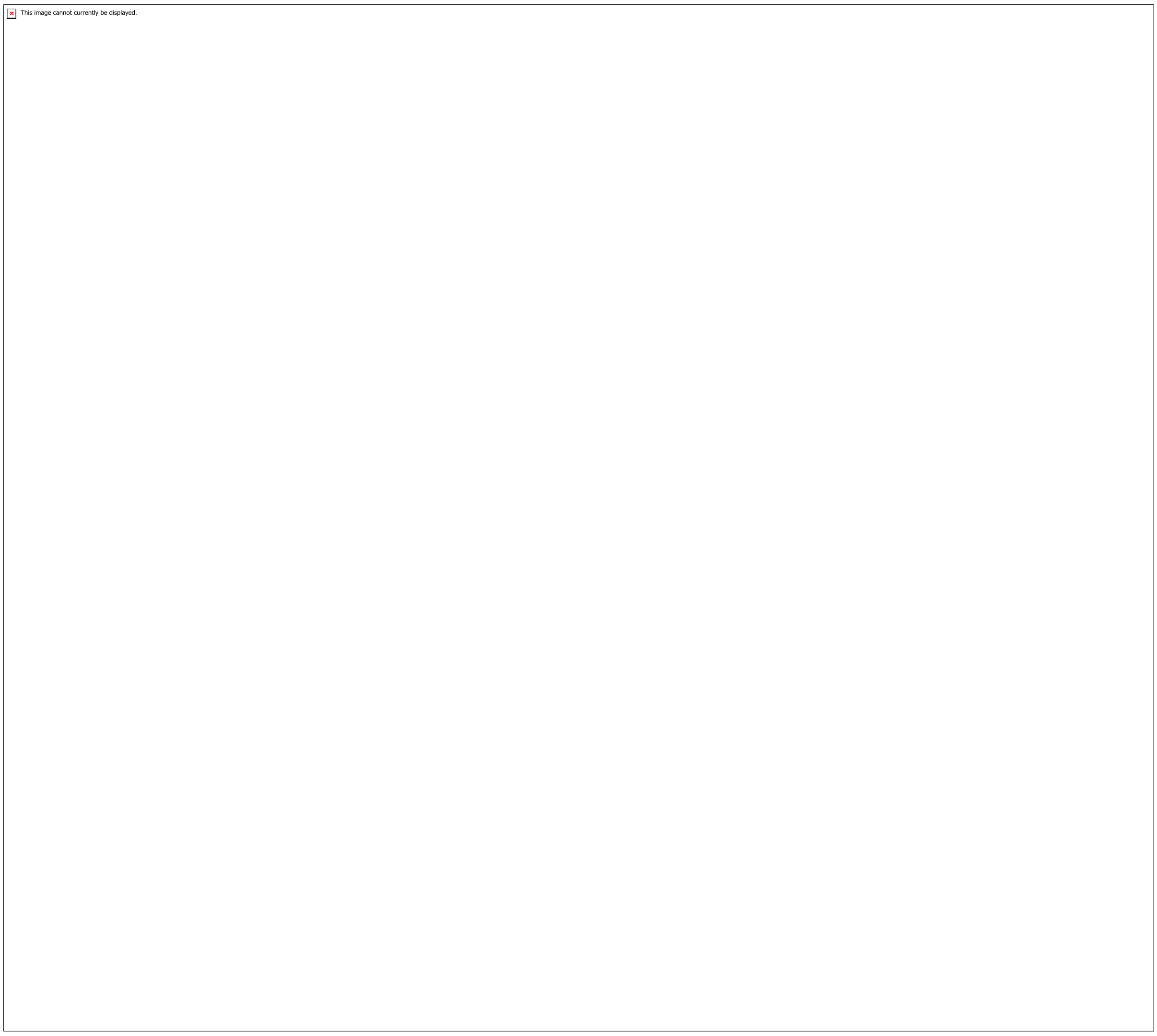


Send SMS Service - Step 5

Install the new service by pushing the execution button. If the status turns to green, the service can be executed.

Send SMS Service - Step 6

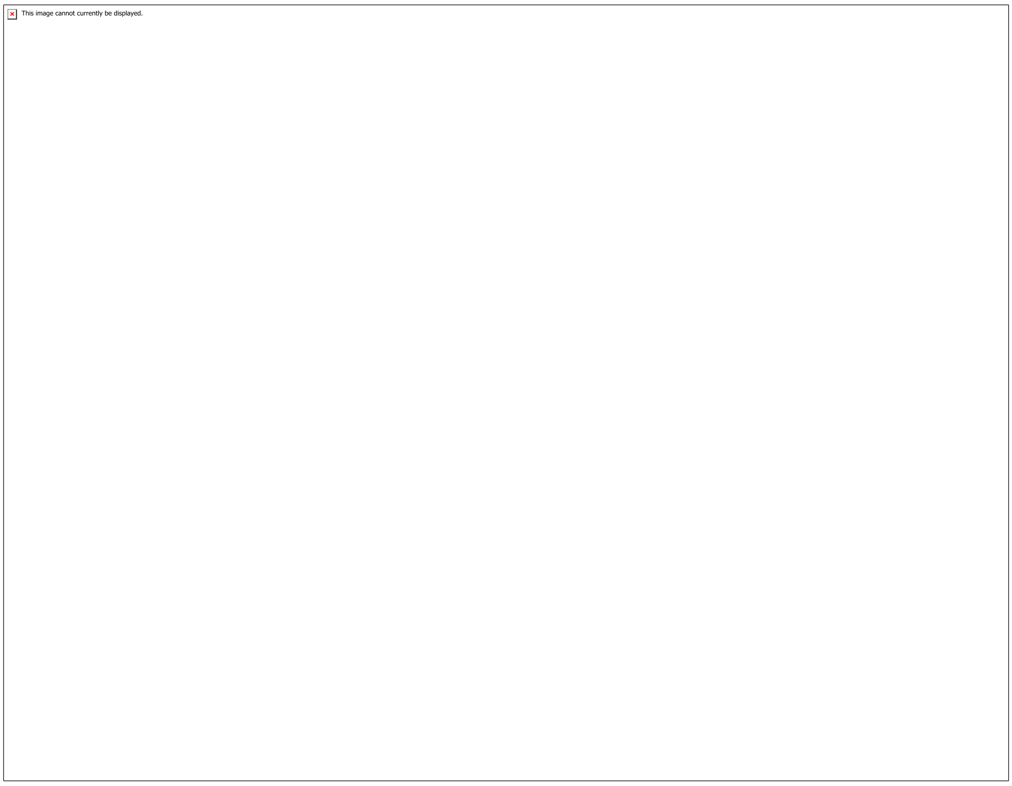
Test the new service and login under your user name as a developer. You find the new service as link and start it by pushing the link. A new tab is opened with the web dialog you have designed. Fill in data, activated the action button and the SMS is sent!



Send SMS Service - Step 7

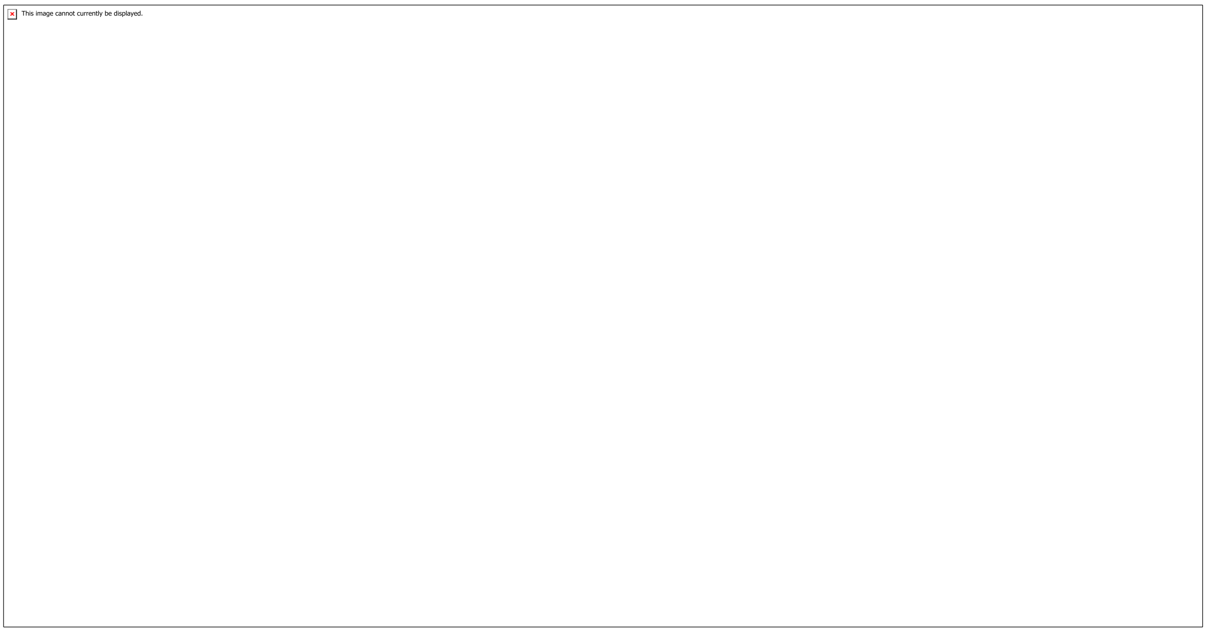
14.7.2 Using Data Stores

A data store can be used to store and retrieve data for your service composition, e.g. diary data, addresses, locations etc. Once you have created a data store you can add, modify, read or remove the data. A simple address book with the two services (add a new contact and read my contacts) illustrates the handling. For adding a new contact you drag the 'New data store' from the repository. The input port is connected with one or more output ports from other services. Here a 'web dialog' with a Field Element Name and Field Element Phone number is used in order to allow the user to enter the data



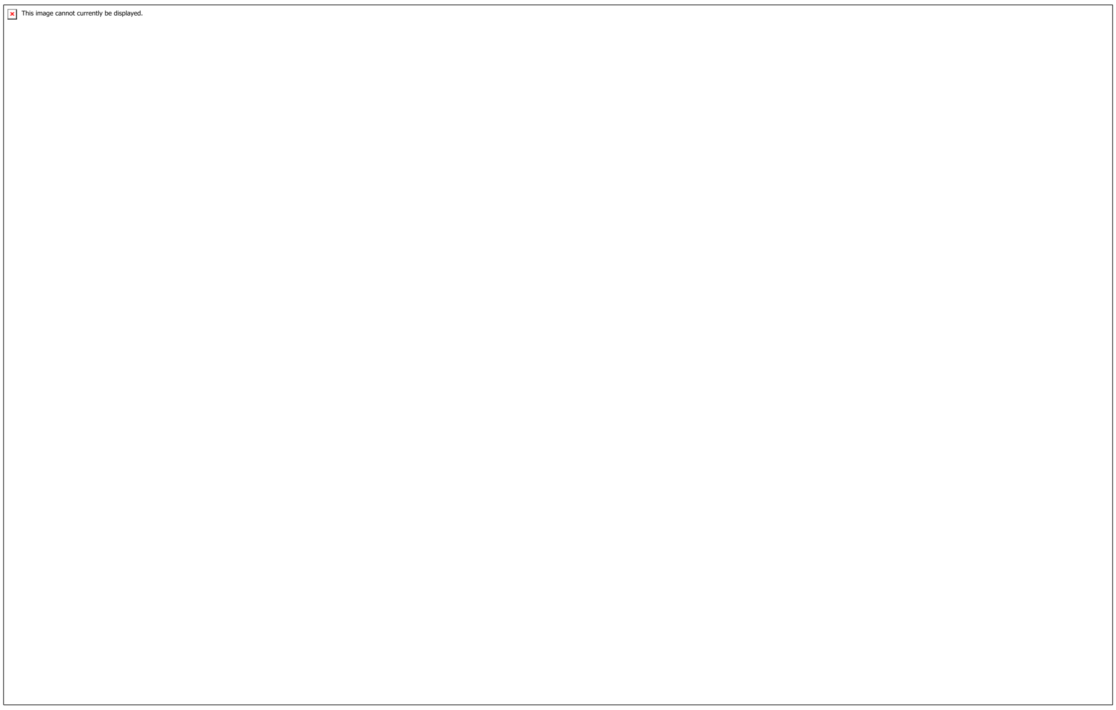
Using Data Stores - Step 1

After connecting of an output port (e.g. Name of ‘Web Dialog’) to the input port New (of ‘New Data Store’), the port is added to ‘New data store’. When all input data are defined for the data store, denominate it with a name (e.g. Contacts) for the data store. You can decide, whether the data store is user-specific (e.g. diary) or common (e.g. survey) by setting a flag.



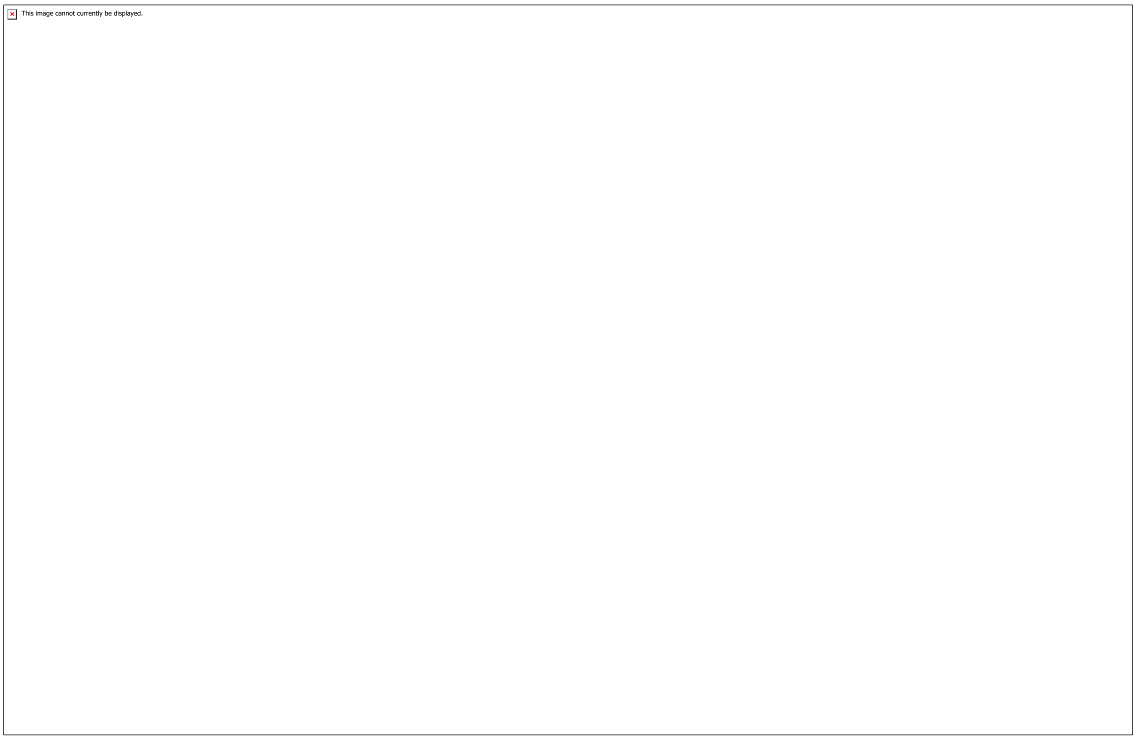
Using Data Stores - Step 2

Click the + to save the store. After storage the name of the service is changed to ‘Add data store’. Then save the new composition by giving it a name (e.g. addContact).



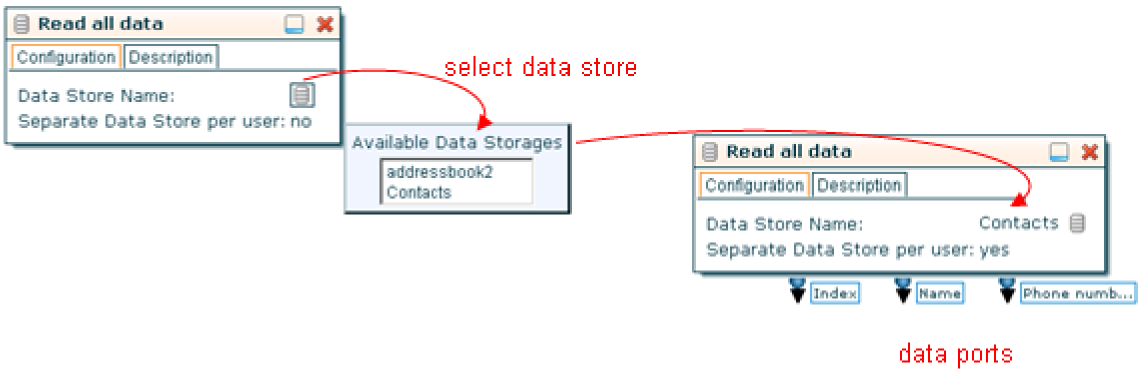
Using Data Stores - Step 3

You install it and test it by clicking on the link. Enter data in the dialog and repeat it with some contacts.



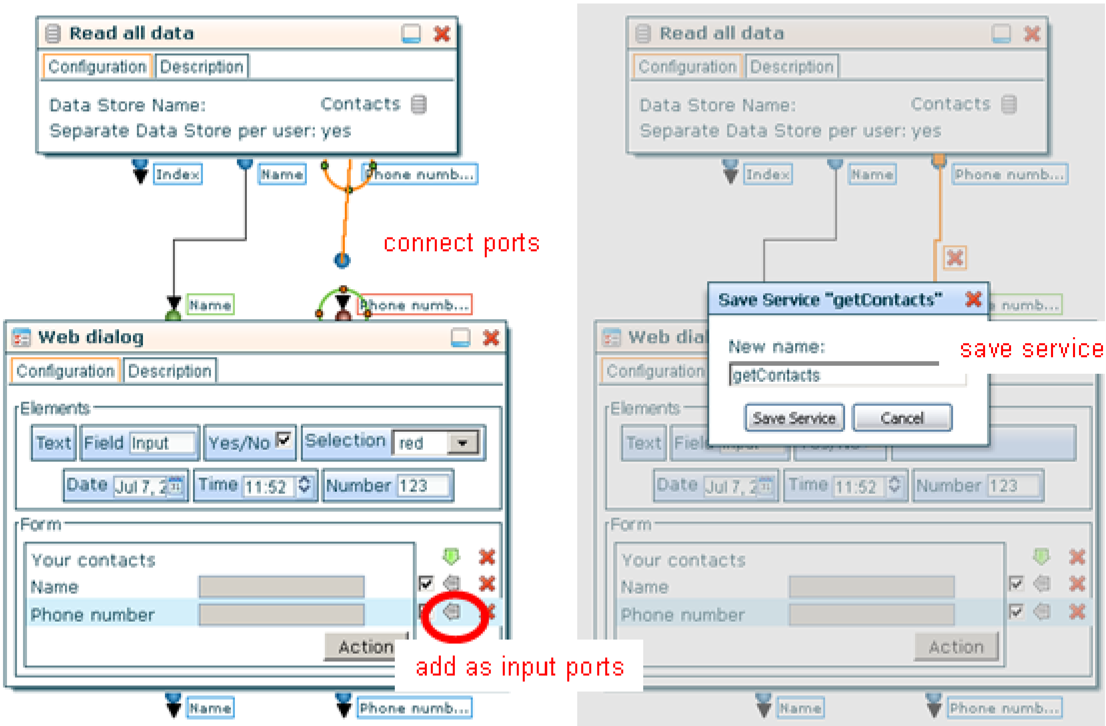
Using Data Stores - Step 4

For displaying the data of your contacts, create a new service for reading the contacts. Drop the ‘Read all data’ service and choose Contacts from the Data Stores. The service has the output ports to read the data of Contacts (and in additional port Index, which can be used to modify the data).



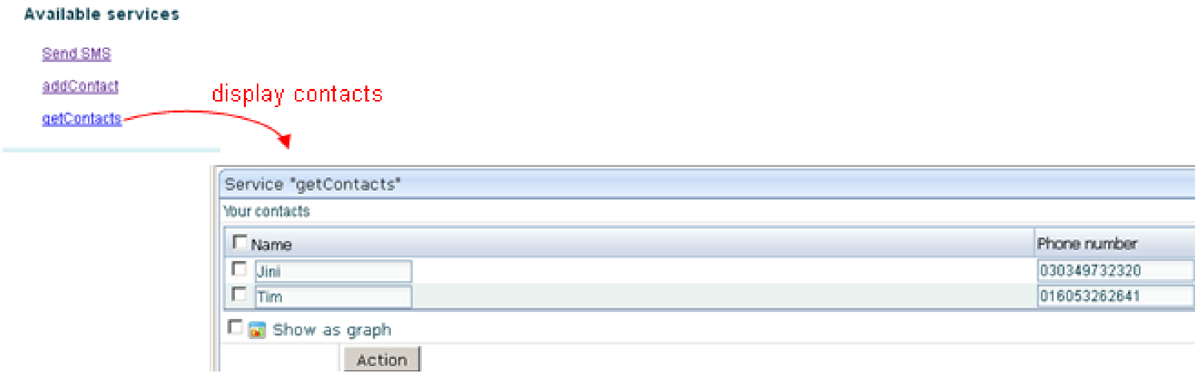
Using Data Stores - Step 5

To display the data you can use a 'Web dialog'. Configure the dialog by dragging and dropping the Elements. Mark the fields Name and Phone number as input ports by pressing the green arrow. Connect the corresponding ports and save the composition with the name getContacts.



Using Data Stores - Step 6

Install and test getContacts. You get a list of contacts, which you have added to your contact store.



Using Data Stores - Step 7

14.8 Basic Design Principles

The design goal of Mashup Factory was to implement a special purpose BPEL editor for non-experts using a graphical approach to express Service Orchestration. Any technical aspects of the BPEL specification should be hidden from the user experience by using a data flow oriented service composition approach. The underlying BPEL structures should be fully transparent to the end user.

14.8.1 Data flow paradigm

Web services are invoked by providing input data as parameters and retrieving the return values as result of the Web service call. This concept was remodeled to a data flow approach where the input data for a graphical representation of a Web service "flows" into input ports and the result data returned from Web service invocation is presented at output ports. These ports can be connected by virtually wiring the ports in the graphical editor as if the output data of one Web service flow into the input ports of other Web services. By wiring the different Web services the end-user defines the sequence in which the services will be called at runtime by the BPEL execution engine resulting in an Service Orchestration.

14.8.2 Typed ports

Web service parameters are typed and can even handle complex types. In order to keep this typed data handling in the graphical composition approach the input and output ports of the Web service building blocks are also typed. The wiring logic allows only connecting ports of the same type (since it isn't of much sense to "feed" a user name into a port which expects geo coordinates). The data typing uses a two level hierarchical design. The lower level denotes a primitive type like Integer or String the higher level abstracts from the primitive type by defining a semantically meaningful type like "username", "date" or "geo position". Only the semantically meaningful types are presented at the user interface of the service editor. The only exception are generic service components like the dialog service, which allows end-users to build customized forms which will be visually displayed at service execution time. For the sake of clearness only form components/fields with primitive types may be used in the form editor (as there are too many high level types). The wiring logic takes the underlying primitive types into account when a port of the form service is connected to an ordinary port (e.g. a form port of type String is allowed to connect to a port of type "phone number" because the underlying type is also String).

14.9 Detailed Open Specifications

14.9.1 Open API Specifications

The Service Mashup GE Mashup Factory is not exposed as a service but as a Rich Internet Application, accessed through the end user's Web browser. Although some GE components are exposed as services, they only expose an API for internal consumption (within the GE), but it is not foreseen that they will be integrated by other GEs.

The Mashup Factory will access the Mediator and Repository REST APIs:

- FIWARE.OpenSpecification.Apps.MediatorREST
- FIWARE.OpenSpecification.Apps.RepositoryREST

14.10 Re-utilised Technologies/Specifications

The Service Mashup GE requires both authentication and authorization in order to safeguard the different compositions from its users.

- It is recommended to use the OAuth2 protocol: http://tools.ietf.org/html/draft-ietf-oauth-v2-30

On the other hand, Service Mashup GE relies on the Mediator and Repository GEs, so it must support the following technologies and specifications:

- RESTful web services
- HTTP/1.1
- JSON and XML data serialization formats
- Linked USDL

14.11 Terms and definitions

This section comprises a summary of terms and definitions introduced during the previous sections. It intends to establish a vocabulary that will be help to carry out discussions internally and with third parties (e.g., Use Case projects in the EU FP7 Future Internet PPP). For a summary of terms and definitions managed at overall FI-WARE level, please refer to FIWARE Global Terms and Definitions

- **Ajax:** an acronym for Asynchronous JavaScript and XML is a group of interrelated web development techniques used on the client-side to create asynchronous web applications. With Ajax, web applications can send data to, and retrieve data from, a server asynchronously (in the background) without interfering with the display and behavior of the existing page. Ajax is not a single technology, but a group of technologies.
- **Application:** Applications in FI-Ware are composite services that have a IT supported interaction interface (user interface). In most cases consumers do not buy the application they rather buy the right to use the application (user license).
- **BPEL:** Business Process Execution Language (BPEL), short for Web Services Business Process Execution Language (WS-BPEL) is an OASIS standard executable

language for specifying actions within business processes with web services. Processes in BPEL export and import information by using web service interfaces exclusively.

- **Business Process:** Set of related and structured activities producing a specific service or product, thereby achieving one or more business objectives. An operational business process clearly defines the roles and tasks of all involved parties inside an organization to achieve one specific goal.
- **Click-to-call** also known as click-to-talk, click-to-chat and click-to-text, is a form of Web-based communication in which a person clicks an object (e.g., button, image or text) to request an immediate connection with another person in real-time either by phone call, Voice-over-Internet-Protocol (VoIP), or text. Click to talk requests are most commonly made on websites but can also be initiated by hyperlinks placed in email, blogs, wikis, flash animations or video, and other Internet-based object or user interfaces.
- **Composite Service (composition):** Executable composition of business back-end MACs. Common composite services are either orchestrated or choreographed. Orchestrated compositions are defined by a centralized control flow managed by a unique process that orchestrates all the interactions (according to the control flow) between the external services that participate in the composition. Choreographed compositions do not have a centralized process, thus the services participating in the composition autonomously coordinate each other according to some specified coordination rules. Backend compositions are executed in dedicated process execution engines. Target users of tools for creating Composites Services are technical users with algorithmic and process management skills.
- **Data flow:** A data flow is a graphical representation of the "flow" of data through an information system, modeling its process aspects. A Data flow shows what kinds of information will be input to and output from the system, where the data will come from and go to, and where the data will be stored.
- **Java EE:** Java Platform, Enterprise Edition or Java EE is Oracle's enterprise Java computing platform. The platform provides an API and runtime environment for developing and running enterprise software, including network and web services, and other large-scale, multi-tiered, scalable, reliable, and secure network applications. Java EE extends the Java Platform, Standard Edition (Java SE/J2SE), providing an API for object-relational mapping, distributed and multi-tier architectures, and web services. The platform incorporates a design based largely on modular components running on an application server.
- **Mashup:** Executable composition of front-end MACs. There are several kinds of mashups, depending on the technique of composition (spatial rearrangement, wiring, piping, etc.) and the MACs used. They are called application mashups when applications are composed to build new applications and services/data mash-ups if services are composed to generate new services. While composite service is a common term in backend services implementing business processes, the term ‘mashup’ is widely adopted when referring to Web resources (data, services and applications). Front-end compositions heavily depend on the available device environment (including the chosen presentation channels). Target users of mashup platforms are typically users without technical or programming expertise.

- **Mashable Application Component (MAC):** Functional entity able to be consumed executed or combined. Usually this applies to components that will offer not only their main behaviour but also the necessary functionality to allow further compositions with other components. It is envisioned that MACs will offer access, through applications and/or services, to any available FI-WARE resource or functionality, including gadgets, services, data sources, content, and things. Alternatively, it can be denoted as 'service component' or 'application component'.
- **Mediator:** A mediator can facilitate proper communication and interaction amongst components whenever a composed service or application is utilized. There are three major mediation area: Data Mediation (adapting syntactic and/or semantic data formats), Protocol Mediation (adapting the communication protocol), and Process Mediation (adapting the process implementing the business logic of a composed service).
- **Portal:** A web portal is a web site that brings information from diverse sources in a unified way. Usually, each information source gets its dedicated area on the page for displaying information (a portlet); often, the user can configure which ones to display.
- **Provider:** Actor who publishes and offers (provides) certain business functionality on the Web through a service/application endpoint. This role also takes care of maintaining this business functionality.
- **QoS:** Quality of service is the ability to provide different priority to different applications, users, or data flows, or to guarantee a certain level of performance to a data flow.
- **Registry and Repository:** Generic enablers that able to store models and configuration information along with all the necessary meta-information to enable searching, social search, recommendation and browsing, so end users as well as services are able to easily find what they need.
- **REST:** REpresentational State Transfer is a style of software architecture for distributed systems such as the World Wide Web. REST has emerged as a predominant Web service design model. REST facilitates the transaction between web servers by allowing loose coupling between different services. REST is less strongly typed than its counterpart, SOAP. The REST language uses nouns and verbs, and has an emphasis on readability. Unlike SOAP, REST does not require XML parsing and does not require a message header to and from a service provider. This ultimately uses less bandwidth. REST error-handling also differs from that used by SOAP.
- **Rich Internet Application (RIA)** is a Web application designed to deliver the same features and functions normally associated with deskop applications. RIAs generally split the processing across the Internet/network divide by locating the user interface and related activity and capability on the client side, and the data manipulation and operation on the application server side. An RIA normally runs inside a Web browser.
- **RSS:** Rich Site Summary (originally RDF Site Summary, often dubbed Really Simple Syndication) is a family of web feed formats used to publish frequently updated works—such as blog entries, news headlines, audio, and video—in a standardized format. An RSS document (which is called a "feed", "web feed", or "channel") includes full or summarized text, plus metadata such as publishing dates and authorship.

- **Service:** We use the term service in a very general sense. A service is a means of delivering value to customers by facilitating outcomes customers want to achieve without the ownership of specific costs and risks. Services could be supported by IT. In this case we say that the interaction with the service provider is through a technical interface (for instance a mobile app user interface or a Web service). Applications could be seen as such IT supported Services that often ar also composite services.
- **Service Composition:** in SOA domain, a service composition is an added value service created by aggregation of existing third party services according to some predefined work and data flow. Aggregated services provide specialized business functionality on which the service composition functionality has been split down.
- **Service Orchestration:** in SOA domain, a service orchestration is a particular architectural choice for service composition where a central orchestrated process manages the service composition work and data flow invocations the external third party services in the order determined by the work flow. Service orchestrations are specified by suitable orchestration languages and deployed in execution engines who interpret these specifications.
- **Servlet Container:** A Servlet is a Java-based server-side web technology. A software developer may use a servlet to add dynamic content to a web server using the Java platform. The generated content is commonly HTML, but may be other data such as XML. To deploy and run a Servlet, a web container must be used. A web container (also known as a Servlet container) is essentially the component of a web server that interacts with the Servlets.
- **SMS:** Short Message Service (SMS) is a text messaging service component of phone, web, or mobile communication systems, using standardized communications protocols that allow the exchange of short text messages between fixed line or mobile phone devices.
- **SOAP:** originally defined as Simple Object Access Protocol, is a protocol specification for exchanging structured information in the implementation of Web Services in computer networks. It relies on Extensible Markup Language (XML) for its message format, and usually relies on other Application Layer protocols, most notably Hypertext Transfer Protocol (HTTP) and Simple Mail Transfer Protocol (SMTP), for message negotiation and transmission.
- **Unified Service Description Language (USDL):** USDL is a platform-neutral language for describing services, covering a variety of service types, such as purely human services, transactional services, informational services, software components, digital media, platform services and infrastructure services. The core set of language modules offers the specification of functional and technical service properties, legal and financial aspects, service levels, interaction information and corresponding participants. USDL is offering extension points for the derivation of domain-specific service description languages by extending or changing the available language modules.
- **User Interface:** In computer science and human–computer interaction, the user interface (of a computer program) refers to the graphical, textual and auditory information the program presents to the user, and the control sequences (such as keystrokes with the computer keyboard, movements of the computer mouse, and selections with the touchscreen) the user employs to control the program.

- **XML database** is a data persistence software system that allows data to be stored in XML format. These data can then be queried, exported and serialized into the desired format. XML databases are usually associated with document-oriented databases. The internal model of such databases depends on XML and uses XML documents as the fundamental unit of storage, which are, however, not necessarily stored in the form of text files.

15 FIWARE OpenSpecification Apps ApplicationMashup

You can find the content of this chapter as well in the wiki of fi-ware.

Name	FIWARE.OpenSpecification.Apps.ApplicationMashup
Chapter	Apps,
Catalogue-Link to Implementation	Wirecloud
Owner	UPM, Javier Soriano

15.1 Preface

Within this document you find a self-contained open specification of a FI-WARE generic enabler, please consult as well the FI-WARE Product Vision, the website on http://www.fi-ware.org and similar pages in order to understand the complete context of the FI-WARE project.

15.2 Copyright

15.3 Legal Notice

Please check the following **FI-WARE Open Specification Legal Notice (implicit patents license)** to understand the rights to use this open specification.

Note: UPM provides the software associated to the Application Mashup, Wirecloud, as open source under Affero General Public License version 3 (AGPL v.3) with a classpath-like exception so widgets and operators can be licensed under any license. Please check the specific terms and conditions linked to this open source license at https://github.com/Wirecloud/wirecloud/blob/develop/LICENSE.txt

15.4 Overview

Web application mashups integrate heterogeneous data, application logic, and UI components (widgets/gadgets) sourced from the Web to create new coherent and value-adding composite applications. They are targeted at leveraging the "long tail" of the Web of Services (e.g. the so-called Web APIs, which have proliferated during recent years and have doubled in number during 2012. See programmableweb.com) by exploiting rapid development, the Do-It-Yourself (DIY) metaphor, and ability to share. They typically serve a specific situational (i.e. immediate, short-lived, customized, specific) need, frequently with high potential for reuse. It is this "situationality", which prevents them from being offered as 'off-the-shelf' functionality by solution providers.

Web application mashups can be manually developed using conventional web programming technologies, but this fails to take full advantage of the approach. Application mashup tools and platforms such as the one being specified by the FI_WARE's *Application Mashup GE* are aimed at development paradigms that do not require programming skills and, hence, target end users (being them business staff, customers or citizens). They also help to leverage innovation through experimentation and rapid prototyping by enabling their users (a) to discover the best suited mashable components (widgets, operators and off-the-shelf mashuplets) for their devised mashup from a vast, ever-growing distributed catalogue, and (b) to visually mash them up to compose the application.

Key features of the *Application Mashup GE* that will be covered by this open specification are:

- Support for a Platform-independent Mashup Definition Language (MDL) and a Widget Definition Language (WDL), which are needed to describe the application mashup and its building blocks so that any platform implementing the GE's open specifications will be able to instantiate and execute them. A mashup's MDL links to the WDL descriptions of its constituent widgets. These two languages are deeply described later as part of this open specification.
- Support for XML/RDF template schemas for both the WDL and the MDL languages, containing all widget- and mashup-related contextual information, plus all the preferences, state properties, and wiring/piping, context and rendering information (i.e. elements that manage the platform-widget interaction) required to support application mashup persistence and to instantiate and run the application mashup on a platform that conforms to these open specifications.
- USDL extensions to the WDL and MDL: WDL-RDF / MDL-RDF vocabularies for representing WDL/MDL data as part of a USDL offering.
- Support for a zipped file format (WGT) that allows mashable components to be conveniently stored and distributed.
- Support for *wiring*: a mechanism empowering end users to easily connect widgets in a mashup to create a fully-fledged event-driven dashboard/cockpit with RIA functionality. Alternative *wiring* editors can be implemented, provided that they generate a MDL description of the resulting mashup.
- Support for *piping*: a mechanism empowering end users to easily connect widgets to back-end services or data sources through an extendable set of operators, including filters, aggregators, adapters, etc. Different *piping* editors (commonly offered as part of a *wiring* editor) are allowed provided that they give a MDL description of the resulting mashup.
- Support for visual rendering of the widgets in the application mashup UI. Different editors are allowed as long as they provide a description of the resulting mashup in MDL.
- MAC (widget, operator and mashup) life-cycle management support.
- An application mashup execution engine model capable of deploying and running a mashup from a MDL file. It provides support for managing mashup state persistence, and for managing the wiring and piping mechanisms.

- Support for interaction with a *catalogue* of mashable components: the catalogue empowers end users to store and share their newly created application mashups with other colleagues and users by communicating with the Store GE.

This document contains all the information required in order to build compliant products that can work as alternative implementations of the Application Mashup GE and therefore may replace any implementation developed in FI-WARE within a particular FI-WARE Instance.

15.4.1 Target usage

FI-WARE strives to exploit the ability to compose application and service technologies, thus enabling to support cross-selling and to take advantage of the derived network scaling effects in multiple ways. The platform enables composition either from the front-end perspective --application mash-ups- or the back-end perspective --composite services. Specifically, the Application Mashup GE targets composition from the front-end perspective and is expected to leverage the creation and the execution of value-added applications not only by application providers, but also by intermediaries and end users acting as composers, a.k.a. prosumers. Prosumers are consumer-side end users who cannot find an application that fits their needs and therefore modify/create an application mashup in an ad-hoc manner for their own consumption. As the capabilities and skills of the target users being considered are expected to be very diverse, all kinds of usability issues, conceptual simplification, recommendation and guidance, etc. are taken into consideration.

15.5 Basic Concepts

15.5.1 Key concepts and ideas

The Application Mashup GE describes a Web platform that helps users to easily and visually create and run their own Web application mashups. Its functionality can be divided into a client-side part running on the user web browser and a server-side part running on a web server.

The Application Mashup GE is based on a composition model already published by the authors of this specification in a journal publication[1] (please refer to that publication for a detailed description of the underlying composition model of this enabler), which has been specifically designed to empower end users with few or no programming skills to create and share their own web composite applications in a fully visual fashion:

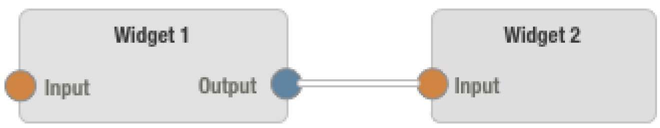
Widgets are the key elements of the composition model that the Application Mashup GE must support. Together with connectors and mashups (mashups are considered as building blocks for other application mashups), they make up the complete set of Mashable Application Components (MAC, see Terms and Definitions) that the Application Mashup GE must support. A widget is a lightweight Web application that runs on the user's web browser, in the context of an Application Mashup GE implementation. Widgets are usually developed using current Web technologies (HTML(5), CSS, Javascript, ...) and they are bound to heterogeneous data coming from the Web (e.g. Web APIs). They can be regarded as the service front-end, because they offer to users a graphical user interface (GUI), so that they can easily get a visual representation of the service data and functionality to which the widget is bound.

The figure below shows an example of what iGoogle's widgets (one of the first products to implement this idea) look like:

An example of some isolated widgets coexisting in the same desktop

These *early* widgets *per se* are isolated applications that do not interact with each other. However, the Application Mashup GE aims at providing a mechanism to visually compose a fully-fledged web application from different widgets that can now interact with each other via events and data sharing. This mechanism is what the composition model calls **wiring**. The idea behind wiring is easy: widgets expose (data/event) inputs and (data/event) outputs, so that an output from one widget can be linked to other widgets' inputs following a composition technique based on pre- and post-condition mechanisms. This way, the Application Mashup GE manages the data/event flow between widgets.

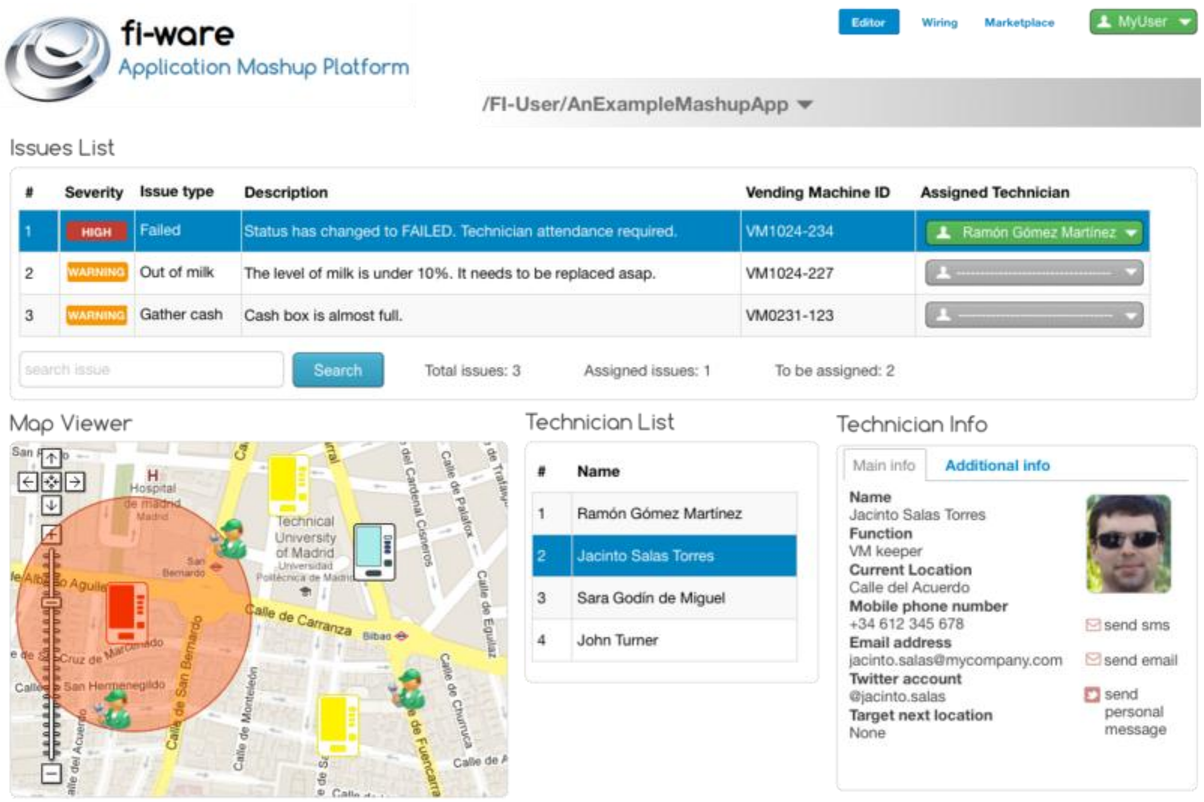
The mechanism allows for the use of event-driven *programming* features, e.g. a widget can send an event through one of its outputs on an event trigger. The figure below shows an example of the wiring metaphor:



An abstract representation of how the Application Mashup GE could support the Wiring mechanism

Widgets supported by the Application Mashup GE must be able to access their data from services in at least the following two ways: *programmatically* or by means of *operators* and through a visual technique called *piping* that establishes how these operators can be combined to form a *pipe*.
The Application Mashup GE supports the invocation of services *programmatically* from the widget's code: through what we call *WidgetAPI* (see the Architecture and [Open API Specification] page of the GE). Moreover, following the ideas from the composition model, it also supports operator use and the *piping* mechanism. This targets end users (i.e. users with few or no programming skills): an *operator* does not offer a GUI but, like widgets, it has an abstract representation with both inputs and outputs and can thus be wired to widgets allowing the data flow between them. Operators are usually bound to some kind of data source (SOAP service, REST API, etc.). In other words, operators are configured out-of-the-box to get access to a backend service, but they can also be made to subscribe to and get events from a publish/subscribe system. They can also act as filters, aggregators, mediators, etc. when used in the *piping* technique to build a *pipe*.

To sum up, an implementation of the Application Mashup GE must support the process of visually creating a composite web application by composing different widgets using the wiring mechanism, which interconnects those widgets, as along with the piping mechanism, that makes use of operators to get access to new data, perform an operation on that data, and finally pass it to the widgets through their inputs.
The figure below shows and example of what a web application mashup looks like. It is made up of a number of widgets, which interoperate with each other by exchanging data and events following the connections defined by the user. These widgets can be easily repositioned and/or resized to reflect the user needs and/or preferences.



An implementation of the Application Mashup GE showing how the mashup developers can arrange widgets to create their own Web mashup

15.5.2 Example scenario

To illustrate what is expected from the Application Mashup Generic Enabler, we have borrowed the following example scenario from the FInest Use Case Project, which is part of the FI-PPP program (http://www.finest-ppp.eu/). The scenario is part of its *Fish transport from Ålesund to Europe* use case:

"A fish producer needs to ship frozen/dried fish from Norway to a customer overseas. The scenario covers the feedering phase, i.e. the shipping from Ålesund to Northern Europe. The fish cargo is first delivered at the Port of Ålesund (ÅRH) and stored and stuffed in container at the terminal (Tyrholm & Farstad: TF). The shipping line NCL covers the North Sea voyage (feedering) from Ålesund to Hamburg/Rotterdam, and further shipped overseas by a deep-sea container shipping line (e.g. APL). The process involves customs and food health declarations. The transport set-up is mostly fixed."

As it is: The Port updates the website with information on the port's services, capacity, resources, and weather (in practice, port calls info updated systematically). This serves as information source for customers (ship agents, terminal operators) and all other stakeholders.

Challenges: Much manual info registration, and a lot of work duplication.

For improvement in the future, the port envisions the following improvements:

- A marketing portal, like a resource hub accessible from the website, enabling online management of bookings, resources and services as well as communication and coordination with third party service provider systems.
- Automatic update of Webpages (“ship calling”, “at port”, “departure”, etc.) based on information from SafeSeaNet and actual data from AIS (Automatic Identification System).
- Online registration of booking directly by the ship / ship agent.

In order to make these improvements, FInest demands from FI-WARE the following EPIC that will be covered by the Application Mashup GE:

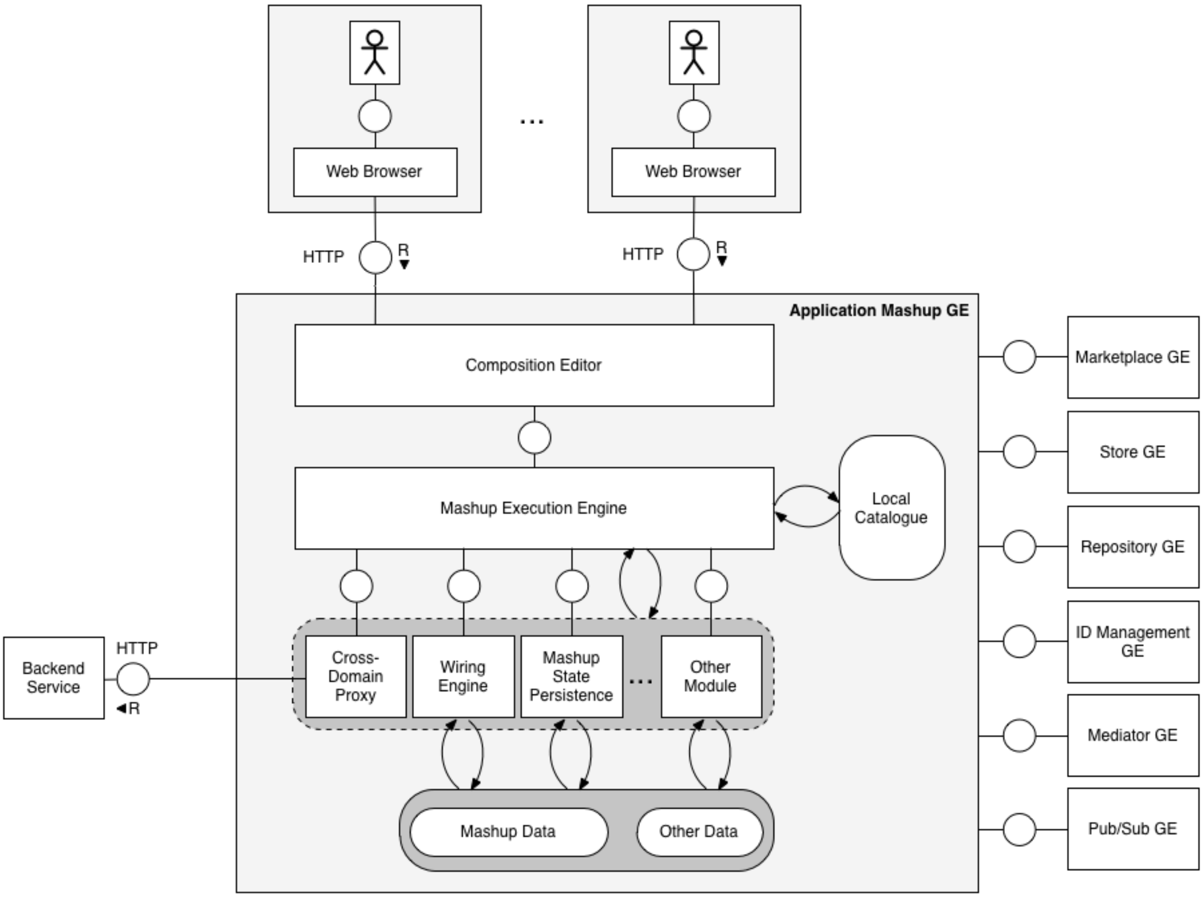
"*FInest.Epic.IoS.WidgetPlatformInfrastructure:* A visual portal website is needed where each user can add, remove and use widgets. Therefore, also a widget repository is needed from which a user can select widgets. An infrastructure should be provided to deploy new widgets in the portal. It should be easy for end users to use."

There follows the description of how the Application Mashup GE can be used to help to deal with the envisioned improvements:

- The functionality and information sources are split into a set of widgets. There is one widget for each resource that will be made accessible from the website: management of bookings and registrations, management of resources, management of services. Widgets from a third party service provider capable of communicating and coordinating with their systems, event-driven widgets connected to SafeSeaNet and actual data from AIS, e.g. "ship calling", "at port", "departure", etc. are also added to the catalogue of available widgets.
- These widgets are shared and offered through a repository (or store, or marketplace) which the project stakeholders and customers (ship agents, terminal operators, etc.) can search to select and retrieve the offerings of their interest.
- Each customer and stakeholder involved in this scenario, regardless of their level of technical or programming skills can leverage the application mashup editor to visually build a customized cockpit with the most valuable data and operations for their work by adding, removing and using available widgets and mashuplets (off-the-shelf mashups that can be customized by adding and removing widgets to/from them). Moreover, they even can share the resulting application mashup for future use by other customers or stake holders (for further customization).
- A widget platform (or application mashup container) will serve as the envisioned visual portal website where these customers and stakeholders can easily deploy and use the widgets that make up the application mashup (i.e. the customized cockpit or information/operations dashboard that best fit their interests).

15.6 Application Mashup Architecture

This section describes the Application Mashup GE architecture. The diagrams use FMC (Fundamental Modelling Concepts) notation to facilitate the communication not only between technical experts but also between them and business or domain experts. The Application Mashup GE provides the functionality necessary for developing and executing mashups. As the figure below shows, the core of the Application Mashup has three main components: the **Composition Editor**, the **Mashup Execution Engine**, and the **Local Catalogue**.



The Application Mashup GE Architecture

The **Composition Editor** component is the web-based tool with which end users interact via a web browser in order to create their own mashup applications. This component must, at least, offer end users a kind of *workspace* where they can spatially place or arrange widgets, plus an extra view of the wiring mechanism to set the interconnection between the arranged widgets. Because this component is a visual editor, this document does not set the visual appearance that this tool must have. It is up to the GE's implementation developers to create their own look & feel for this tool.

The **Mashup Execution Engine** component is probably the most important part of the GE. It coordinates widget execution and controls the data flow between widgets. It can access the Local Catalogue to deploy and execute stored widgets. The functionality of this component can be connected to and extended by a number of plug-in modules as shown in the Application Mashup GE Architecture figure. Module functionality is exposed to the widgets by means of the WidgetAPI (see Open API Specifications). Some of these plug-in modules must always be there:

- The **Cross-Domain Proxy** module: this component will provide widgets with a proxy to overcome the Javascript cross-domain problem.
- The **Wiring Engine** Module: this component manages the wiring mechanism.
- The **Mashup State Persistence** Module: this module is in charge of guaranteeing the persistence of the MACs under execution. This includes not only to store the widgets

and operators involved in the mashup and their state, but also their position in the editor view, their interconnections (wiring and piping) and so on.

It must be possible to enhance widget functionality by adding new modules to the Mashup Execution Engine. For example, a Publish/Subscribe module could be added to provide widgets with the ability to receive and publish data in a pub/sub fashion using the new added module.

All plug-in modules must be able to make use of internal storage (i.e. a database) for their specific persistence needs.

The third main component is the **Local Catalogue**. This component is where MACs, either purchased from the FI-WARE Store GE or installed (uploaded) by the end-user, are stored, configured, and set ready for deployment and execution. This component should be a kind of showcase for the logged user of the Application Mashup GE.

The following sections describe the languages needed to support widgets, operators and mashups, including the USDL extensions for all business-related GEs to process any MAC as an offering, and the specific file formats used to store and distribute widgets. By implementing these artifacts, a concrete implementation of the Application Mashup GE will support an internal representation of MACs (widgets and mashups), which is necessary to interact with them.

15.6.1 Mashup and Widgets Definition Languages (MDL and WDL)

The Application Mashup GE should be implemented as a mashup platform that empowers users to create their own application mashups. Application mashups are made of a set of widgets interconnected with each other (that is, wired). To fully support widgets (and mashups) instantiation, the implementation of the Application Mashup GE must support platform-independent widget and mashup languages.

The *Mashup Definition Language* (MDL) and the *Widget Definition Language* (WDL) are the chosen languages. They define all the inner information (metadata) regarding both a mashup and their widgets and their relationships/interconnections. This includes typical metadata, such as widget's name, vendor, version, last updated date, but also graphical information such as the location of the widgets on the editor canvas, widget width and height, etc.

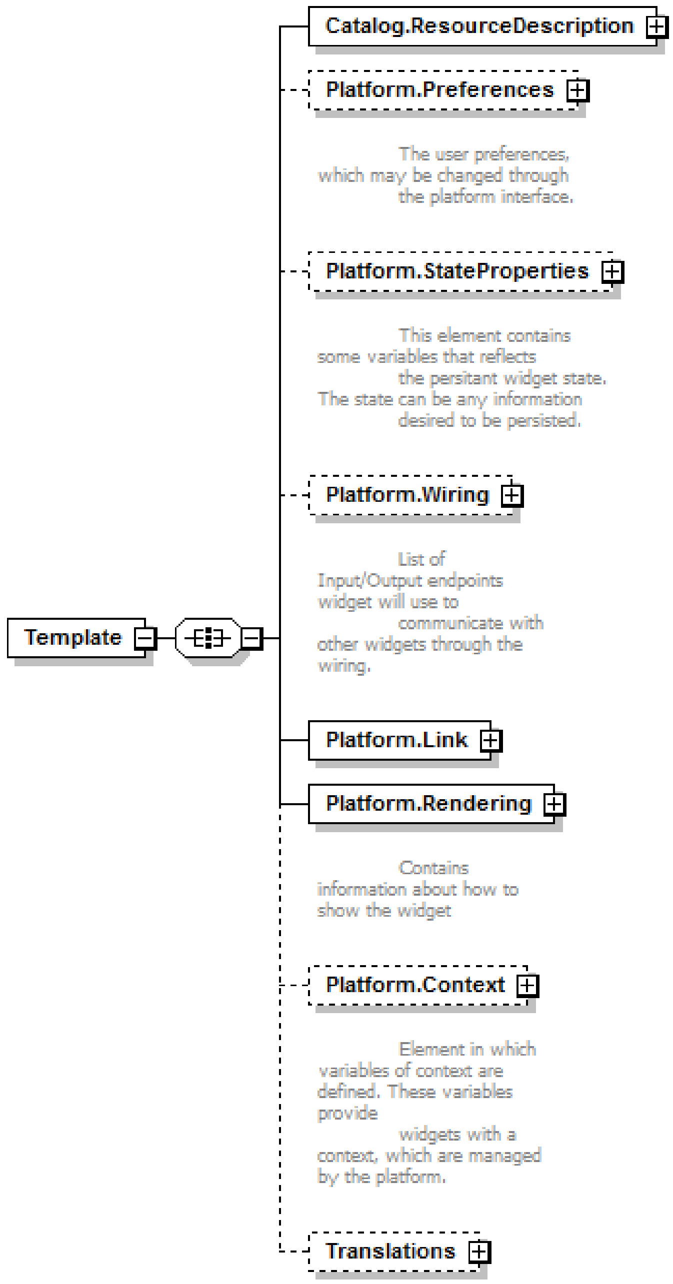
The following section shows the concept of "template". The template represents the definition of both languages and must be supported by the Application Mashup GE.

15.6.1.1 *Mashup and Widget Template*

To internally represent and deal with both mashups and widgets, the Application Mashup GE must support their "templates". A template is an XML file that contains all mashup and widget-related contextual information needed by the Application Mashup plus a set of preferences, state properties, and wiring, context and rendering information. Both MDL and WDL templates have their associated XML Schema. The latest version of the XML Schemas described in the following sections is available at:

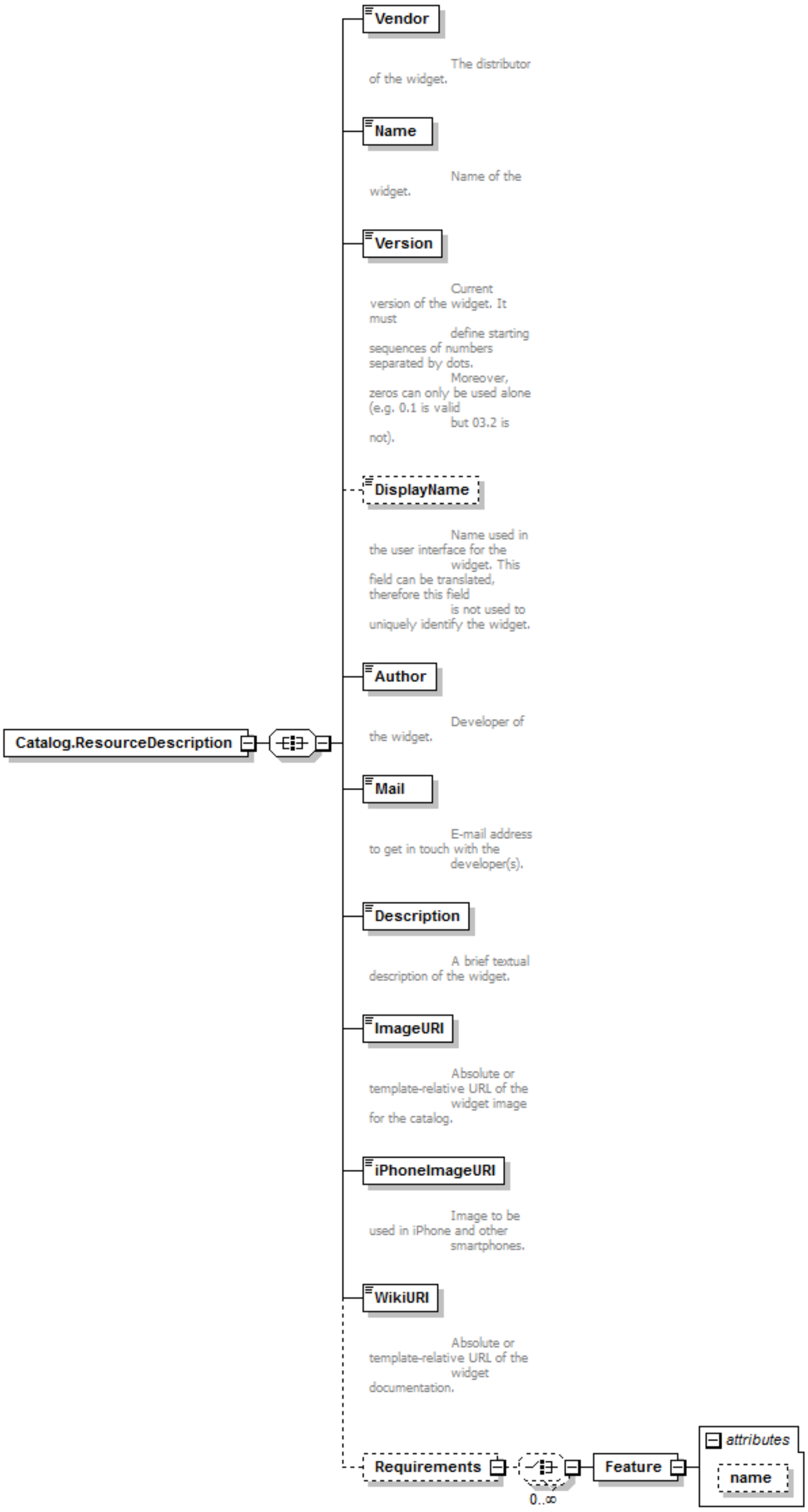
- MDL XML Template Schema
- WDL XML Template Schema

(1)WDL Template description as a XML Schema Definition
First we create a description of the widget template XML Schema, i.e. what WDL looks like. It uses the http://morfeo-project.org/2007/Template namespace for the root element, called **Template**. The figure below shows the `Template` element and the sequence of subelements that it contains.



The "Template" root element

The `Template` element defines all the widget-related contextual information in an XML element called **Catalog.ResourceDescription**. This is a mandatory element of the XML document. The figure below depicts what it looks like:



The "Catalog.ResourceDescription" element

This core element it is made up of the following attributes:

- **Vendor:** Company that distributes the widget. It cannot contain the character "/".

- **Name:** Name of the widget. It cannot contain the character "/".
- **Version:** Current widget version number. It must define starting sequences of numbers separated by dots. Zeros can only be used alone (e.g. 0.1 is valid but 03.2 is not).
- **DisplayName:** Name shown in the user interface of the widget. This field can be translated; therefore this field does not identify the widget.
- **Author:** Widget developers.
- **Mail:** Developer's e-mail address.
- **Description**: Full widget description to be shown in the catalogue.
- **ImageURI:** Absolute or template-relative URL of the image shown in the catalogue.
- **iPhoneImageURI:** Image to be used in iPhones and other smartphones.
- **WikiURI:** Absolute or template-relative URL of the widget documentation.

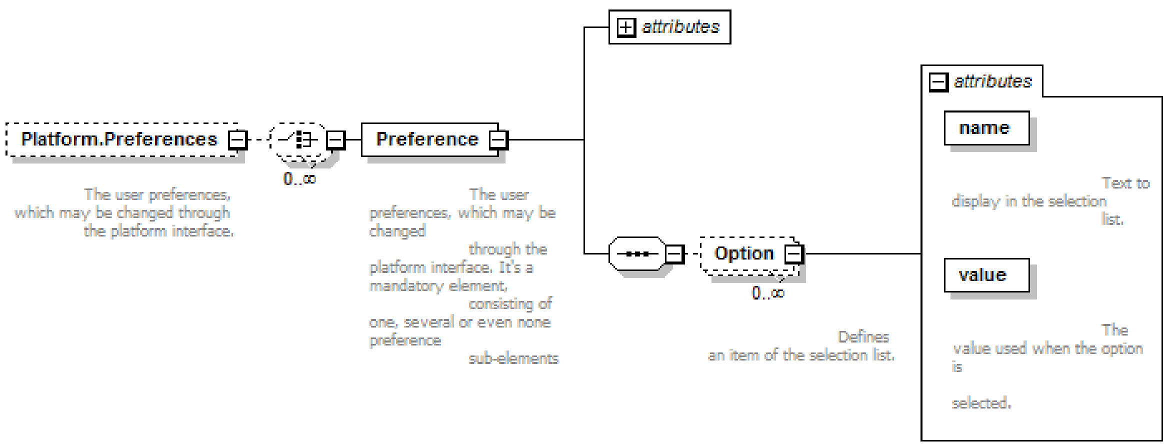
The *vendor*, *name* and *version* fields are the widget's ID. Therefore, no such identifier can appear more than once in any collection of the Application Mashup GE stored resources (this includes widgets, mashups, operators, etc.).

XML elements that manage the Platform-Widget interaction

To guarantee the platform-widget interaction, templates also define a set of variables that widgets use to get connected to the environment and set different platform options. Likewise, it also defines some other interface elements, such as the initial widget size. They are all managed by the platform, which will ensure their persistence.
Let us go through all these elements:

The Platform.Preferences element

The first platform-related element is the `Platform.Preferences` one:



The "Platform.Preferences" element

It defines user preferences, which may be changed through the platform interface. It is a mandatory element that is made up of one, many or none `Preference` sub-elements. This defines the actual user preference. It requires the following attributes:

- **name:** name of the preference to be referenced in the source code.
- **type:** preference data type: text (string), number, Boolean, password and list.
- **description:** text that describes the preference.

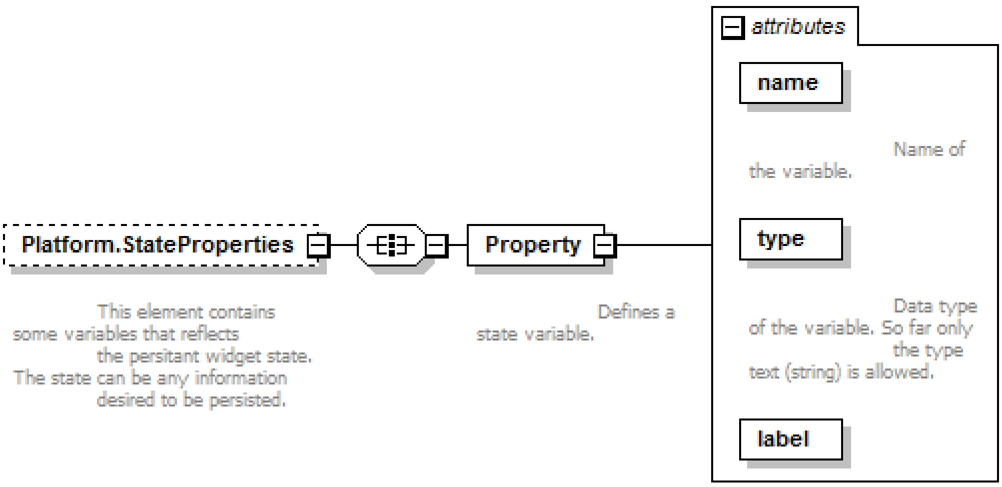
- **label:** text that the preference will show in the user interface.
- **default:** preference default value.

If the *type* attribute is set to "list", the different choices are defined by means of the **Option** element. It has the following attributes:

- **name:** text to be displayed in the selection list.
- **value:** value to be used when the option is selected.

The Platform.StateProperties element

The next XML element is the **Platform.StateProperties** element. Its main purpose is to define a set of properties to store the state of the widget while it is executing, in order to have it available for future executions. Its structure is shown in the figure below:



The Platform.StateProperties element

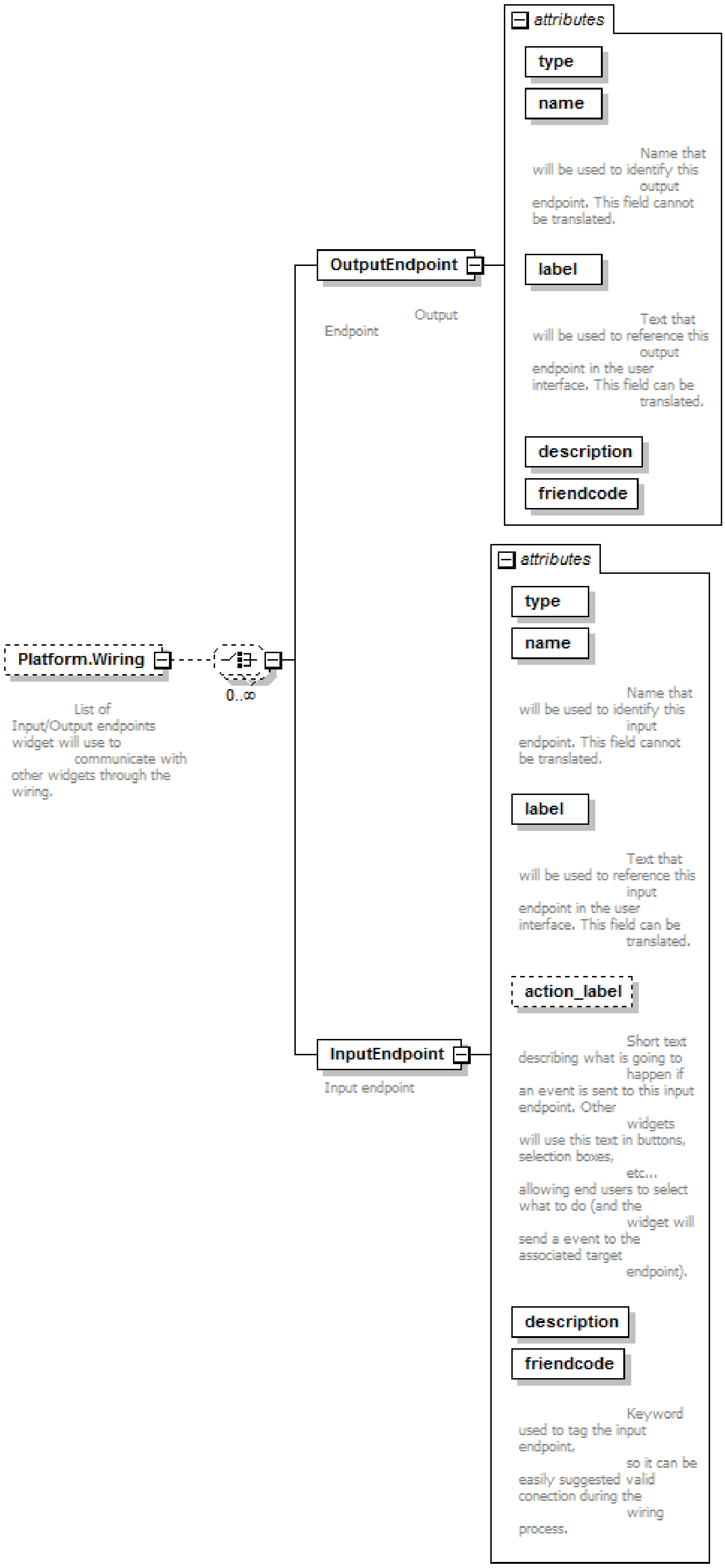
This element is required. It is made up of a list of **Property** elements and requires the following attributes:

- **name:** property name.
- **type:** property data type: only "text" (string) datatype does make sense in here.
- **label:** text to be displayed in the user interface.

The Platform.Wiring element

This is probably one of the most important widget template elements. It defines both the widget inputs and outputs needed to intercommunicate with other widgets. The Application Mashup GE implementation must take this information into account to manage and control the wiring mechanism and its internal data flow.

The figure below depicts the **Platform.Wiring** element:



The Platform.Wiring element.

This element may contain any number of **InputEndpoint** and **OutputEndpoint** elements. Widgets may send data (events) through an output endpoint. To do so, they must declare the endpoint using the `OutputEndpoint` element. These elements have the following attributes:

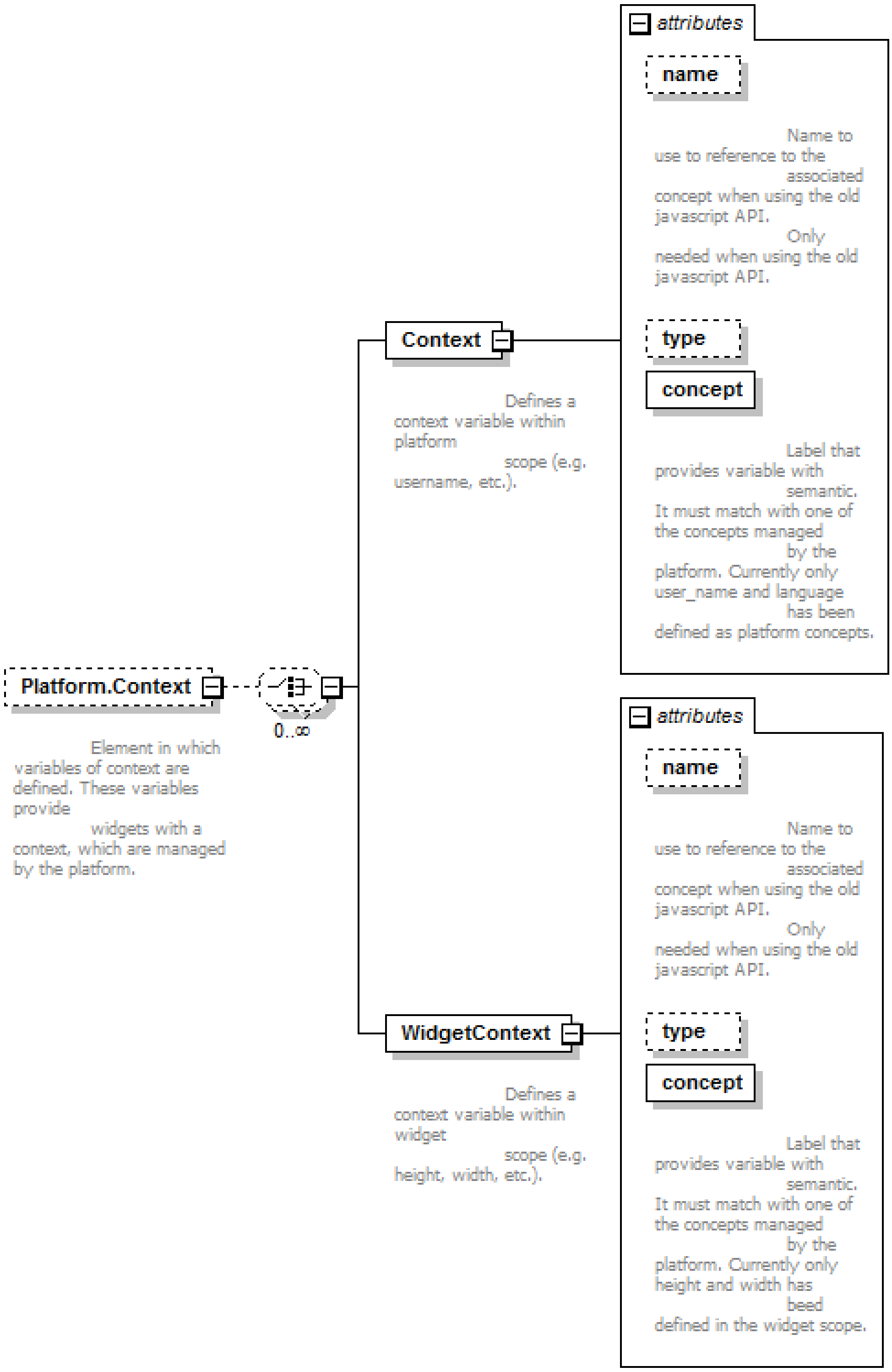
- **name:** output endpoint name.
- **type:** output endpoint data type: only "text" (string) datatype does make sense in here.
- **label:** text to be displayed in the user interface.
- **description:** text that describes the output.
- **friendcode:** keyword used as an output endpoint tag: it will help the platform to make suggestions in the wiring process.

On the other hand, widgets can receive asynchronous data through the input endpoints. These endpoints are meant to be used by the widget for receiving data (events) coming from other widgets. The required `InputEndpoint` elements requires the following attributes:

- **name:** input endpoint name.
- **type:** input endpoint data type: only "text" (string) datatype does make sense in here.
- **label:** text to be displayed in the user interface.
- **actionlabel:** short text that describes what is going to happen if an event is sent to this input endpoint. Widgets could use this text in buttons, selection boxes, etc... allowing end users to select what to do (and the widget will send an event to the associated target endpoint)
- **description:** text that describes the input.
- **friendcode:** keyword used as an input endpoint tag: it will help the platform to make suggestions in the wiring process.

The Platform.Context element

Widgets can have associated context information (i.e. usernames, current height and width...). The `Platform.Context` element defines which data the widget will be able to access and be notified if changed. The structure of this element is depicted in the figure below:



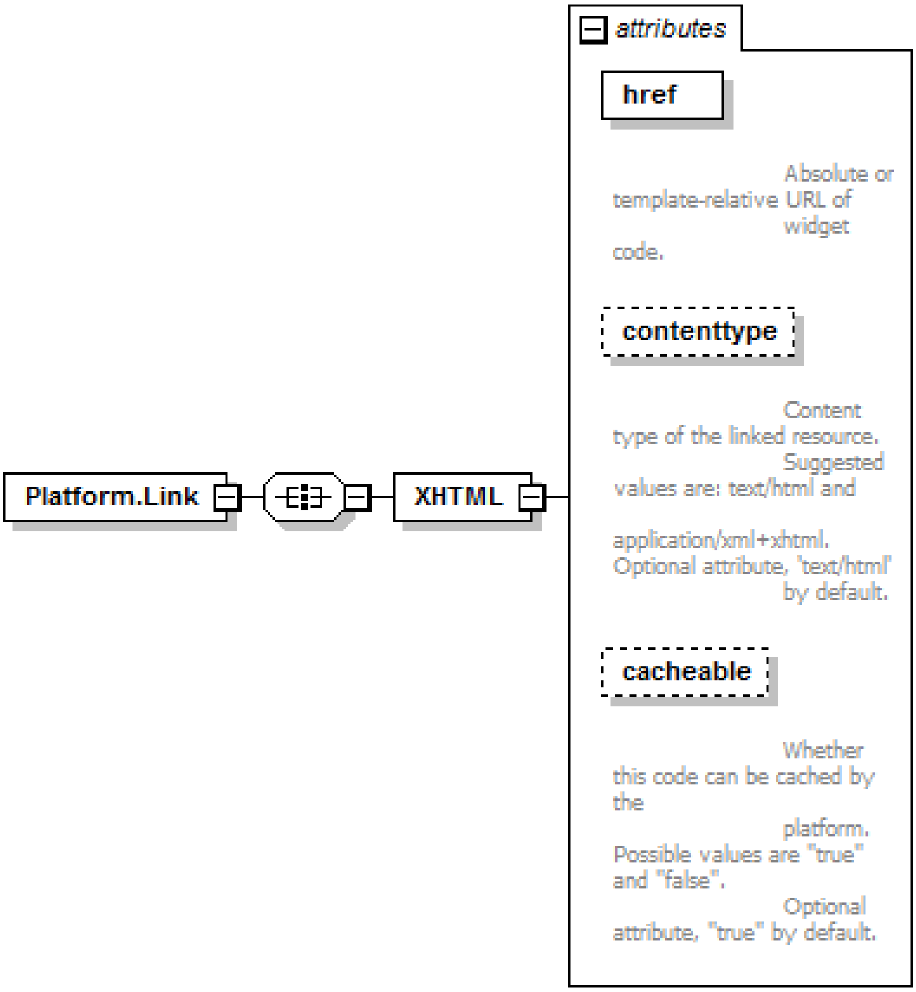
The Platform.Context element

This mandatory element can be followed by any number of these two child elements: **Context** and **WidgetContext**. The **Context** defines a platform-related context variable (i.e. username), whereas the **WidgetContext** defines a widget-related context variable (i.e. height). Both of them must have the following attributes:

- **name:** variable name.
- **type:** data type of the variable. Only "text" (string) datatype does make sense in here.
- **concept:** text that gives the variable meaning by annotating it with semantics. It must match with one of the concepts managed by the platform. Currently only *user_name* and *language* have been defined as platform concepts, and *height* and *width* in the widget scope.

The Platform.Link element

The actual source code of the widget must be linked to this template. To do this, the `Platform.Link` element is needed.



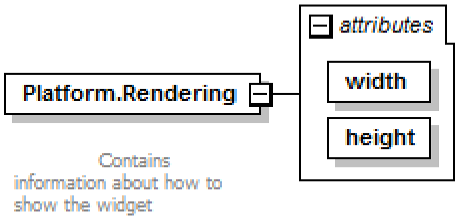
The Platform.Link element binds the template with the actual widget source code

It is made up of the **XHTML** element, which has the following attributes:

- **href:** absolute or template-relative URL of widget code.
- **contenttype:** linked resource content type: suggested values are: text/html and application/xml+xhtml. This is an optional attribute, with 'text/html' by default.
- **cacheable:** sets if the linked code can be cached by the platform: possible values are "true" and "false". This is an optional attribute, "true" by default.

The Platform.Rendering element

The last template XML element is `Platform.Rendering`. It specifies the default width and height of the widget once it is deployed in the user workspace.

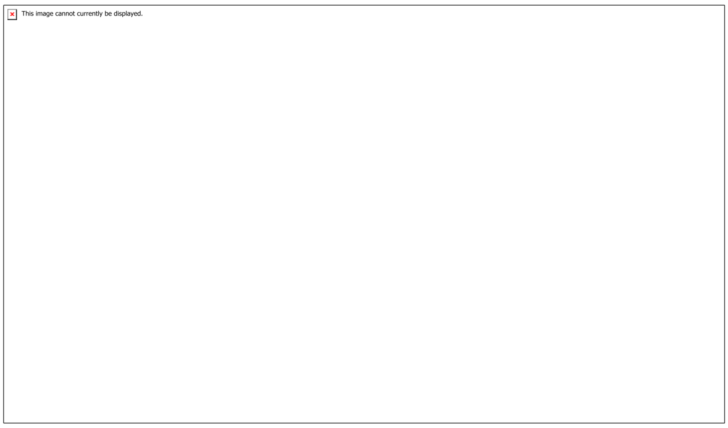


The Platform.Rendering element

Width and **height** are its only subelements. They represent the initial width and height of the widget.

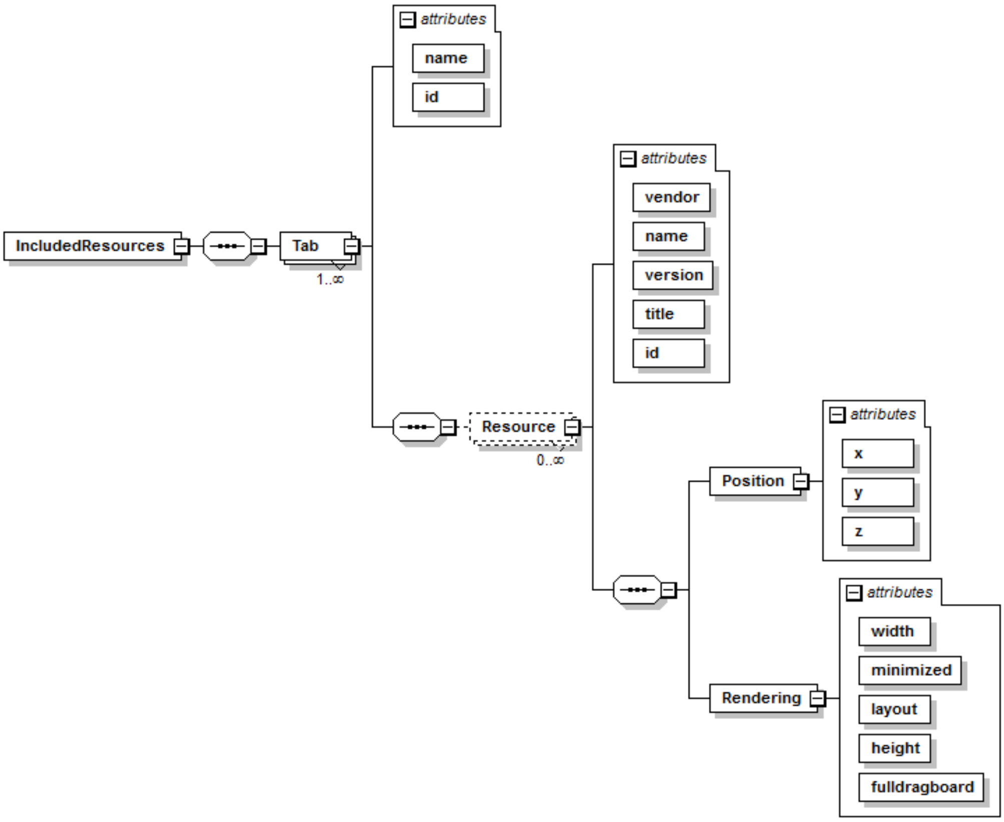
(2)MDL Template description as a XML Schema Definition

The MDL XML template schema is quite similar to the WDL template and is used to describe a mashup composed of widgets. The figure below shows the Mashup `Template` element and its sequence of subelements.



The Mashup "Template" root element

The **Catalog.ResourceDescription** element has the same fields as in the widget template with an extra field called **IncludedResources** that is used to describe widgets within the mashup. The figure below depicts what it looks like:



The "IncludedResources" element

This element contains at least one **Tab** element that represents tabs in Application Mashup GE dashboard. It has the following attributes

- **name:** the name of the tab
- **id:** the identification of the tab; this id is internal to the template.

The **Tab** element may contain any number of **Resource** elements which represent widget instances used in the mashup. It has the following attributes:

- **vendor** the widget distributor; it cannot contain the character "/".
- **name** name of the widget; it cannot contain the character "/".
- **version** current version of the widget; it must define starting sequences of numbers separated by dots, where zeros can only be used alone (e.g. 0.1 is valid but 03.2 is not).
- **title** name to be displayed in the widget dashboard.
- **id** the widget identification; this id is internal to the mashup template.

The **Resource** element is made up of a **Position** element and a **Rendering** element. The **Position** element describes the widget position into the dashboard. It has the following attributes:

- **X:** the widget's x coordinate.
- **Y:** the widget's Y coordinate.
- **Z:** the widget's Z coordinate.

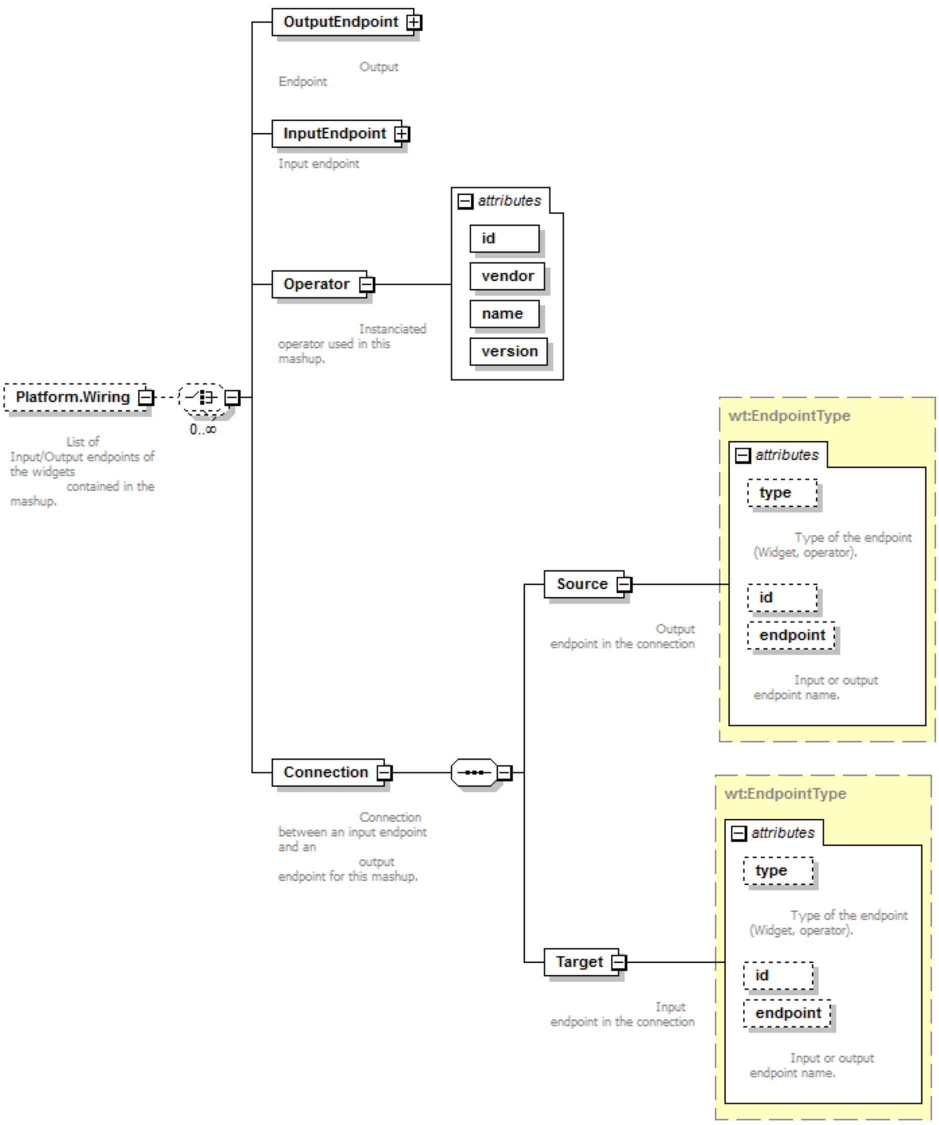
The **Rendering** element describes some characteristics of the widget representation. It has the following attributes:

- **width:** widget width in the dashboard.

- **minimized:** Boolean attribute that defines whether the widget is minimized in the dashboard
- **layout:** widget layout in the dashboard
- **height:** widget height in the dashboard
- **fulldragboard:** Boolean attribute that describes whether the widget is using all the dashboard.

The Platform.Wiring element

This element describes how widgets in the mashup are connected using their output and input endpoints.



The "Platform.Wiring" element

The **InputEndpoint** and **OutputEndpoint** elements define the same information as in the WDL template. The **Platform.Wiring** element contains all the input and output endpoints of all the widgets and operators in the mashup.
The **Platform.Wiring** element may contain any number of **Operator** elements. An **Operator** element defines an operator that is used in the wiring. It has the following attributes:

- **id:** identification of the operator; this id is internal to the mashup template.
- **vendor:** the distributor of the operator; it cannot contain the character "/".
- **name:** operator name; it cannot contain the character "/".
- **version:** current operator version; it must define starting sequences of numbers separated by dots where zeros can only be used alone (e.g. 0.1 is valid but 03.2 is not).

The **Platform.Wiring** element may contain any number of **Connection** elements. These elements describe which output endpoints are connected with which input endpoints. The **Connection** elements are composed of a **Source** element and a **Target** element. The **Source** element defines the output endpoint of the connection. It has the following attributes.

- **type:** type of the element that has the output endpoint; this attribute could have the values "widget" or "operator".
- **id:** id of the element that has the output endpoint; this id is the same as the id defined in the **Resource** element if the element is a widget, whereas this id is the same as the id defined in the **Operator** element if the element is an operator.
- **endpoint:** the name of the output endpoint. This name is the same as the defined in the **OutputEnpoint** element.

The **Target** element defines the input endpoint of the connection. It has the following attributes:

- **type:** type of element that has the input endpoint; the possible values of this attribute are "widget" or "operator".
- **id:** id of the element that has the input endpoint; this id is the same as the id defined in the **Resource** element if the element is a widget, whereas this id is the same as the id defined in the **Operator** element if the element is an operator.
- **endpoint**: the name of the input endpoint; this name is the same as the defined in the **InputEnpoint** element.

15.6.1.2 *Mashup and Widgets as a USDL offering: USDL extension*

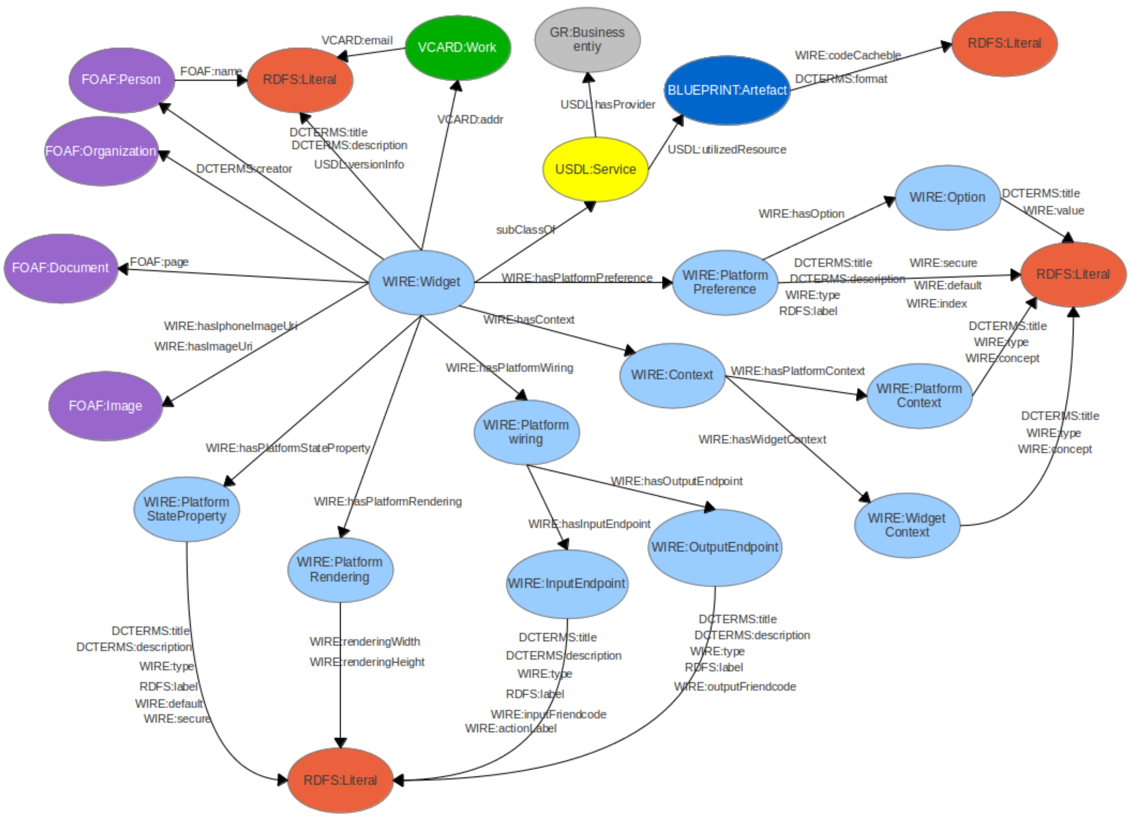
In order for both mashups and widgets to be offered as a USDL offering in the Store GE so that both widgets and mashups can be part of the data managed by the FI-WARE's Marketplace, Store and Repository Generic Enablers, the Application Mashup GE must make use of the following RDF(S) vocabularies, built upon Linked Data principles as Linked USDL extensions.

The first specification, WDL-RDF (https://github.com/Wirecloud/wirecloud/blob/develop/docs/source/widgets/template/rdf_template.rdf), deals with the definition of the information that the Application Mashup GE must use to instantiate a widget, including its user preferences, state properties, wiring information, and so on. The second specification, MDL-RDF (https://github.com/Wirecloud/wirecloud/blob/develop/docs/source/mashups/mashup_template_rdf.rdf), defines the mashup-related information needed to create an instance of the user workspace, including platform-specific information such as widget instances, wiring and piping between widgets, etc.

The following sections show both vocabularies to be used within the USDL offerings.

(1)WDL-RDF

The diagram below shows the WDL-RDF vocabulary.



The WDL-RDF extension for USDL

The Application Mashup GE must support this vocabulary to provide a way to represent WDL information as part of a USDL offering.

Classes

Class: `wire:Widget`

This class represents a widget. This is the main class of the vocabulary.

URI: http://wirecloud.conwet.fi.upm.es/ns/widget#Widget

Properties include:

`dcterms:title, dcterms:description, dcterms:creator, usdl:hasProvider, usdl:utilizedResource, foaf:page, wire:hasPlatformPreference, wire:hasPlatformWiring, wire:hasPlatformRendering, wire:hasPlatformStateProperty, usdl:versionInfo, wire:hasImageUri, wire.hasiPhoneImageUri, wire:displayName, vcard:addr`

Subclassof: `usdl-core:Service`

Class: `wire:Operator`

This class represents an operator.

URI: http://wirecloud.conwet.fi.upm.es/ns/widget#Operator

Properties include:

`dcterms:title, dcterms:description, dcterms:creator, usdl:hasProvider, usdl:utilizedResource, foaf: page, wire:hasPlatformPreference, wire:hasPlatformWiring, wire:hasPlatformRendering,`

`wire:hasPlatformStateProperty, usdl:versionInfo, wire:hasImageUri, wire.hasiPhoneImageUri, wire:displayName, vcard:addr`
Subclassof: `usdl-core:Service`

Class: `wire:PlatformPreference`
This class represents a user preference in the Application Mashup GE, that is, data users can see and configure. The Enabler must make this value persistent and provide users with tools to edit and validate this data.
URI: http://wirecloud.conwet.fi.upm.es/ns/widget#PlatformPreference
Properties include:
`wire:hasOption, dcterms:title, dcterms:description, rdfs:label, wire:type, wire:default, wire:secure`
Used with: `wire:hasPlatformPreference`

Class: `wire:PlatformWiring`
This class represents the wiring status of a widget.
URI: http://wirecloud.conwet.fi.upm.es/ns/widget#PlatformWiring
Properties include:
`wire:hasOutputEndpoint, wire:hasInputEnpoint`
Used with: `wire:hasPlatformWiring`

Class: `wire:PlatformRendering`
This class represents the widget size when it is instantiated.
URI: http://wirecloud.conwet.fi.upm.es/ns/widget#PlatformRendering
Properties include:
`wire:renderingWidth, wire.renderingHeight`
Used with: `wire:hasPlatformRendering`

Class: wire:PlatformStateProperty
This class represents a widget state variable that the platform needs to know in order to make it persistent.
URI: http://wirecloud.conwet.fi.upm.es/ns/widget#PlatformStateProperty
Properties include:
`dcterms:title, dcterms:description, wire:type, rdfs:label, wire:default, wire:secure`
Used with: `wire:hasPlatformStateProperty`

Class: `wire:Option`
This class represents an option that a user preference could have.
URI: http://wirecloud.conwet.fi.upm.es/ns/widget#Option
Properties include:
`dcterms:title, wire:value`
Used with: `wire:hasOption`

Class: `wire:OutputEndpoint`
This class represents an output endpoint.
URI: http://wirecloud.conwet.fi.upm.es/ns/widget#OutputEndpoint

Properties include:
`dcterms:title, dcterms:description, rdfs:label, wire:type, wire:outputFriendcode`
Used with: `wire:hasOutputEndpoint`

Class: `wire:InputEndpoint`
This class represents an input endpoint.
URI: http://wirecloud.conwet.fi.upm.es/ns/widget#InputEndpoint
Properties include:
`dcterms:title, dcterms:description, rdfs:label, wire:type, wire:inputFriendcode, wire:actionLabel`
Used with: `wire:hasInputEndpoint`

Properties

Property: `wire:hasPlatformPreference`
This property states a user widget preference.
URI: http://wirecloud.conwet.fi.upm.es/ns/Widget#hasPlatformPreference
Domain: `wire:Widget`
Range: `wire:PlatformPreference`

Property: `wire:hasContext`
This property states the widget context.
URI: http://wirecloud.conwet.fi.upm.es/ns/Widget#hasContext
Domain: `wire:Widget`
Range: `wire:Context`

Property: `wire:hasPlatformWiring`
This property states the widget wiring status.
URI: http://wirecloud.conwet.fi.upm.es/ns/Widget#hasPlatformWiring
Domain: `wire:Widget`
Range: `wire:PlatformWiring`

Property: `wire:hasPlatformRendering`
This property states how the widget must be rendered.
URI: http://wirecloud.conwet.fi.upm.es/ns/Widget#hasPlatformRendering
Domain: `wire:Widget`
Range: `wire:PlatformRendering`

Property: `wire:hasPlatformStateProperty`
This property states a widget state variable.
URI: http://wirecloud.conwet.fi.upm.es/ns/Widget#hasPlatformStateProperty
Domain: `wire:Widget`
Range: `wire:PlatformStateProperty`

Property: `wire:hasOption`
This property states a user preference option.

URI: http://wirecloud.conwet.fi.upm.es/ns/Widget#hasOption
Domain: `wire:PlatformPreference`
Range: `wire:Option`

Property: `wire:hasPlatformContext`
This property states a platform-context variable of the context.
URI: http://wirecloud.conwet.fi.upm.es/ns/Widget#hasPlatformContext
Domain: `wire:Context`
Range: `wire:PlatformContext`

Property: `wire:hasWidgetContext`
This property states a widget-context variable of the context.
URI: http://wirecloud.conwet.fi.upm.es/ns/Widget#hasWidgetContext
Domain: `wire:Context`
Range: `wire:WidgetContext`

Property: `wire:hasOutputEndpoint`
This property states a widget wiring output endpoint.
URI: http://wirecloud.conwet.fi.upm.es/ns/Widget#hasOutputEndpoint
Domain: `wire:PlatformWiring`
Range: `wire:OutputEndpoint`

Property: `wire:hasInputEndpoint`
This property states a widget wiring input endpoint.
URI: http://wirecloud.conwet.fi.upm.es/ns/Widget#hasInputEndpoint
Domain: `wire:PlatformWiring`
Range: `wire:InputEndpoint`

Property: `wire:platformContextConcept`
This property states the platform-context variable concept.
URI: http://wirecloud.conwet.fi.upm.es/ns/Widget#platformContextConcept
Domain: `wire:PlatformContext`
Range: `rdfs:Literal`

Property: `wire:WidgetContextConcept`
This property states the widget-context variable concept.
URI: http://wirecloud.conwet.fi.upm.es/ns/Widget#platformWidgetConcept
Domain: `wire:WidgetContext`
Range: `rdfs:Literal`

Property: `wire:outputFriendcode`
This property states an output's *friendcode*.
URI: http://wirecloud.conwet.fi.upm.es/ns/Widget#outputFriendcode
Domain: `wire:OutputEndpoint`
Range: `rdfs:Literal`

Property: `wire:inputFriendcode`
This property states an input's *friendcode*.
URI: http://wirecloud.conwet.fi.upm.es/ns/Widget#inputFriendcode
Domain: `wire:InputEndpoint`
Range: `rdfs:Literal`

Property: `wire:actionLabel`
This property states an input's action label.
URI: http://wirecloud.conwet.fi.upm.es/ns/Widget#actionLabel
Domain: `wire:InputEndpoint`
Range: `rdfs:Literal`

Property: `wire:hasImageUri`
This property states the URI of the image associated with the widget.
URI: http://wirecloud.conwet.fi.upm.es/ns/Widget#hasImageUri
Domain: `wire:Widget`
Range: `foaf:Image`

Property: `wire:hasiPhoneImageUri`
This property states the URI of the image associated with the Widget if the platform is running on an iPhone.
URI: http://wirecloud.conwet.fi.upm.es/ns/Widget#hasiPhoneImageUri
Domain: `wire:Widget`
Range: `foaf:Image`

Property: `wire:displayName`
This property states the widget name to be displayed.
URI: http://wirecloud.conwet.fi.upm.es/ns/Widget#displayName
Domain: `wire:Widget`
Range: `rdfs:Literal`

Property: `wire:value`
This property states the widget configuration element value.
URI: http://wirecloud.conwet.fi.upm.es/ns/Widget#value
Range: `rdfs:Literal`

Property: `wire:type`
This property states the widget configuration element type.
URI: http://wirecloud.conwet.fi.upm.es/ns/Widget#type
Range: `rdfs:Literal`

Property: `wire:default`
This property states the widget configuration element default value.
URI: http://wirecloud.conwet.fi.upm.es/ns/Widget#default
Range: `rdfs:Literal`

Property: `wire:secure`
This property states whether or not a widget configuration element is secure.
URI: http://wirecloud.conwet.fi.upm.es/ns/Widget#value
Range: `rdfs:Literal`

Property: `wire:index`
This property states the logical order of elements of the same type.
URI: http://wirecloud.conwet.fi.upm.es/ns/Widget#value
Range: `rdfs:Literal`

Property: `wire:codeContentType`
This property states the widget code MIME type. The widget code URI is represented using `usdl-core:Resource`
URI: http://wirecloud.conwet.fi.upm.es/ns/Widget#codeContentType
Domain: `usdl-core:Resource`
Range: `rdfs:Literal`

Property: `wire:codeCacheable`
This property states whether or not the widget code is cacheable.
URI: http://wirecloud.conwet.fi.upm.es/ns/Widget#codeCacheable
Domain: `usdl-core:Resource`
Range: `rdfs:Literal`

(2)MDL-RDF
The diagram below shows the MDL-RDF vocabulary.

The MDL-RDF extension for USDL

Like WDL-RDF, this vocabulary must be supported by the Application Mashup GE to provide a way to represent MDL information as part of a USDL offering.

Classes

Class: `wire-m:Mashup`

This class represents a mashup. It will be implemented as a workspace.

URI :http://wirecloud.conwet.fi.upm.es/ns/mashup#Mashup

Properties include:

`wire-m:hasMashupPreference, wire-m:hasMashupParam, wire-m:hasTab, wire-m:hasMashupWiring, wire:hasImageUri, wire:hasiPhoneImageUri, wire:version`

subClassOf: `usdl:CompositeService`

Class: `wire-m:Tab`

This class represents a workspace tab.

URI: http://wirecloud.conwet.fi.upm.es/ns/mashup#Tab

Properties include:
`wire-m:hasiWidget, wire-m:hasTabPreference, dcterms:title`
Used with:
`wire-m:hasTab`

Class: `wire-m:iWidget`
This class represents a widget instance.
URI: http://wirecloud.conwet.fi.upm.es/ns/mashup#iWidget
Properties include:
`wire-m:hasPosition, wire-m:hasiWidgetRendering, wire-m:hasiWidgetPreference, wire-m:hasiWidgetProperty`
Used with:
`wire-m:hasiWidget`
subClassOf: `wire:Widget`

Class: `wire-m:MashupPreference`
This class represents a mashup preference.
URI: http://wirecloud.conwet.fi.upm.es/ns/mashup#MashupPreference
Properties include:
`dcterms:title, wire:value`
Used with:
`wire-m:hasMashupPreference`

Class: `wire-m:MashupParam`
This class represents a mashup parameter.
URI: http://wirecloud.conwet.fi.upm.es/ns/mashup#MashupParam
Properties include:
`dcterms:title, wire:value`
Used with:
`wire-m:hasMashupParam`

Class: `wire-m:Position`
This class represents the position of a widget instance in the tab.
URI: http://wirecloud.conwet.fi.upm.es/ns/mashup#Position
Properties include:
`wire-m:x, wire-m:y, wire-m:z`
Used with:
`wire-m:hasPosition`

Class: `wire-m:iWidgetPreference`
This class represents a widget instance preference.
URI: http://wirecloud.conwet.fi.upm.es/ns/mashup#iWidgetPreference
Properties include:
`dcterms:title, wire:value, wire-m:readonly, wire-m:hidden`
Used with:
`wire-m:hasiWidgetPreference`

Class: `wire-m:iWidgetRendering`

This class represents a widget instance rendering.
URI: http://wirecloud.conwet.fi.upm.es/ns/mashup#iWidgetRendering
Properties include:
`wire-m:fullDragboard, wire-m:layout, wire-m:minimized, wire:renderingHeight, wire:renderingWidth`
Used with:
`wire-m:hasiWidgetRendering`

Class: `wire-m:iWidgetProperty`
This class represents a widget instance property.
URI: http://wirecloud.conwet.fi.upm.es/ns/mashup#iWidgetProperty
Properties include:
`wire-m:readonly, wire:value`
Used with:
`wire-m:hasiWidgetProperty`

Class: `wire-m:TabPreference`
This class represents a tab preference.
URI: http://wirecloud.conwet.fi.upm.es/ns/mashup#TabPreference
Properties include:
`dcterms:title, wire:value`
Used with:
`wire-m:hasTabPreference`

Class: `wire-m:Connection`
This class represents a wiring connection between two widget instances or operator instances.
URI: http://wirecloud.conwet.fi.upm.es/ns/mashup#Connection
Properties include:
`wire-m:hasSource, wire-m:hasTarget, dcterms:title, wire-m:readonly`
Used with:
`wire-m:hasConnection`

Class: `wire-m:Source`
This class represents a widget instance or operator instance that is the source of a connection.
URI: http://wirecloud.conwet.fi.upm.es/ns/mashup#Source
Properties include:
`wire-m:sourceId, wire-m:endpoint, wire:type`
Used with:
`wire-m:hasSource`

Class: `wire-m:Target`
This class represents a widget instance or operator instance that is the target of a connection.

URI: http://wirecloud.conwet.fi.upm.es/ns/mashup#Target
Properties include:

`wire-m:targetId, wire-m:endpoint, wire:type`
Used with:
`wire-m:hasTarget`

Class: `wire-m:iOperator`
This class represents an operator instance.
URI: http://wirecloud.conwet.fi.upm.es/ns/mashup#iOperator
Properties include:
`wire-m:iOperatorId, dcterms:title`
Used with:
`wire-m:hasiOperator`

Properties

Property: `wire-m:hasMashupPreference`
This property states a mashup preference.
URI: http://wirecloud.conwet.fi.upm.es/ns/mashup#hasMashupPreference
Domain: `wire-m:Mashup`
Range: `wire-m:MashupPreference`

Property: `wire-m:hasMashupParam`
This property states a mashup parameter.
URI: http://wirecloud.conwet.fi.upm.es/ns/mashup#hasMashupParam
Domain: `wire-m:Mashup`
Range: `wire-m:MashupParam`

Property: `wire-m:hasTab`
This property states that a given tab is part of a workspace.
URI: http://wirecloud.conwet.fi.upm.es/ns/mashup#hasTab
Domain: `wire-m:Mashup`
Range: `wire-m:Tab`

Property: `wire-m:hasiWidget`
This property states that a given widget instance is instantiated in a tab.
URI: http://wirecloud.conwet.fi.upm.es/ns/mashup#hasiWidget
Domain: `wire-m:Tab`
Range: `wire-m:iWidget`

Property: `wire-m:hasTabPreference`
This property states a tab preference.
URI: http://wirecloud.conwet.fi.upm.es/ns/mashup#hasTabPreference
Domain: `wire-m:Tab`
Range: `wire-m:TabPreference`

Property: `wire-m:hasPosition`
This property states the position of an widget instance in a tab.
URI: http://wirecloud.conwet.fi.upm.es/ns/mashup#hasPosition

Domain: `wire-m:iWidget`
Range: `wire-m:Position`

Property: `wire-m:hasiWidgetPreference`
This property states a widget instance preference.
URI: http://wirecloud.conwet.fi.upm.es/ns/mashup#hasiWidgetPreference
Domain: `wire-m:iWidget`
Range: `wire-m:iWidgetPreference`

Property: `wire-m:hasiWidgetProperty`
This property states a widget instance property.
URI: http://wirecloud.conwet.fi.upm.es/ns/mashup#hasiWidgetProperty
Domain: `wire-m:iWidget`
Range: `wire-m:iWidgetProperty`

Property: `wire-m:hasiWidgetRendering`
This property states the rendering of a widget instance.
URI: http://wirecloud.conwet.fi.upm.es/ns/mashup#hasiWidgetRendering
Domain: `wire-m:iWidget`
Range: `wire-m:iWidgetRendering`

Property: `wire-m:hasConnection`
This property states a wiring connection.
URI: http://wirecloud.conwet.fi.upm.es/ns/mashup#hasConnection
Domain: `wire:PlatformWiring`
Range: `wire-m:Connection`

Property: `wire-m:hasSource`
This property states the source of a connection.
URI: http://wirecloud.conwet.fi.upm.es/ns/mashup#hasSource
Domain: `wire-m:Connection`
Range: `wire-m:Source`

Property: `wire-m:hasTarget`
This property states the target of a connection.
URI: http://wirecloud.conwet.fi.upm.es/ns/mashup#hasTarget
Domain: `wire-m:Connection`
Range: `wire-m:Target`

Property: `wire-m:targetId`
This property states the ID of a target.
URI: http://wirecloud.conwet.fi.upm.es/ns/mashup#targetId
Domain: `wire-m:Target`
Range: `rdfs:Literal`

Property: `wire-m:sourceId`

This property states the ID of a source.
URI: http://wirecloud.conwet.fi.upm.es/ns/mashup#sourceId
Domain: `wire-m:Source`
Range: `rdfs:Literal`

Property: `wire-m:endpoint`
This property states the ID of the widget instance or operator instance that is the source or target of a connection.
URI: http://wirecloud.conwet.fi.upm.es/ns/mashup#endpoint
Range: `rdfs:Literal`

Property: `wire-m:hasiOperator`
This property states the wiring of an operator's instance.
URI: http://wirecloud.conwet.fi.upm.es/ns/mashup#hasiOperator
Domain: `wire:PlatformWiring`
Range: `wire-m:iOperator`

Property: `wire-m:x`
This property states the x coordinate of a widget instance position.
URI: http://wirecloud.conwet.fi.upm.es/ns/mashup#x
Domain: `wire-m:Position`
Range: `rdfs:Literal`

Property: `wire-m:y`
This property states the y coordinate of a widget instance position.
URI: http://wirecloud.conwet.fi.upm.es/ns/mashup#y
Domain: `wire-m:Position`
Range: `rdfs:Literal`

Property: `wire-m:z`
This property states the z coordinate of a widget instance position.
URI: http://wirecloud.conwet.fi.upm.es/ns/mashup#z
Domain: `wire-m:Position`
Range: `rdfs:Literal`

Property: `wire-m:fullDragboard`
This property states whether a widget instance occupies the whole space in the tab.
URI: http://wirecloud.conwet.fi.upm.es/ns/mashup#fullDragboard
Domain: `wire-m:iWidgetRendering`
Range: `rdfs:Literal`

Property: `wire-m:layout`
This property states the layout of a widget instance.
URI: http://wirecloud.conwet.fi.upm.es/ns/mashup#layout
Domain: `wire-m:iWidgetRendering`
Range: `rdfs:Literal`

Property: `wire-m:minimized`
This property states whether a widget instance is minimized in its tab.
URI: http://wirecloud.conwet.fi.upm.es/ns/mashup#minimized
Domain: `wire-m:iWidgetRendering`
Range: `rdfs:Literal`

Property: `wire-m:hidden`
This property states whether a widget instance is hidden in its tab.
URI: http://wirecloud.conwet.fi.upm.es/ns/mashup#hidden
Domain: `wire-m:iWidgetPreference`
Range: `rdfs:Literal`

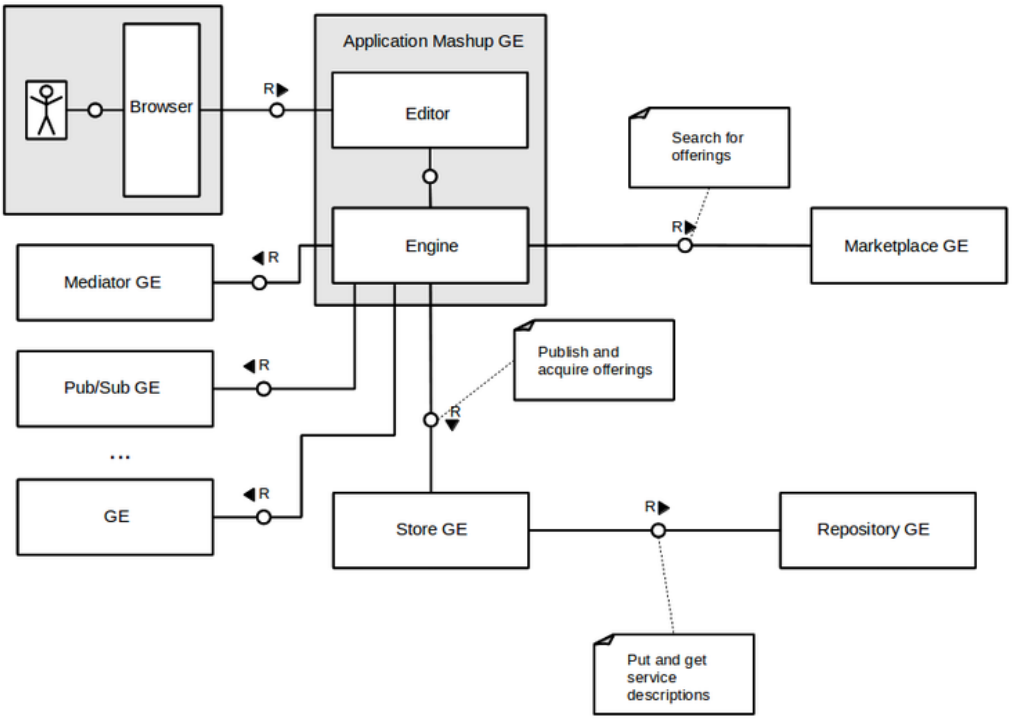
Property: `wire-m:readonly`
This property states whether a mashup configuration element is read only.
URI: http://wirecloud.conwet.fi.upm.es/ns/mashup#readonly
Range: `rdfs:Literal`

15.6.1.3 *WGT zipped file format*

The Mashup Application GE relies on PKWare's Zip specification as the archive format for the self-packaged version of the Mashable Application Components. The packaging format acts as a container for files used by a MAC whereas the only initial requirement is to have a configuration document declaring metadata and configuration parameters for the MAC. This configuration file must use one of the metadata description languages supported by the Mashup Application GE (WDL and MDL in either of its flavours: XML or RDF). This configuration file must be present at the root of the Zip container and the name must be `config.xml` or `config.rdf`. Any relative path/URL included in the configuration document will use the root of the zip file as the base path/URL.
The Mashup Application GE should prohibit relative paths for accessing files outside the container. This is especially important as the Mashup Application GE may extract these files to the file system.

15.7 Main Interactions

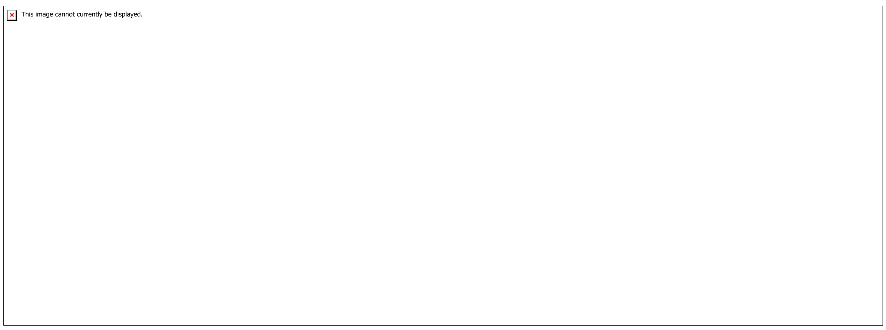
This section describes in detail all the interactions that the Application Mashup GE must support both with users and with other FI-WARE GEs.
The Application Mashup GE is closely related to other FI-WARE Generic Enablers, especially those concerning the business infrastructure and the provision of data sources. The figure below depicts some of these relationships:



How the Application Mashup GE relates to the other Generic Enablers

15.7.1 Life-cycle of a Mashable Application Component (mashup, widget and operators)

Note that Web mashups are aimed at leveraging the "long tail" of the Internet of Services by exploiting rapid development, the "Do-It-Yourself" (DIY) metaphor, and the ability to share mashable components. They typically serve a specific situational (i.e. immediate, short-lived, customized, specific) need, often with a high reuse potential. This need for sharing means that the Application Mashup GE should be fully compliant with the FI-WARE's Marketplace, Store and Repository Generic Enablers. The fact that a MAC can be offered in a Store before being used in the Application Mashup GE results in the definition of the following MAC life-cycle:



Lifecycle of a MAC (mashup, widget and operator)

Mashable Application Components (i.e. mashups, widgets and operators) must pass through the following states:

- **Published**
- **Bought/installed**
- **Deployed**

The init state for a MAC means that the MAC is neither published in the store, bought, nor installed in the user local repository. A MAC is **published** when it is made available to Store customers. Users that are interested in using a **published** MAC, can buy the MAC, thus transferring it to a *bought* state. Once *bought*, the MAC is automatically **installed** in the local catalogue of the Application Mashup GE. An alternative is to *upload* a MAC that the users have developed and which they do not have to buy. This is why the state is named **bought/installed**. Once the users have *uploaded* the MAC to the local catalogue, they can proceed to *publish* the MAC. Once the MAC is installed, it can be **deployed** in the user workspace. *Bought* and *installed* MACs must be **deployed** in the user workspace before they can be *configured*.

15.7.2 Interaction diagrams

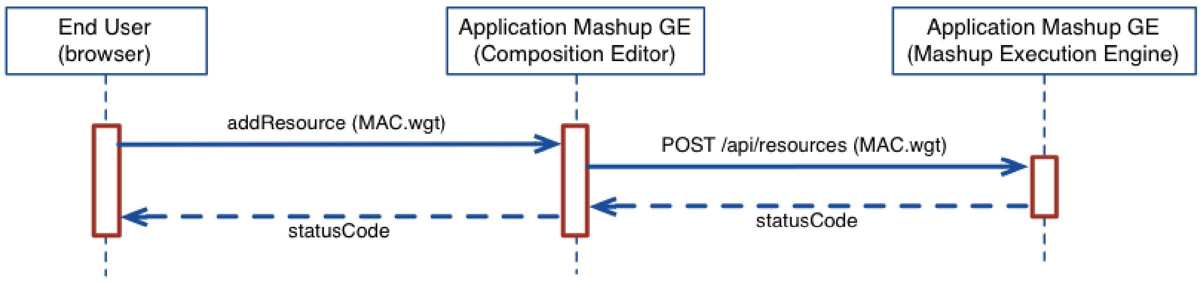
The Application Mashup Generic Enabler must be designed and developed to enable, at least, the interactions shown in this section. They cover the user-platform interactions needed to visually create a web application mashup, plus the main interactions between the platform and other generic enablers.

15.7.2.1 *User-Platform Interactions*

The interactions that the Application Mashup GE must support with regard to its users are as follows.

(1)Upload a Mashable Application Component to the Local Catalogue

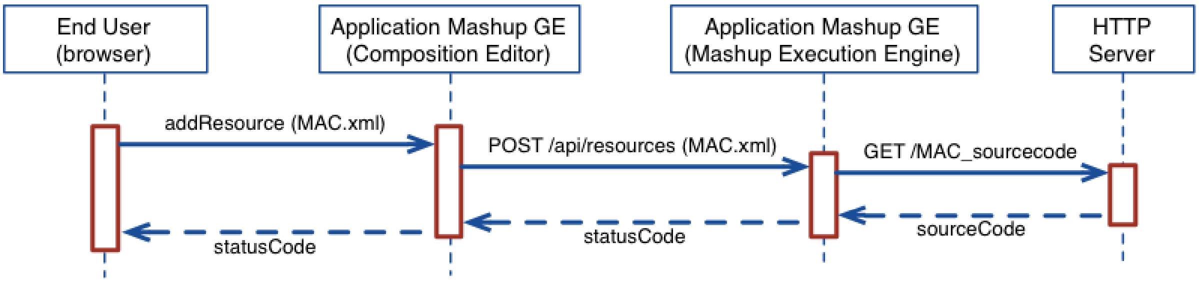
MAC developers must be able to upload their own developed resources to the local catalogue of the Application Mashup GE. End users must also be able to upload the MACs they already have stored in their local hard disk to the local catalogue. The implementation of the GE must enable users to select their new *.wgt packaged MAC and upload it to the Local Catalogue.



Uploading a packaged MAC to the Local Catalogue

It should also be possible to upload the XML template of the MAC, where the Application

Mashup GE is in charge of getting and storing the linked source code of the MAC in the Local Catalogue.



Uploading a MAC from its XML template to the Local Catalogue

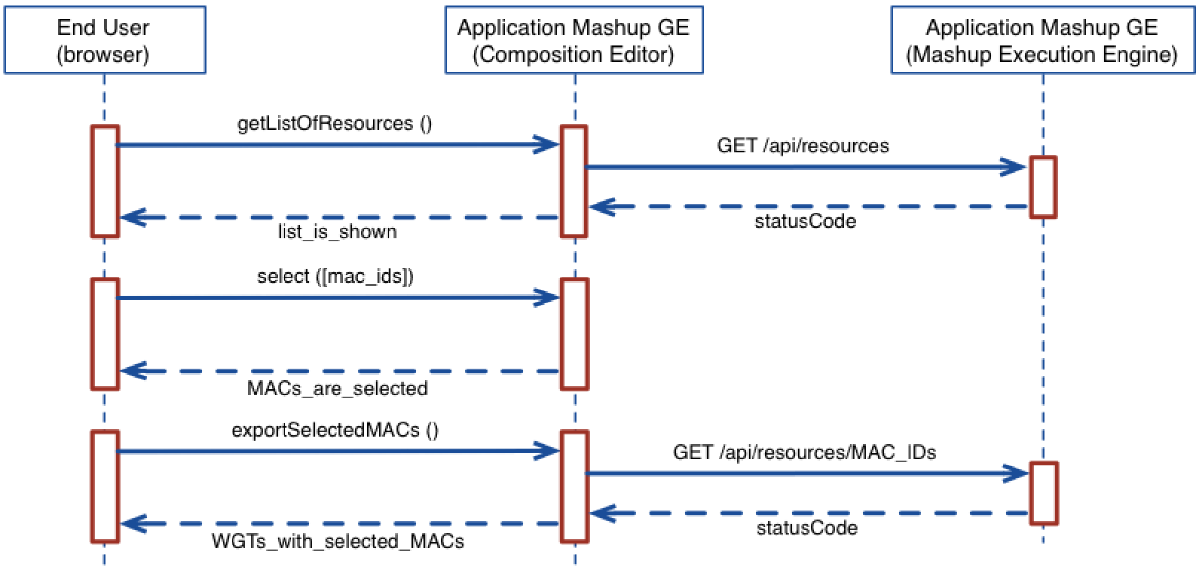
Regardless of the upload method, this interaction must result in the uploaded MAC being stored in the local catalogue, ready for configuration and/or deployment. In other words, the MAC will be at the **Bought/Installed state** of its lifecycle. A `HTTP/1.1 201 Created` Status Code response will be received if the interaction went well.

Note that there are two possible scenarios if the uploaded MAC is a mashup:

- If the widgets within the mashup are currently installed in the local catalogue, the uploaded mashup will reference the widgets and will run out-of-the-box.
- If some of the widgets have a commercial license, and the license has to be bought for the widget to be used, the uploaded mashup will be installed, but the GE must warn and notify users that they have to buy the licensed widgets.

(2)Export a MAC from the local catalogue

Platform users must be able to export (download) any of the MACs they have installed in the local catalogue. Users should select the MACs they want to export and click on an export button for the Application Mashup GE implementation to generate a packaged version of the selected MACs, enabling users to download MACs using their Web browser.



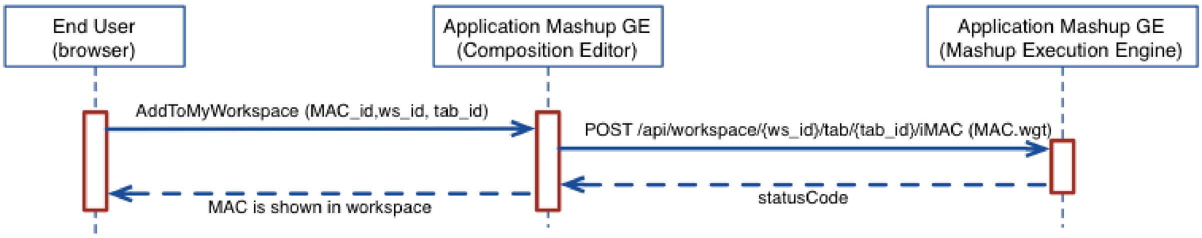
Exporting (downloading) a packaged MAC from the Local Catalogue

(3)Deploy a MAC to get a new runtime instance

The ***Deploy MAC*** functionality instantiates a mashup or widget, that is available in the local catalogue in the Mashup Execution Engine. This operation is invoked by the mashup developer from the Composition Editor. The call should include the following information:

- *macID*: id of the mashup for instantiation.
- *wsID*: id of the active user workspace.
- *tabID*: id of the current tab within the active user workspace.

As a result of this invocation, the engine will get the MAC template from the local catalogue and will execute the MAC. It will also be available in the Mashup Editor mashup developer workspace. Its state will switch to **deployed**.

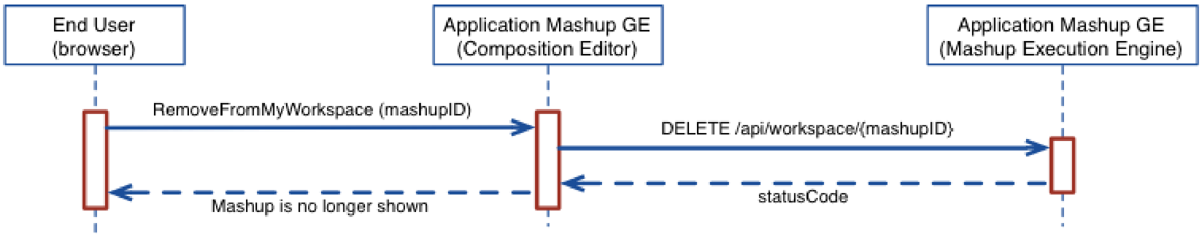


Interaction with the Mashup Execution Engine to deploy both mashups and widgets

(4)Undeploy a MAC. Remove an instance from execution

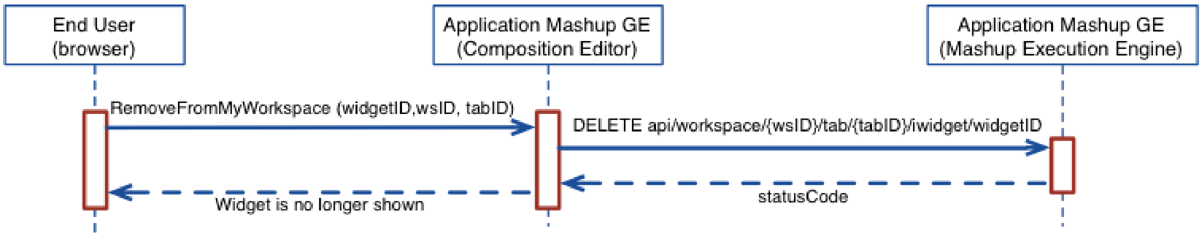
The operation ***Undeploy MAC*** removes a mashup application or a widget from execution. Mashup developers invoke this operation from the mashup composition editor when they want to delete the whole mashup application or just a single widget.

The mashupID is required to undeploy a mashup:



Interaction needed to undeploy a mashup

The widgetID, workspaceID and tabID are required to undeploy a widget.

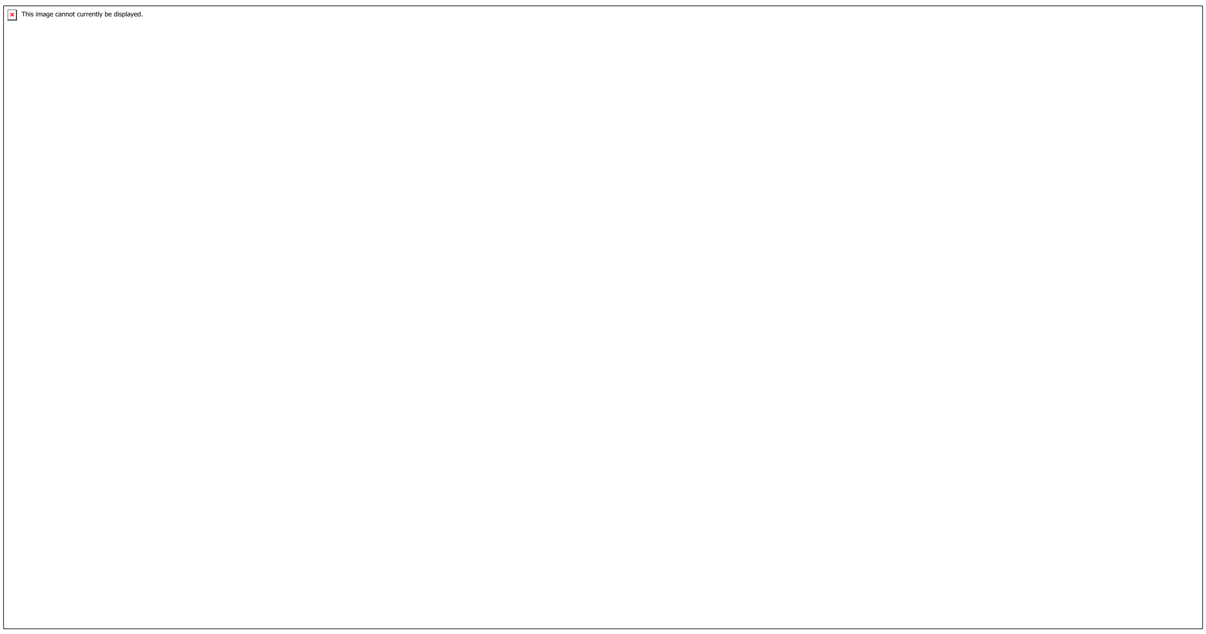


Interaction needed to undeploy a widget

As a result of this operation, the mashup or widget will stop executing, and thus it will reach the **bought/installed** state in its lifecycle.

(5)Interconnect widgets/operators using wiring
Wiring functionality enables users to connect one or more widgets/operators to one or more other widgets/operators by means of a channel. The Composition Editor will help users to connect one or more of the possible outputs of a widget/operator with the input of another widget/operator. This way, data flows between MACs allowing the mashup application to act as an information and process dashboard.
Besides, piping deals with how operators can bind to a specific backend service to gain access to data provided by the service. Then, users can wire the operator outputs either to other operators in order to perform some kind of data filtering/adaptation processes or to other widgets to consume the data.

The figure below shows how users set up channels between widgets/operators for wiring/piping.



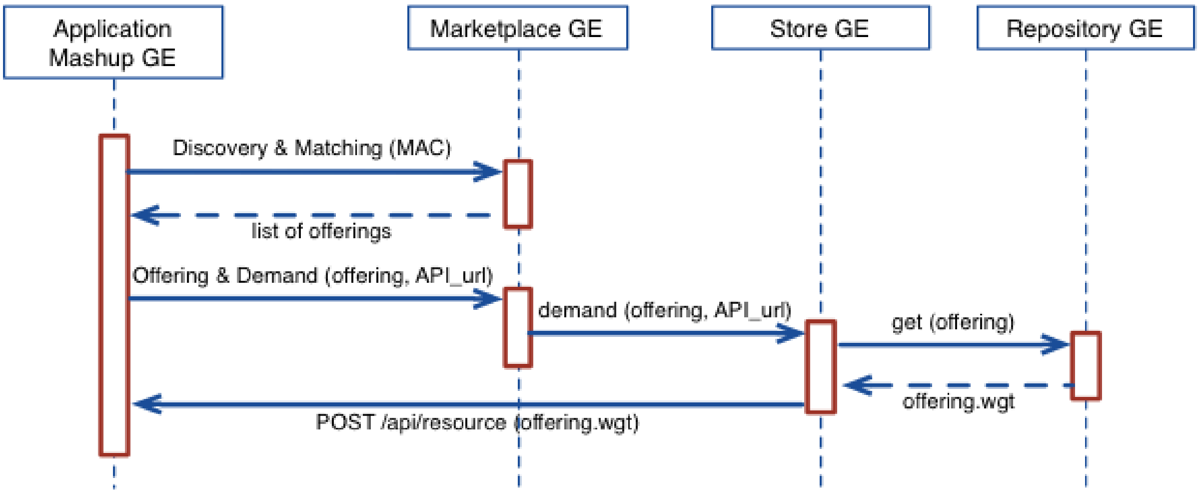
Widget Interconnection Management process

15.7.2.2 *Interactions with other FI-WARE Generic Enablers*

The Application Mashup GE is closely related with the Business-related FI-WARE GEs. The main interactions are as follows.

(1)Buy MACs from a Store

Buying both mashup applications, widgets and operators from an external FI-WARE Store is one of the topics to be taken into account by the Application Mashup GE. Once users have used the Marketplace GE to search and select the MAC that they want to buy, the Application Mashup GE must provide the Store with a URL (through the Application Mashup RESTful API) and request the uploading of the bought MAC. The Store GE will be the actor that uploads the MAC to the local catalogue. Once the MAC has been uploaded, it is automatically installed in the local catalogue. From this point onwards, it will be possible for the MAC to be instantiated and thus executed.

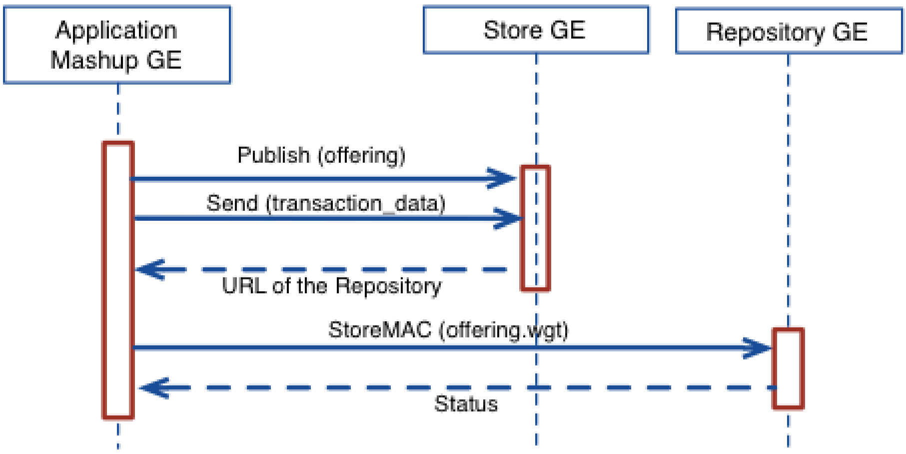


Buying a new MAC from a Store

(2)Publish a MAC to a Store

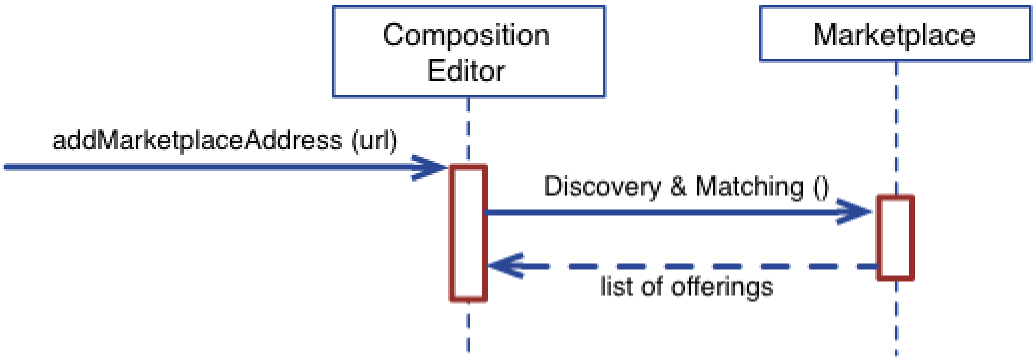
Once users have either developed and uploaded a new widget to the local catalogue or created their own mashup application, the Application Mashup GE must enable users to contact the Store GE to publish their brand new MAC.

The Application Mashup GE must enable users to notify the Store GE that they intend to publish the MAC. The Store GE is responsible for the entire transactions process (i.e. sending of pricing data, card number, etc.), which is out of the scope of the Application Mashup GE. However, at some point of the interaction, the Application Mashup must send the packaged MAC to the Store/Repository for storage when it is set to **published**.



Publishing a new MAC to a given Store

(3)Add Marketplace
The Application Mashup GE must be able to include new Marketplaces to search for new MACs. To do this, Marketplaces must be accessible from the Editor and new ones could be added from time to time. This functionality adds the Marketplace URI to the Composition Editor's internal list of marketplaces.



Adding the URL of a new Marketplace

15.8 Basic Design Principles

- **API Technology Independence**

  The API abstracts from the specific implementation technology. Implementations using more than one type of platform and framework should be possible.

- **Web Browsers should not limit the functionalities of the Application Mashup GE**

  HTML5, CSS and JavaScript must be used to fully exploit the brand new Web applications capabilities.

- **User-matched interaction abstraction level**

  Editors could cater for different user expertise (from technical experts skilled in the composition language to domain experts without technical expertise or even simple end users with no programming or technical skills) and roles (from composed service creators, to resellers and finally prosumers) by hiding complexity behind different types of building blocks, trading off flexibility for simplicity.

15.9 Re-utilized Technologies/Specifications

The Application Mashup GE requires both authentication and authorization in order to safeguard the different compositions from its users.

- Use of the OAuth2 protocol is recommended: [1]

On the other hand, the Application Mashup GE relies on the Marketplace, Store and Repository GEs, and it must support the following technologies and specifications:

- RESTful web services
- HTTP/1.1
- JSON and XML data serialization formats
- Linked USDL

There are a number of widget- and mashup-related specifications that should be considered and/or contributed to, including the four specifications listed in the following section:

15.9.1 OpenSocial

OpenSocial is a public specification that defines a component hosting environment (container) and a set of common application programming interfaces (APIs) for web-based applications.

15.9.2 Widget Packaging and XML Configuration

W3C has published a set of specifications describing their view about widgets. "Widget Packaging and XML Configuration" is one of the most prominent specifications in this set.

15.9.3 OpenAjax Hub 2.0 Specification

The OpenAjax Hub is a standard JavaScript functionality set defined by the OpenAjax Alliance that addresses key interoperability and security issues that arise when multiple Ajax libraries and/or components are used within the same web page. The OpenAjax Hub represents one of the key technical contributions of the OpenAjax Alliance to the Ajax community consistent with the Alliance's mission. Seehttp://www.openajax.org for information on the OpenAjax Alliance.

The key feature of OpenAjax Hub 2.0 is its publish/subscribe engine that includes a "Managed Hub" mechanism that enables a host application to isolate untrustworthy components into secure sandboxes.

15.9.4 OMA Enterprise Mashup Markup Language

The Open Mashup Alliance (OMA) is a consortium of individuals and organizations dedicated to the successful use of Enterprise Mashup technologies and adoption of an open language that promotes Enterprise Mashup interoperability and portability.
OMA has developed a free-to-use Enterprise Mashup Markup Language (EMML) to promote the development, interoperability and compatibility of Enterprise Mashup offerings. The OMA also provides a reference runtime implementation that processes mashup scripts written in EMML.

15.10 References

1. ↑ Lizcano, D., Alonso, F., Soriano, J., and López, G. (2011) A new end user composition model to empower knowledge workers to develop rich Internet applications. In Journal of Web Engineering, Vol.10 No. 3, pp. 197-233, Rinton Press Inc. Sept. 2011

15.11 Detailed Specifications

15.11.1 Open API Specifications

The Application Mashup GE offers two separate APIs that cannot be combined because they are of different types: the WidgetAPI is a JavaScript API, whereas the ApplicationMashupAPI is a RESTful API:

- FIWARE.OpenSpecification.Apps.WidgetAPI
- FIWARE.OpenSpecification.Apps.ApplicationMashupAPI

The Application Mashup GE will access the Repository, Registry and Marketplace via their REST API:

- Repository Open RESTful API Specification
- FIWARE.OpenSpecification.Apps.RegistryREST
- FIWARE.OpenSpecification.Apps.MarketplaceRegistrationREST
- FIWARE.OpenSpecification.Apps.MarketplaceOfferingsREST
- FIWARE.OpenSpecification.Apps.MarketplaceSearchREST

15.11.2 Other Open Specifications

The Application Mashup GE will use information retrieved from the Repository and the Marketplace using the Linked USDL specifications:

- Linked USDL Core Vocabulary
- Linked USDL Pricing Vocabulary
- Linked USDL Service Level Agreements Vocabulary
- Linked USDL Security Vocabulary

15.12 Terms and definitions

This section comprises a summary of terms and definitions introduced during the previous sections. It intends to establish a vocabulary that will be of help to carry out discussions internally and with third parties (e.g., Use Case projects in the EU FP7 Future Internet PPP). For a summary of terms and definitions managed at overall FI-WARE level, please refer to FIWARE Global Terms and Definitions

- **Aggregator (Role):** A Role that supports domain specialists and third-parties in aggregating services and apps for new and unforeseen opportunities and needs. It does so by providing the dedicated tooling for aggregating services at different levels: UI, service operation, business process or business object levels.
- **Application:** Applications in FI-WARE are composite services that have a IT supported interaction interface (user interface). In most cases consumers do not buy the application, instead they buy the right to use the application (user license).
- **Broker (Role):** The business network's central point of service access, being used to expose services from providers that are delivered through the Broker's service delivery functionality. The broker is the central instance for enabling monetization.
- **Business Element:** Core element of a business model, such as pricing models, revenue sharing models, promotions, SLAs, etc.
- **Business Framework:** Set of concepts and assets responsible for supporting the implementation of innovative business models in a flexible way.
- **Business Model:** Strategy and approach that defines how a particular service/application is supposed to generate revenue and profit. Therefore, a Business Model can be implemented as a set of business elements which can be combined and customized in a flexible way and in accordance to business and market requirements and other characteristics.
- **Business Process:** Set of related and structured activities producing a specific service or product, thereby achieving one or more business objectives. An operational business process clearly defines the roles and tasks of all involved parties inside an organization to achieve one specific goal.
- **Business Role:** Set of responsibilities and tasks that can be assigned to concrete business role owners, such as a human being or a software component.
- **Channel:** Resources through which services are accessed by end users. Examples for well-known channels are Web sites/portals, web-based brokers (like iTunes, eBay and Amazon), social networks (like Facebook, LinkedIn and MySpace), mobile channels (Android, iOS) and work centers. The access mode to these channels is governed by technical channels like the Web, mobile devices and voice response, where each of these channels requires its own specific workflow.
- **Channel Maker (Role):** Supports parties in creating outlets (the Channels) through which services are consumed, i.e. Web sites, social networks or mobile platforms. The Channel Maker interacts with the Broker for discovery of services during the process of creating or updating channel specifications as well as for storing channel specifications and channeled service constraints in the Broker.
- **Composite Service (composition):** Executable composition of business back-end MACs (see MAC definition later in this list). Common composite services are either orchestrated or choreographed. Orchestrated compositions are defined by a

centralized control flow managed by a unique process that orchestrates all the interactions (according to the control flow) between the external services that participate in the composition. Choreographed compositions do not have a centralized process, thus the services participating in the composition autonomously coordinate each other according to some specified coordination rules. Backend compositions are executed in dedicated process execution engines. Target users of tools for creating Composites Services are technical users with algorithmic and process management skills.

- **Consumer (Role):** Actor who searches for and consumes particular business functionality exposed on the Web as a service/application that satisfies her own needs.
- **Desktop Environment:** Multi-channel client platform enabling users to access and use their applications and services.
- **Event-driven Composition:** Components concerned with the composition of business logic, which is driven by asynchronous events. This implies run-time selection of MACs and the creation/modification of orchestration workflows based on composition logic defined at design-time and adapted to context and the state of the communication at run-time.
- **Front-end/Back-end Composition:** Front-end compositions define a front-end application as an aggregation of visual mashable application pieces (named as widgets, gadgets, portlets, etc.) and back-end services. Front-end compositions interact with end-users, in the sense that front-end compositions consume data provided by the end-users and provide data to them. Thus the front-end composition (or mashup) will have a direct influence on the application look and feel; every component will add a new user interaction feature. Back-end compositions define a back-end business service (also known as process) as an aggregation of backend services as defined for service composition term, the end-user being oblivious to the composition process. While back-end components represent atomization of business logic and information processing, front-end components represent atomization of information presentation and user interaction.
- **Gateway (Role):** The Gateway role enables linking between separate systems and services, allowing them to exchange information in a controlled way despite different technologies and authoritative realms. A Gateway provides interoperability solutions for other applications, including data mapping as well as run-time data store-forward and message translation. Gateway services are advertised through the Broker, allowing providers and aggregators to search for candidate gateway services for interface adaptation to particular message standards. The Mediation is the central generic enabler. Other important functionalities are eventing, dispatching, security, connectors and integration adaptors, configuration, and change propagation.
- **Hoster (Role):** Allows the various infrastructure services in cloud environments to be leveraged as part of provisioning an application in a business network. A service can be deployed onto a specific cloud using the Hoster's interface. This enables service providers to re-host services and applications from their on-premise environments to cloud-based, on-demand environments to attract new users at much lower cost.
- **Marketplace:** Part of the business framework providing means for service providers, to publish their service offerings, and means for service consumers, to compare and

select a specific service implementation. A marketplace can offer services from different stores and thus different service providers. The actual buying of a specific service is handled by the related service store.

- **Mashup:** Executable composition of front-end MACs. There are several kinds of mashups, depending on the technique of composition (spatial rearrangement, wiring, piping, etc.) and the MACs used. They are called application mashups when applications are composed to build new applications and services/data mash-ups if services are composed to generate new services. While composite service is a common term in backend services implementing business processes, the term 'mashup' is widely adopted when referring to Web resources (data, services and applications). Front-end compositions heavily depend on the available device environment (including the chosen presentation channels). Target users of mashup platforms are typically users without technical or programming expertise.
- **Mashable Application Component (MAC):** Functional entity able to be consumed executed or combined. Usually this applies to components that will offer not only their main behaviour but also the necessary functionality to allow further compositions with other components. It is envisioned that MACs will offer access, through applications and/or services, to any available FI-WARE resource or functionality, including gadgets, services, data sources, content, and things. Alternatively, it can be denoted as 'service component' or 'application component'.
- **Mediator:** A mediator can facilitate proper communication and interaction amongst components whenever a composed service or application is utilized. There are three major mediation area: Data Mediation (adapting syntactic and/or semantic data formats), Protocol Mediation (adapting the communication protocol), and Process Mediation (adapting the process implementing the business logic of a composed service).
- **Monetization:** Process or activity to provide a product (in this context: a service) in exchange for money. The Provider publishes certain functionality and makes it available through the Broker. The service access by the Consumer is being accounted, according to the underlying business model, and the resulting revenue is shared across the involved service providers.
- **Premise (Role):** On-Premise operators provide in-house or on-site solutions, which are used within a company (such as ERP) or are offered to business partners under specific terms and conditions. These systems and services are to be regarded as external and legacy to the FI-Ware platform, because they do not conform to the architecture and API specifications of FI-WARE. They will only be accessible to FI-WARE services and applications through the Gateway.
- **Prosumer:** A user role able to produce, share and consume their own products and modify/adapt products made by others.
- **Provider (Role):** Actor who publishes and offers (provides) certain business functionality on the Web through a service/application endpoint. This role also takes care of maintaining this business functionality.
- **Registry and Repository:** Generic enablers that able to store models and configuration information along with all the necessary meta-information to enable searching, social search, recommendation and browsing, so end users as well as services are able to easily find what they need.

- **Revenue Settlement:** Process of transferring the actual charges for specific service consumption from the consumer to the service provider.
- **Revenue Sharing:** Process of splitting the charges of particular service consumption between the parties providing the specific service (composition) according to a specified revenue sharing model.
- **Service:** We use the term service in a very general sense. A service is a means of delivering value to customers by facilitating outcomes customers want to achieve without the ownership of specific costs and risks. Services could be supported by IT. In this case we say that the interaction with the service provider is through a technical interface (for instance a mobile app user interface or a Web service). Applications could be seen as such IT supported Services that often are also composite services.
- **Service Composition:** in SOA domain, a service composition is an added value service created by aggregation of existing third party services, according to some predefined work and data flow. Aggregated services provide specialized business functionality, on which the service composition functionality has been split down.
- **Service Delivery Framework:** Service Delivery Framework (or Service Delivery Platform (SDP)) refers to a set of components that provide service delivery functionality (such as service creation, session control & protocols) for a type of service. In the context of FI-WARE, it is defined as a set of functional building blocks and tools to (1) manage the lifecycle of software services, (2) creating new services by creating service compositions and mashups, (3) providing means for publishing services through different channels on different platforms, (4) offering marketplaces and stores for monetizing available services and (5) sharing the service revenues between the involved service providers.
- **Service Level Agreement (SLA):** A service level agreement is a legally binding and formally defined service contract, between a service provider and a service consumer, specifying the contracted qualitative aspects of a specific service (e.g. performance, security, privacy, availability or redundancy). In other words, SLAs not only specify that the provider will just deliver some service, but that this service will also be delivered on time, at a given price, and with money back if the pledge is broken.
- **Service Orchestration:** in SOA domain, a service orchestration is a particular architectural choice for service composition where a central orchestrated process manages the service composition work and data flow invocations of the external third party services in the order determined by the work flow. Service orchestrations are specified by suitable orchestration languages and deployed in execution engines who interpret these specifications.
- **Store:** An external component integrated with the business framework, offering a set of services that are published to a selected set of marketplaces. The store thereby holds the service portfolio of a specific service provider. In case a specific service is purchased on a service marketplace, the service store handles the actual buying of a specific service (as a financial business transaction).
- **Unified Service Description Language (USDL):** USDL is a platform-neutral language for describing services, covering a variety of service types, such as purely human services, transactional services, informational services, software components, digital media, platform services and infrastructure services. The core set of language

	modules offers the specification of functional and technical service properties, legal and financial aspects, service levels, interaction information and corresponding participants. USDL is offering extension points for the derivation of domain-specific service description languages by extending or changing the available language modules.

16 FIWARE OpenSpecification Apps Widget API

You can find the content of this chapter as well in the wiki of fi-ware.

16.1 Introduction to the *Widget* API

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16.1.1 Widget API Core

The Application Mashup GE offers two separate APIs that cannot be combined because of their different nature: The Widget API (the subject of this entry) is a JavaScript API, while the ApplicationMashupAPI is a RESTful one. You can find the Application Mashup Open RESTful API in this separate entry:

- FIWARE.OpenSpecification.Apps.ApplicationMashupAPI

The Widget API is a JavaScript API that allows deployed widgets in a Mashup Execution Engine to gain access to its functionalities. It does not make sense to expose it as a RESTful API since it needs to be consumed by a widget in its own local execution environment. Amongst other functionalities, this API allows the widgets to gain access to remote resources. For example, in order to gain access to a remote REST API or to resolve cross-domain problems, a widget needs to use a proxy through the Widget API.

16.1.2 Intended Audience

This specification is intended for service front-end (aka gadget/widget) developers. This document provides a full specification of how to make widgets interoperate with the Mashup Execution Engine. To use this information, the reader should firstly have a general understanding of the Generic Enablers for Composition and Mashup.
You should also be familiar with:

- JavaScript

16.1.3 API Change History

Revision Date	Changes Summary
Apr 27, 2012	• Initial version

16.1.4 How to Read This Document

It is assumed that reader is familiarized with JavaScript. Along the document, some special notations are applied to differentiate some special words or concepts. The following list summarizes these special notations.

- A bold font is used to represent method names.
- Function parameters are represented in italic font.

For a description of some terms used along this document, see ApplicationMashup.

16.2 *Widget* API

16.2.1 MashupPlatform.http

16.2.1.1 ***request options***

Generic options:

- *contentType* (String; default *application/x-www-form-urlencoded*): The Content-type header for a request. This header must be changed if data in another format (like XML) have to be sent.
- *encoding* (String; default *UTF-8*): The encoding for the contents of a request. It is best left as-is, but should weird encoding issues arise, it might be necessary tweaking this.
- *method* (String; default *POST*): The HTTP method to use for the request.
- *parameters* (Object): The parameters for the request, which will be encoded into the URL for a get method, or into the request body for the other methods.
- *postBody* (String): Specific contents for the request body on a post method. If it is not provided, the contents of the parameters option will be used instead.
- *requestHeaders* (Object): A set of key-value pairs, with properties representing header names.
- *forceProxy* (Boolean; default *false*): Sends the request through the proxy regardless of the other options passed.
- *context* (Object; default *null*): this is the value to be passed as *this* parameter to the callbacks.

Callback options:

- *onSuccess*: Invoked when a request completes and its status code belongs in the 2xy family. This is skipped if a code-specific callback is defined (e.g., on200), and happens before *onComplete*.
- *onFailure*: Invoked when a request completes and its status code exists but it does not belong in the 2xy family. This is skipped if a code-specific callback is defined (e.g. on403) and happens before *onComplete*.
- *onXYZ* (with XYZ representing any HTTP status code): Invoked just after the response is complete if the status code is the exact code used in the callback name. Prevents execution of *onSuccess* and *onFailure*. Happens before *onComplete*.
- *onComplete*: Triggered at the very end of a request's life-cycle, after the request completes, status-specific callbacks are called, and possible automatic behaviors are processed. Guaranteed to run regardless of what happened during the request.

16.2.1.2 *Methods*

(1)MashupPlatform.http.buildProxyURL(url, options)
Builds a URL suitable for working around the cross-domain problem. This usually is handled using the Mashup Execution Engine proxy but it also can be handled using the access control request headers if the browser has support for them. If all the needed requirements are meet, this function will return a URL without using the proxy.

- *url* - Target URL.
- *options* - Optional object with request options (see the request options section for more details).

(2)MashupPlatform.http.makeRequest(url, options)
Sends a HTTP request.

- *url* - Target URL of the request.
- *options* - Optional object with request options (see the request options section for more details). MashupPlatform.wiring

16.2.1.3 *Methods*

(1)MashupPlatform.wiring.pushEvent(outputName, data)
Sends an event through the wiring.

- *outputName* - Name of the output endpoint as defined in the GDL.
- *data* - Event content.

(2)MashupPlatform.wiring.registerCallback(inputName, callback)
Registers a callback for a given input endpoint. If the given endpoint already has registered a callback, it will be replaced by the new one.

- *inputName* - Name of the input endpoint as defined in the GDL.
- *callback* - Callback function to use when an event reaches the given input endpoint.

16.2.2 MashupPlatform.prefs

Widgets may use the methods defined in this module to retrieve and to be notified of changes in the values of their preferences.

16.2.2.1 *Methods*

(1)MashupPlatform.prefs.get(key)
Retrieves the value of a preference.

- *key* - Name of the preference to fetch.

(2)MashupPlatform.prefs.registerCallback(callback)
Registers a callback for listening preference changes.

- *callback* - Callback function that will be called when widget's preferences are changed.

17 FIWARE OpenSpecification Apps Application Mashup API

You can find the content of this chapter as well in the wiki of fi-ware.

17.1 Introduction to the *Application Mashup* API

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17.1.1 Application Mashup Core

The Application Mashup GE offers two separate APIs that cannot be combined because of their different nature: The Widget API is a JavaScript API, while the Application Mashup API (the subject of this entry) is a RESTful one. You can find the Widget API in this separate entry:

- FIWARE.OpenSpecification.Apps.WidgetAPI

The Application Mashup API is a RESTful, resource-oriented API accessed via HTTP that uses various representations for information interchange. This API provides the functionality to create and modify workspaces and the functionality to manage the resources available for building these workspaces.

17.1.2 Intended Audience

This specification is intended for both software developers and reimplementers of this API. For the former, this document provides a full specification of how to interoperate with products that implement the Application Mashup API. For the latter, this specification indicates the interface to be implemented and provided to clients.
To use this information, the reader should firstly have a general understanding of the Generic Enabler service Application Mashup. You should also be familiar with:

- RESTful web services
- HTTP/1.1
- JSON and/or XML data serialization formats.

17.1.3 API Change History

This version of the Application Mashup API Guide replaces and obsoletes all previous versions. The most recent changes are described in the table below:

Revision Date	Changes Summary
Jun 28, 2013	• Changed error response format and used error codes
Apr 18, 2013	• Revised version
Nov 2, 2012	• Initial version

17.1.4 How to Read This Document

It is assumed that the reader is familiar with the REST architecture style. Within the document, some special notations are applied to differentiate some special words or concepts. The following list summarizes these special notations.

- A bold, mono-spaced font is used to represent code or logical entities, e.g., HTTP method (`GET, PUT, POST, DELETE`).
- An italic font is used to represent document titles or some other kind of special text, e.g., *URI*.
- Variables are represented between brackets, e.g. {id} and in italic font. The reader can replace the id with an appropriate value.

For a description of some terms used along this document, see the Application Mashup GE description.

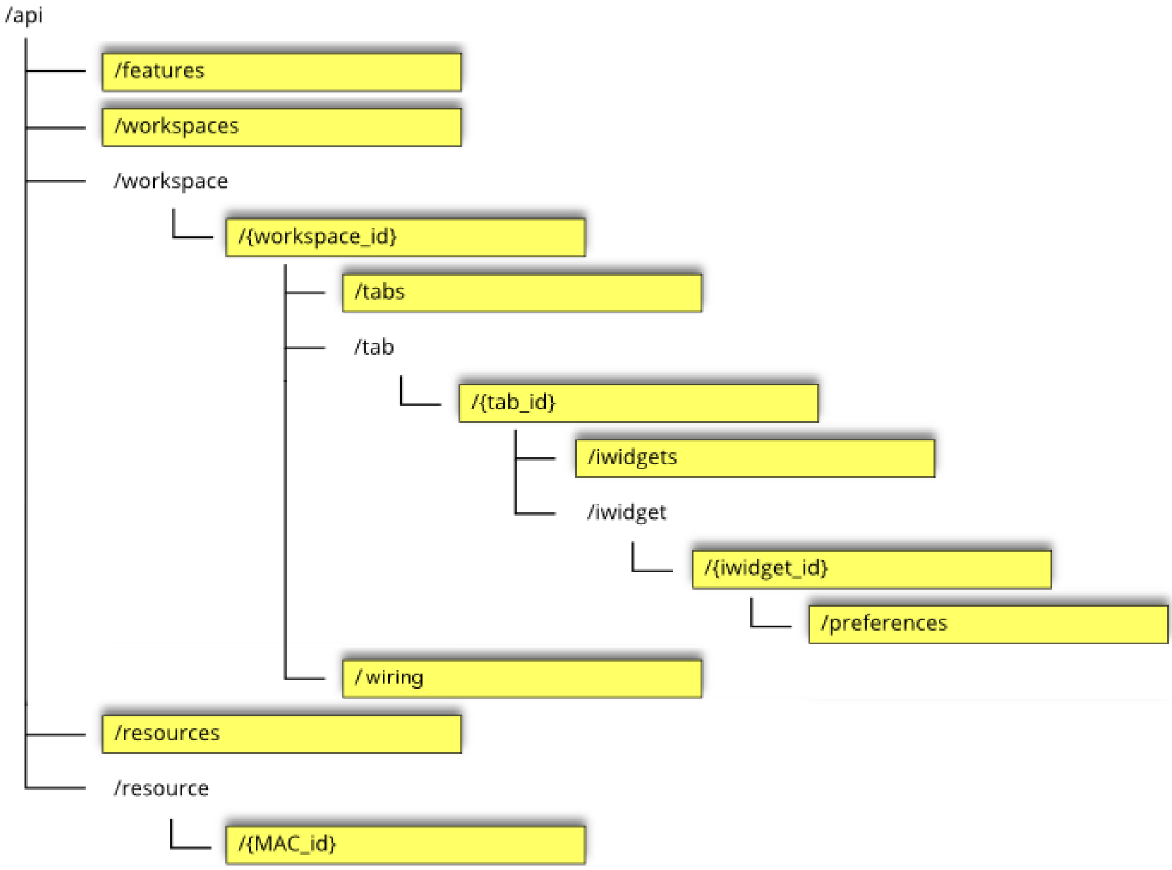
17.1.5 Additional Resources

You can download the most current version of this document from the FI-WARE API specification website at Application Mashup API. For more details about the Application Mashup GE that this API is based upon, please refer to the Application Mashup GE description.
High Level Description. Related documents, including an Architectural Description, are available at the same site.

17.2 General *Mashup Application* API Information

17.2.1 Resources Summary

The following figure summarizes the resources considered in the Application Mashup RESTful API



17.2.2 Authentication

Each HTTP request against the *Application Mashup API* requires the inclusion of specific authentication credentials. The specific implementation of this API may support multiple authentication schemes (OAuth, Basic Auth, Token) and will be determined by the specific provider that implements the GE. Please contact the provider to determine the best way to authenticate against this API. Remember that some authentication schemes may require that the API operates using SSL over HTTP (HTTPS).

17.2.3 Representation Format

The *Application Mashup* API supports at least JSON for delivering any kind of resources, it may also support simple text, XML and HTML output format. The request format is specified using the Content-Type header and is required for operations that have a request body. The response format can be specified in requests using the Accept header. Note that it is possible for a response to be serialized using a format different from the request.

The interfaces should support data exchange through multiple formats:

- *text/plain* - A linefeed separated list of elements for easy mashup and scripting.
- *text/html* - An human-readable HTML rendering of the results of the operation as output format.
- *application/json* - A JSON representation of the input and output for mashups or JavaScript-based Web Apps
- *application/xml* - A XML description of the input and output.

- *application/x-www-form-urlencoded* - May be used for submitting using HTML forms.
- *multipart/form-data* - Should be used for submitting HTML forms containing files.
- *application/octet-stream* - Used for uploading/downloading packaged Mashable Application Components.

17.2.4 Representation Transport

Resource representation is transmitted between client and server by using HTTP 1.1 protocol, as defined by IETF RFC-2616. Each time an HTTP request contains payload, a Content-Type header shall be used to specify the MIME type of wrapped representation. In addition, both client and server may use as many HTTP headers as they consider necessary.

17.2.5 Resource Identification

The resource identification for HTTP transport is made using the mechanisms described by HTTP protocol specification as defined by IETF RFC-2616.

17.2.6 Links and References

The Application Mashup API is relying on Web principles:

- consistent URI structure based on REST style protocol
- HTTP content negotiation to allow the client to choose the appropriate data format supporting XML, JSON, ...

17.2.7 Limits

The capacity of the system can be managed in order to prevent the abuse of the system through some limitations. These limitations will be configured by the operator and may differ from one implementation to other of the GE implementation.

17.2.7.1 *Rate Limits*

These limits are specified both in human readable wild-card and in regular expressions and will indicate for each HTTP verb which will be the maximum number of operations per time unit that a user can request. After each unit time the counter is initialized again.
In the event a request exceeds the thresholds established for your account, a 413 HTTP response will be returned with a Retry-After header to notify the client when they can attempt to try again.

17.2.8 Versions

The Mashup Application API is considered to be an extension of itself, so the current version of the Mashup Application API can be queried using the resource described in the next section. The core extension defining the Mashup Application API is known as "ApplicationMashup".

17.2.9 Extensions

The Application Mashup GE can be extended. The Application Mashup GE provides the resource described below. This allows the introduction of new features in the API without requiring an update of the version, for instance, or to allow the introduction of vendor specific functionality.

Verb	URI	Description
GET	/api/features	List of all available extensions

Example request:

```
GET /api/features HTTP/1.1
Accept: application/json
```

Example response:

```
200 OK
Content-Type: application/json

{
    "ApplicationMashup": "1.0"
}
```

17.2.10 Faults

17.2.10.1 *Synchronous Faults*

Error responses will be encoded using the most appropriated content-type in base to the Accept header of the request. In any case, the response will provide a human-readable message for displaying to end users.

XML Example:

```
<?xml version="1.0" encoding="UTF-8"?>
<error>
   <description>Missing dependencies</description>
   <details>
       <missingDependencies>
           <element>Wirecloud/nonavailable-operator/1.0</element>
           <element>Wirecloud/nonavailable-widget/1.0</element>
       </missingDependencies>
   </details>
```

```
</error>
```

JSON Example:

```
{
    "description": "Missing dependencies",
    "details": {
       "missingDependencies": [
           "Wirecloud/nonavailable-operator/1.0",
           "Wirecloud/nonavailable-widget/1.0"
       ]
    }
}
```

Fault Element	Associated Error Codes	Expected in All Requests?
Bad Request	400	YES
Unauthorized	401	YES
Forbidden	403	YES
Not Found	404	YES
Conflict	409	NO
Request Entity Too Large	413	YES
Unprocessable Entity	422	NO
Internal Server error	50X	YES

17.3 API Operations

17.3.1 Managing Workspaces

The description of the operations is shown in the next table:

Verb	URI	Description	Mandatory/optional
GET	/api/workspaces	Get the list of workspaces available for the	Mandatory

		user	
POST	/api/workspaces	Create a new workspace	Mandatory
GET	/api/workspace/{workspace_id}	Get info about a specific workspace	Mandatory
DELETE	/api/workspace/{workspace_id}	Delete a workspace	Mandatory
PUT	/api/workspace/{workspace_id}/wiring	Updates workspace wiring configuration	Mandatory
POST	/api/workspace/{workspace_id}/tabs	Create a new workspace tab	Mandatory
DELETE	/api/workspace/{workspace_id}/tab/{tab_id}	Delete a workspace tab	Mandatory
POST	/api/workspace/{workspace_id}/tab/{tab_id}/iwidgets	Add a new instance of a widget into the tab	Mandatory
POST	/api/workspace/{workspace_id}/tab/{tab_id}/iwidget/{iwidget_id}	Update widget instance status	Mandatory
POST	/api/workspace/{workspace_id}/tab/{tab_id}/iwidget/{iwidget_id}/preferences	Update widget instance preferences	Mandatory
DELETE	/api/workspace/{workspace_id}/tab/{tab_id}/iwidget/{iwidget_id}	Removes an instance of widget from a tab	Mandatory

17.3.1.1 *Getting Workspaces*

Example request:

```
GET /api/workspaces HTTP/1.1
```

```
Accept: application/json
```

Example response:

```
HTTP/1.1 200 OK
Content-Type: application/json
Vary: Cookie

[
  {
      "name":"tourist_app",
      "creator":"sptel",
      "owned":false,
      "removable":false,
      "active":true,
      "shared":true,
      "id":20
  }
]
```

17.3.1.2 *Creating Workspaces*

Request parameters:

- **mashup** (String): Id of the mashup to use as base for creating the workspace. This option cannot be used along **workspace**.
- **workspace** (String): Id of the workspace to use as base for creating the new workspace. This option cannot be used along **mashup**.
- **name** (String): Name for the new workspace. This parameter is optional if either **mashup** or **workspace** is used. In those cases, the name will be obtained from the referenced mashup or workspace.
- **allow_renaming** (Boolean; default: false): If false, any attempt to create a workspace using a currently used name will fail. If this parameter is true and the name is already in use, a new name will be computed using the indicated name as base.

(1)Creating Workspaces from scratch

Example request:

```
POST /api/workspaces HTTP/1.1
Content-Type: application/json
Accept: application/json

{
```

```
  "name": "test"
}
```

Example response:

```
HTTP/1.1 201 Created
Content-Type: application/json

{
   "name":"test",
   "creator":"admin",
   "wiring":{"operators": {}, "connections": []},
   "empty_params":[],
   "active":false,
   "shared":false,
   "tabs":[
      {
         "visible":true,
         "iwidgets":[],
         "id":84,
         "name":"Tab",
         "preferences":{}
      }
   ],
   "id":81,
   "extra_prefs":{},
   "preferences":{}
}
```

(2)Creating Workspaces from Mashups

Example request:

```
POST /api/workspaces HTTP/1.1
Content-Type: application/json
Accept: application/json

{
  "mashup": "UPM/Mashup/1.0"
}
```

Example response:

```
HTTP/1.1 201 Created
Content-Type: application/json

{
   "name":"example",
   "creator":"admin",
   "wiring":{"operators": {}, "connections": []},
   "empty_params":[],
   "active":false,
   "shared":false,
   "tabs":[
      {
         "visible":true,
         "iwidgets":[
               {
                  "widget":"UPM/Widget1/0.1",
                  "layout":0,
                  "name":"Widget1",
                  "icon_top":-1,
                  "variables":{},
                  "minimized":false,
                  "id":311,
                  "height":28,
                  "zIndex":0,
                  "width":6,
                  "readOnly":false,
                  "icon_left":-1,
                  "tab":3,
                  "transparency":false,
                  "refused_version":null,
                  "top":0,
                  "fulldragboard":false,
                  "left":0
               },
               {
```

```
                    "widget":"UPM/Widget2/0.1",
                    "layout":0,
                    "name":"Widget2",
                    "icon_top":-1,
                    "variables":{},
                    "minimized":false,
                    "id":312,
                    "height":28,
                    "zIndex":0,
                    "width":6,
                    "readOnly":false,
                    "icon_left":-1,
                    "tab":3,
                    "transparency":false,
                    "refused_version":null,
                    "top":0,
                    "fulldragboard":false,
                    "left":7
                 }
          ],
          "id":100,
          "name":"Tab",
          "preferences":{}
       }
    ],
    "id":50,
    "extra_prefs":{},
    "preferences":{}
}
```


Notes:
'UPM/Mashup/1.0' is a mashup available on the local catalogue of the user.

(3)Copying Workspaces
Example request:

```
POST /api/workspaces HTTP/1.1
Content-Type: application/json
Accept: application/json
```

```
{
  "workspace": "3"
}
```

Example response:

```

```

Notes:
'3' is the id of a workspace accesible to the authenticated user.

17.3.1.3 *Getting Workspace details*

Example request:

```
GET /api/workspace/81 HTTP/1.1
Accept: application/json
```

Example response:

```
HTTP/1.1 200 OK
Content-Type: application/json
Vary: Cookie

{
   "name":"test",
   "creator":"admin",
   "wiring":"{\"operators\": {}, \"connections\": []}",
   "empty_params":[],
   "active":false,
   "shared":false,
   "tabs":[
      {
         "visible":true,
         "iwidgets":[],
         "id":84,
         "name":"Tab",
         "preferences":{}
      }
   ],
```

```
    "id":81,
    "extra_prefs":{},
    "preferences":{}
}
```

17.3.1.4 *Deleting Workspaces*

Example request:

```
DELETE /api/workspace/81 HTTP/1.1
Accept: application/json
```

Example response:

```
HTTP/1.1 204 No Content
```

17.3.1.5 *Updating Workspace Wiring Configuration*

Example request:

```
PUT /api/workspace/81/wiring HTTP/1.1
Content-Type: application/json
Accept: application/json

{
    "operators":{
        "0":{
            "name":"UPM/Operator/0.1",
            "id":"0"
        }
    },
    "connections":[
        {
            "source":{
                "type":"iwidget",
                "id":311,
                "endpoint":"location_info_event"
            },
            "target":{
```

```
            "type":"iwidget",
            "id":312,
            "endpoint":"search_text_slot"
         }
      },
      {
         "source":{
            "type":"iwidget",
            "id":311,
            "endpoint":"location_info_event"
         },
         "target":{
            "type":"ioperator",
            "id":0,
            "endpoint":"message"
         }
      }
   ]
}
```

Example response:

```

HTTP/1.1 204 No Content
```

Notes:
'UPM/Operator/1.0' is a operator available on the local catalogue of the user.

17.3.1.6 *Creating Workspace Tabs*

Request parameter:

- **name** (String): Name for the new tab. This parameter is required.

Example request:

```

POST /api/workspace/81/tabs HTTP/1.1
Content-Type: application/json
Accept: application/json


{
  "name": "Tab 2"
}
```

Example response:

```
HTTP/1.1 201 Created
Content-Type: application/json

{
   "id": 3,
   "name":"Tab 2"
}
```

17.3.1.7 *Deleting Workspace Tabs*

Example request:

```
DELETE /api/workspace/81/tab/3 HTTP/1.1
Accept: application/json
```

Example response:

```
HTTP/1.1 204 No Content
```

17.3.1.8 *Adding a New Instance of Widget into a Workspace Tab*

```
POST /api/workspace/81/tab/3/iwidgets HTTP/1.1
Content-Type: application/json
Accept: application/json

{
    "widget": "UPM/Widget/1.0"
}
```

Example response:

```
HTTP/1.1 200 OK
Content-Type: application/json

{
   "widget":"UPM/Widget/1.0",
   "left":12,
```

```
    "top":0,
    "icon_left":-1,
    "icon_top":-1,
    "zIndex":2,
    "width":6,
    "height":28,
    "name":"Widget",
    "layout":0
}
```

Notes:
'UPM/Widget/1.0' is a widget available on the local catalogue of the user.

17.3.1.9 *Updating Widget Instances*

Request parameters:

- **name** (String): Name given to the instance of Widget.
- **tab** (String): Id of the tab where the widget is going to be hosted. Widgets can only be moved between tabs of the same workspace.
- **width** (Number):
- **height** (Number):
- **top** (Number):
- **left** (Number):
- **zIndex** (Number):

Example request:

```
POST /api/workspace/81/tab/3/iwidget/5 HTTP/1.1
Content-Type: application/json
Accept: application/json

{
    "name": "new name"
}
```

Example response:

```
HTTP/1.1 204 No Content
```

17.3.1.10 *Updating Widget Instance Preferences*

Example request:

```
POST /api/workspace/81/tab/3/iwidget/5/preferences HTTP/1.1
Content-Type: application/json
Accept: application/json

{
    "pref": "value"
}
```

Example response:

```

HTTP/1.1 204 No Content
```

17.3.1.11 *Removing Widget Instances From Workspace Tabs*

Example request:

```

DELETE /api/workspace/81/tab/3/iwidget/5 HTTP/1.1
Accept: application/json
```

Example response:

```

HTTP/1.1 204 No Content
```

17.3.2 Managing Local Catalogue

Verb	URI	Description	Mandatory/optional
GET	/api/resources	Get a list of all resources (widgets, operators, etc.) available to the user	Mandatory
POST	/api/resources	Add a resource (widget, operator, etc.) to the local catalogue of the user	Mandatory
GET	/api/resource/{MAC_id}	Download a resource (widget, operator, etc.) from the local catalogue of the user	Mandatory
DELETE	/api/resource/{MAC_id}	Uninstall a resource (widget, operator, etc.) from the local catalogue of the user	Mandatory

17.3.2.1 *Obtaining the list of Mashable Application Components*

Example request:

```
GET /api/resources HTTP/1.1
Accept: application/json
```

Example response:

```
HTTP/1.1 200 OK
Content-Type: application/json

{
   "CoNWeT/multimedia-viewer/0.5": {
      "type": "widget",
      "vendor":"CoNWeT",
      "name":"multimedia-viewer"
      "version":"0.5",
      "description":"This widget allows watch youtube videos, flickr images and another images.",
      "variables":{
         "urlEvent":{
            ....
         },
         "uriEvent":{
            ....
         },
         "apikeyPref":{
            ....
         },
         "uriSlot":{
            ....
         },
         ....
      },
      ...
   },
   "UPM/Operator/1.0": {
      "type": "operator",
      "vendor":"UPM",
      "name":"Operator"
```

```
        "version":"1.0",
        ...
    }
}
```

17.3.2.2 *Uploading Mashable Application Components*

Example request:

```
POST /api/resources HTTP/1.1
Content-Type:           multipart/form-data;           boundary=----
WebKitFormBoundaryHPwaOXLATyUcGQp8
Accept: application/json

------WebKitFormBoundaryHPwaOXLATyUcGQp8
Content-Disposition: form-data; name="file"; filename="widget.wgt"
Content-Type: application/octet-stream

    ...

------WebKitFormBoundaryHPwaOXLATyUcGQp8--
```

Example response:

```
HTTP/1.1 201 Created
Content-Type: application/json

{
   "type": "operator",
   "vendor":"UPM",
   "name":"Widget"
   "version":"1.0",
   ...
}
```

17.3.2.3 *Exporting Mashable Application Components*

Example request:

```
GET /api/resource/UPM/Widget/1.0 HTTP/1.1
```

```
Accept: application/octet-stream
```

Example response:

```
HTTP/1.1 200 OK
Content-type: application/octet-stream
Vary: Accept, Cookie

    ...
```

17.3.2.4 *Uninstalling Mashable Application Components*

Example request:

```
DELETE /api/resource/UPM/Widget/1.0 HTTP/1.1
Accept: application/json
```

Example response:

```
HTTP/1.1 204 No Content
```

17.3.3 Status Codes

200 OK

The request was handled successfully and transmitted in response message.

201 Created

The request was fulfilled and resulted in a new resource being created.

204 No Content

The server successfully processed the request, but did not return any content.

304 Not Modified

Indicates the resource was not modified since last requested. Typically, the HTTP client provides a header like the If-Modified-Since header to provide a time against which to compare. Use of this feature saves bandwidth and reprocessing on both the server and client side, as only the header data must be sent and received in comparison to the entire page being re-processed by the server, then sent again using more bandwidth of the server and client.

400 Bad Request

The request could not be fulfilled due to bad syntax.

401 Unauthorised

The request requires user authentication. If the request already included Authorization credentials, then the 401 response indicates that authorization was refused for those credentials.

403 Forbidden

The server understood the request, but is refusing to fulfill it because the user doesn't have permission to perform the requested action.

404 Not Found

The requested resource could not be found but may be available again in the future. Subsequent requests by the client are permissible.

409 Conflict

Indicates that the request could not be processed because of conflict in the request, such as an already taken name.

413 Request Entity Too Large

The request is larger than the server is willing or able to process.

422 Unprocessable Entity

The request was well-formed but was unable to be followed due to semantic errors.

500 Internal Server Error

A generic error message, returned when no other specific message is suitable.

18 FIWARE OpenSpecification Apps ServiceComposition

You can find the content of this chapter as well in the wiki of fi-ware.

Name	FIWARE.OpenSpecification.Apps.ServiceComposition
Chapter	Apps,
Catalogue-Link to Implementation	[Ericsson Composition]
Owner	EAB, Calin Curescu

```
Disclaimer: The sustainability of this Open Specification cannot be
guaranteed due to internal changes in the project consortium.
```

18.1 Preface

Within this document you find a self-contained open specification of a FI-WARE generic enabler, please consult as well the FI-WARE Product Vision, the website on http://www.fi-ware.org and similar pages in order to understand the complete context of the FI-WARE project.

```
Disclaimer: The sustainability of this Architecture Description
cannot be guaranteed due to internal changes in the project
consortium.
```

18.2 Copyright

- Copyright © 2012 by EAB

18.3 Legal Notice

Please check the following Legal Notice to understand the rights to use these specifications.

18.4 Overview

The Service Composition is a core enabler of the FI-WARE Platform. It allows users to create, manage and execute composed services. It consists of to main parts, the editor and the execution environment. The editor provides users with a graphical environment that allows them to create composed services in a more convenient way, providing graphical constructs for flow control and component service templates (and hiding away some of the service communication and data representation details). These composed service representations (i.e. skeletons) specify the main parts of the business logic of the composed services. During the run-time the composition engine dynamically decides about what services to invoke or which data source to use based on constraints evaluated at that particular time. Essentially the composition engine is creating the workflow step-by-step during runtime, and different composition decisions can be taken depending on external constraints or on the return values of previously executed services.

As an intermediary step, the composed service specification can be stored/fetched from the Repository GE. Moreover the Service Composition GE can search (based on different criteria) the Marketplace GE for services to either be used in a new composition or to be executed by the execution environment.

18.4.1 Target usage

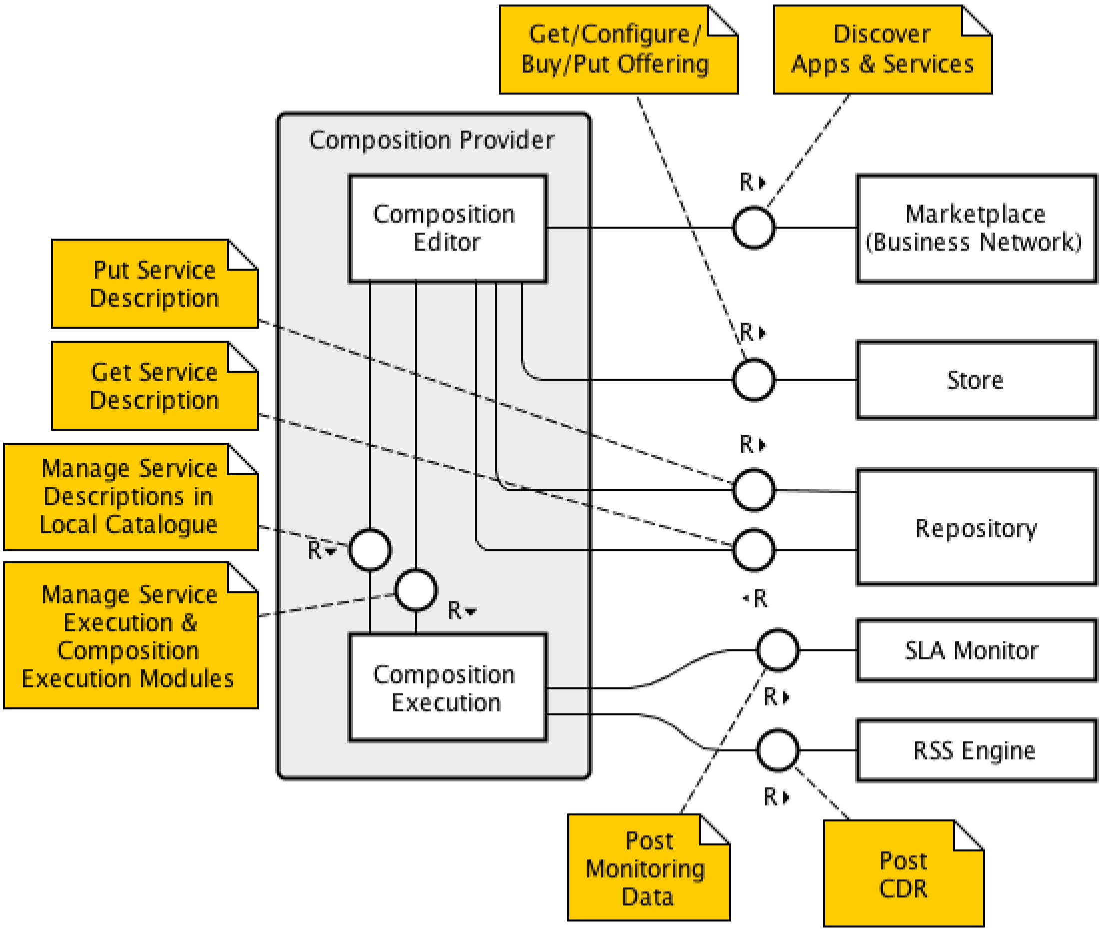
The Service Composition GE helps the service provider to create composed services. Editors should provide an environment to combine and configure applications and services in graphical way. The editor could cater for different user expertise (from technical experts to domain experts without technical expertise or even simple end-users with no programming or technical skills) and roles (from composed service creators, to resellers and finally to prosumers) by hiding complexity behind different types of construction blocs, trading off flexibility for simplicity. The Service Composition GE should allow testing, debugging, installing, executing, controlling and post execution analysis of the composed applications.

Composition descriptions and technical service descriptions should be stored/fetched to/from the Repository GE. The Service Composition could be connected to a user and identity management service for controlling access to the applications.

When creating compositions/mashups editors might connect o the business infrastructure:

- Marketplace to search for services
- Shops to purchase component services them for testing /deployment, and to expose composed services for purchase
- USDL Registry to browse business information related to services

18.5 Composition Provider Architecture



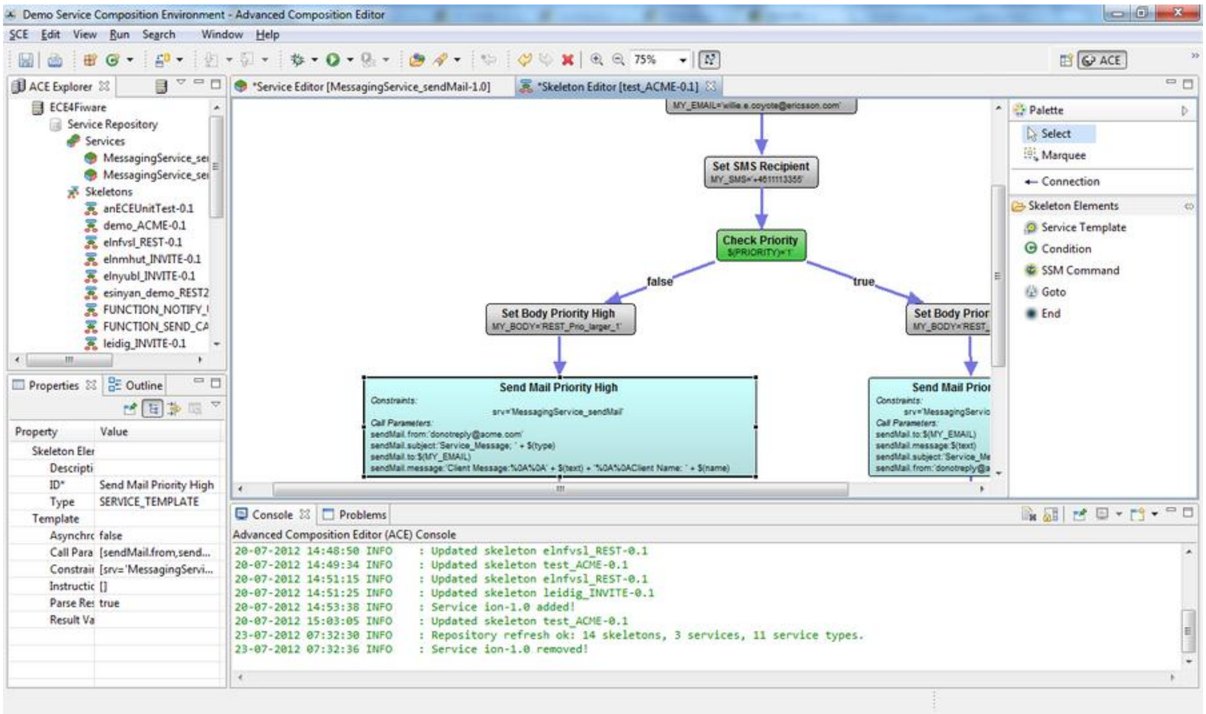
Composition Provider Architecture

18.6 Basic Concepts

The Service Composition GE offers two main functions: composition creation and composition execution.

18.6.1 Composition Creation

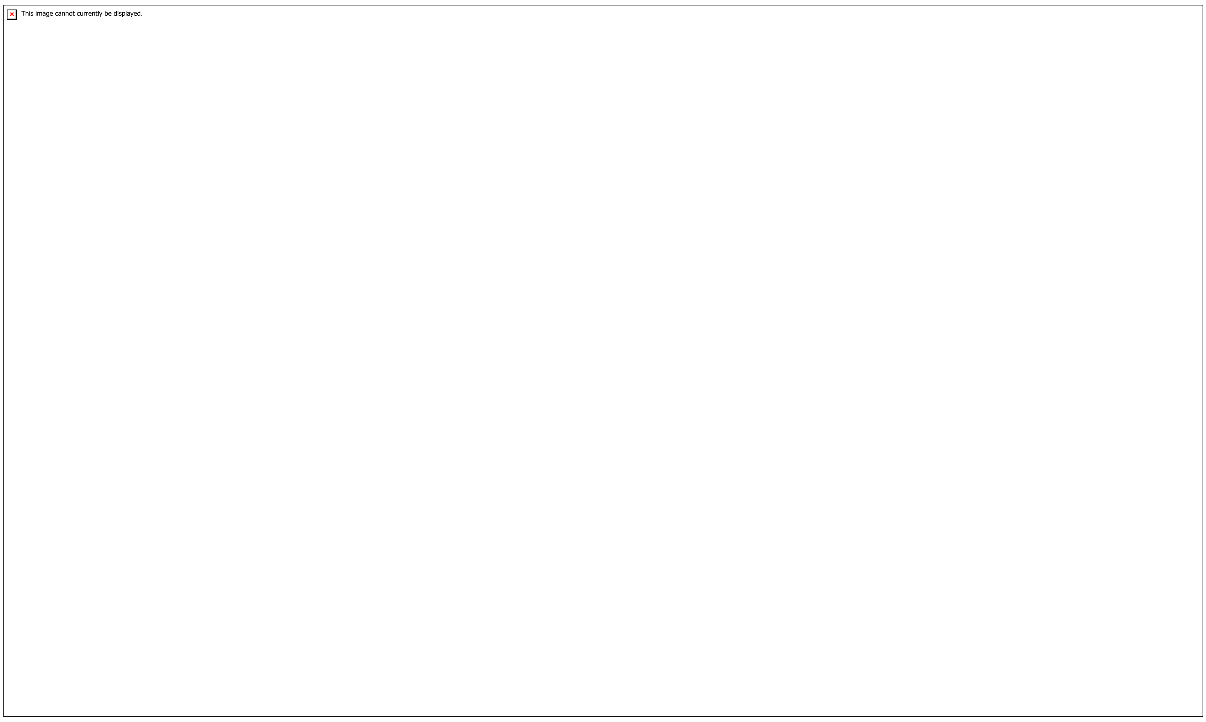
The editor allows the creation of composed services (also denoted as skeletons). The following figure shows the main graphical user interface exposed by the editor. There the user can define service descriptions (to describe how the component services can be invoked) and create compositions by adding skeleton elements and interconnecting them.



Composition Editor GUI

In order to create compositions, we need to specify in the editor how to access the services that represent the components that are invoked when executing the composition. The execution engine needs to know what are the API and the protocol used by these services, and how to set the parameters at invocation time. Thus we need to create a service description for all the services used in a composition.

When creating a service description first we need to specify what service type(s) this service is (e.g. SOAP, REST, SIP, etc). Then we need to specify values for the attributes that will be used when invoking the service (e.g. in case of a SOAP service the namespace, the port, the operation, the parameters passed to the operation, etc). The attributes to be specified could be either fixed or variable.



Composition Editor - Service Description Example

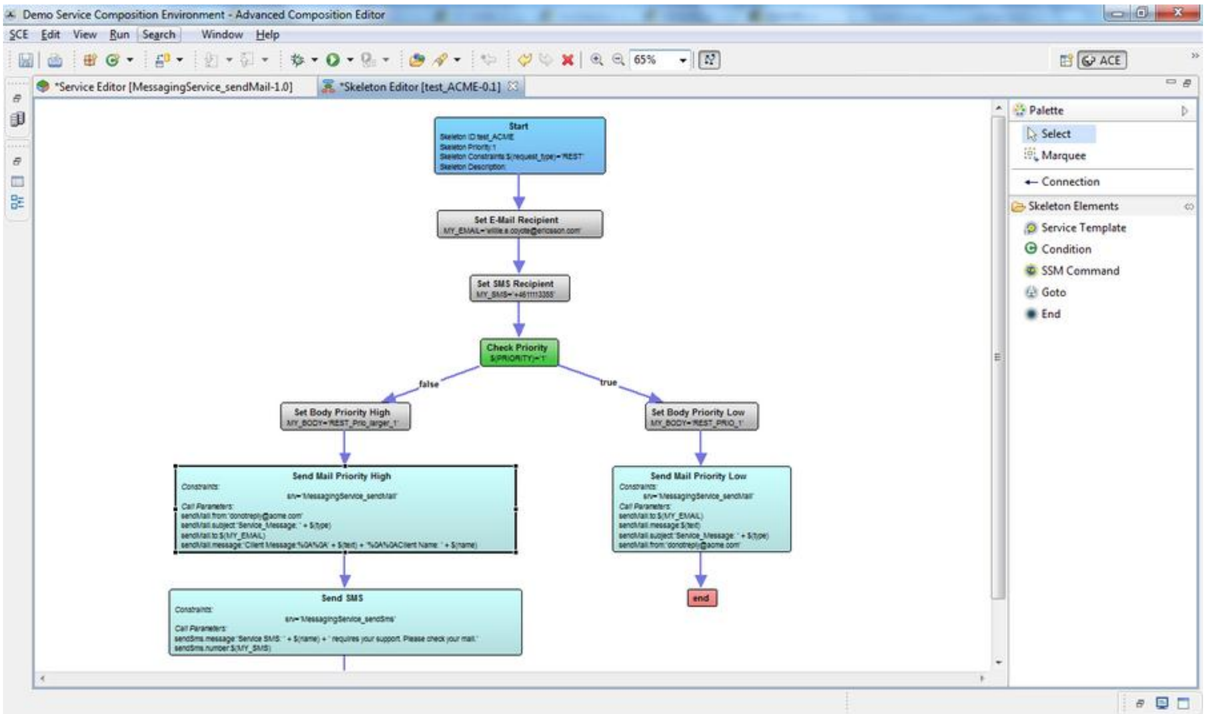
The skeletons provide the business logic, the data and control flow, and service templates (placeholders that are bound to specific service implementation during each invocation). Several services might be suitable to implement a service template. These services can have different input and output parameters and the editor needs to offer the possibility to correctly map the different dataflow types, while providing an easy way to use the unified interface. These elements are placed via drag&drop in the composition editing area and connected by linking their input and output ports. The elements can then be configured using static data or by using the relevant variables. Each skeleton consists of several interconnected elements of the following types:

- Service Template. The service template element is used during execution of the skeleton in a service composition to decide what service shall be invoked. The service description available in the local descriptions storage of the Composition Editor that fulfills the specified constraints at runtime will be selected. Only one service can be specified per service template element. Call parameters, service selection constraints, invocation semantics (synchronous or asynchronous) and the result variable (the name of the variable in which to save the response of the service) can be specified. Service selection constraints will be evaluated when the execution step arrives at this service template, thus providing late-binding for services.
- Condition. The condition element provides the possibility to branch within the skeleton upon certain conditions evaluated during runtime of the service composition execution. Different outgoing branches are supported where one outgoing branch can be connected to an unspecified default condition value which is chosen in case none of the other branches condition matches.
- SSM Command. The SSM Command element provides the option to set or remove variables in the memory space used during service composition execution. The

expression to be assigned in the setVariable clause can be of a static value or a condition to be evaluated at runtime.

- Goto. The goto element provides the option to perform a jump to another skeleton element during skeleton execution. The specified jump target can either be a skeleton element from the same skeleton and thereby offers the possibility to implement a loop construct or can be any skeleton element from a different skeleton present in the advanced composition repository.
- End. Each branch of a skeleton must close with an end element.

A skeleton is created iteratively using the GUI by using a selection tool for selecting skeleton elements and interconnecting them using a connection tool. When making a connection between a Condition Element and another skeleton element, branching can be realized.

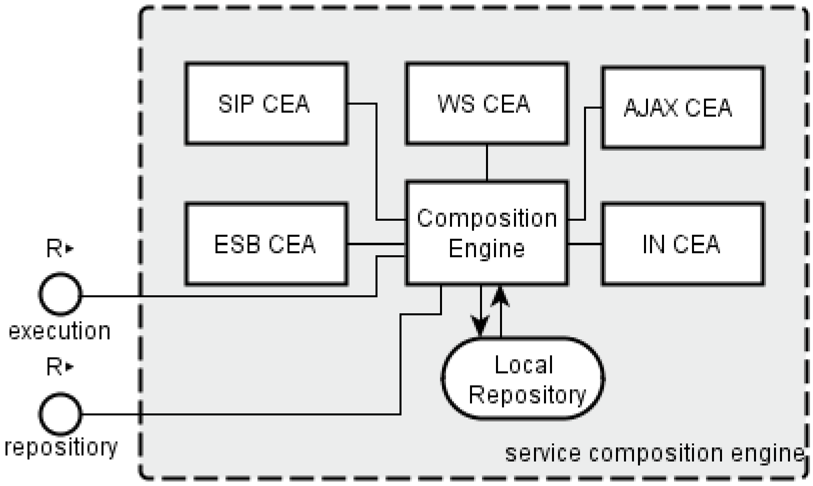


Composition Editor - Service Composition (skeleton) Example

Specifications of global and local constraints are used to decide runtime service selection and event filtering. A global constraint can be specified in the skeleton start element, and is valid in the context of the composite service, for example all services used in that particular skeleton must be SIP services (syntax example: $(srv.type)='SIP'). A local constraint is to be specified within a service template. A constraint matches a service attribute against any SSM variable or literal value. Local constraints are evaluated every time the control flow of the skeleton arrives at the evaluation of a service template and invocation of a component service (syntax example: srv='ServiceName'+$(variable_name)). Note that global constraints are defining restrictions applicable to all components of the composite service, while local constraints are applied only for choosing the particular service specified by that particular template element.

Many communication-type services depend heavily on events, and first class support for events needs to be provided. External and internal events may start actions. Besides events can be filtered and triggered. Basically it is assumed that at execution all the services within a session have access to a shared state via a shared state manager (SSM). Any change in the shared state produces a high-level event related to it, e.g. change of the variable's value can generate a state change event depending on variable name, old value, and new value. These events are the only way of communication between components using different technologies. The SSM employs a subscribe/notify model.

18.6.2 Execution



Execution Environment Architecture

Composite applications descriptions - the skeletons - are retrieved end executed by the engine. Protocol-level details related to the interaction with modules are left to the Composition Execution Agents (CEAs), which are responsible for enforcing composition decisions in the corresponding platform in a technology and protocol specific way. A shared state is used as means of mediating information between the application skeleton and the CEAs, thus coordinating the service execution. A variety of CEAs has been developed. The process is triggered by a composition execution agent (CEA) that receives a triggering event and requests the next step from the composition engine. Based on what the triggering events was, the composition engine selects the matching skeleton and creates a new session. Then, at each step it selects a suitable service that matches all the global and local constraints and serves it to the agent to execute. Execution results from the previous steps together with potential external events can influence the constraint-based decision process selecting the service for the new step. If several services are suitable to implement a certain step one of them is chosen. If a component service fails during execution, the next compatible one might be executed instead. An essential feature is the use of formal technical service descriptions for all constituent services. This service description is important for runtime service discovery, selection, and invocation. It is comprised of information about the service API and additional information used in service binding.

The local descriptions storage keeps skeletons and service descriptions used by the engine (previously created in the editor or obtained from the Repository GE). Further the user can enable/disable the service and skeletons and access logging and tracing information.

The execution environment of the Service Composition exposes basic life-cycle functionality for service and skeleton descriptions including import/export and enabling/disabling them to be triggered for execution.

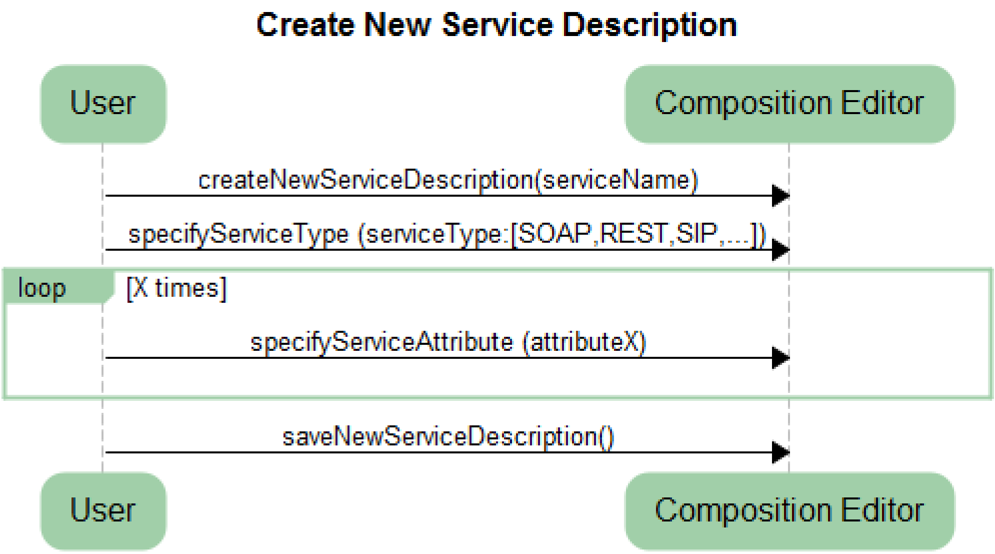
18.7 Main Interactions

18.7.1.1 *Create Composite Services*

This functionality allows the end user to create a new composition skeleton using graphical representation for data and control flow and for service placeholders. This is the main function and will be detailed further. Note that this functionality is not available as an API to be used from other architecture components, but functionality exposed to the end user via a GUI.

- **Create/Edit Service Description**

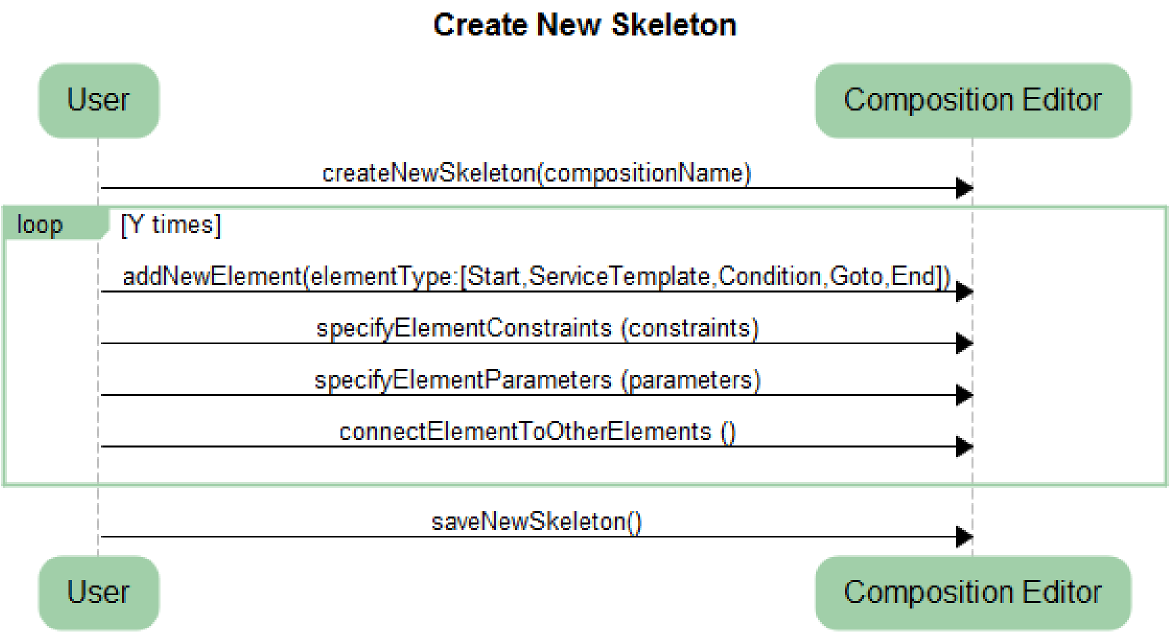
  This function offers users the possibility to create and edit component services. When creating a service description the user specifies what service type(s) this service is (e.g. SOAP, REST, SIP, etc.). Then the user specifies values for the attributes that will be used when invoking the service (e.g. in case of a SOAP service the namespace, the port, the operation, the parameters passed to the operation, etc.). The attributes to be specified could be either fixed or variable. Once a service is created it is stored in the local descriptions storage. Subsequently the user can browse and edit the description of component services that can be used in the composition.



Create New Service Description

- **Create/Edit Skeletons**

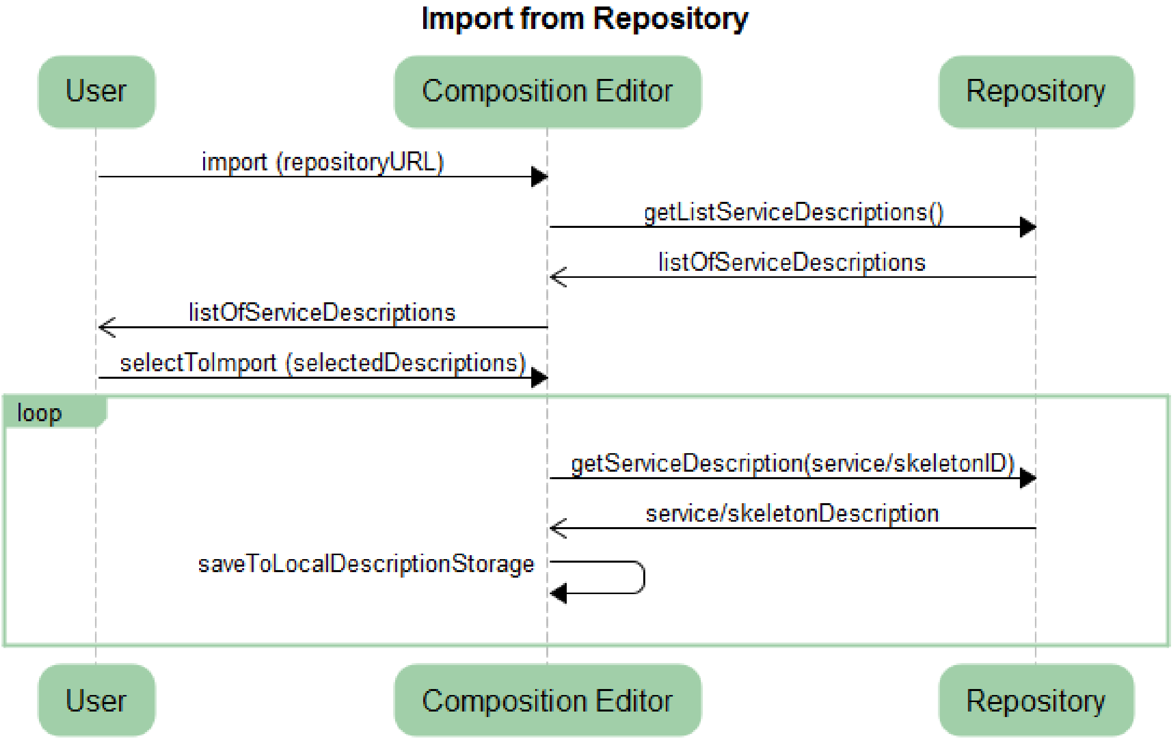
  In building the composition several building blocks are added iteratively, using the GUI. The building blocks expose data flow, control, and service invocation functionality (e.g. StartElement ServiceTemplate, Condition, StateManager Command, Goto, End). Connections between skeleton elements denoting result scope and partial order may be also edited. Two types of constraints are present in the context of skeletons, the skeleton constraint and the service constraints. The service constraints are being used for selecting the appropriate service during skeleton execution upon runtime. The service constraints are mandatory in the service template element and the skeleton constraint is optional in the skeleton start element. Once a skeleton is created it is stored in the local descriptions storage. Subsequently the user can browse and edit available skeletons.



Create New Skeleton

18.7.1.2 *Import Service Descriptions and Skeletons*

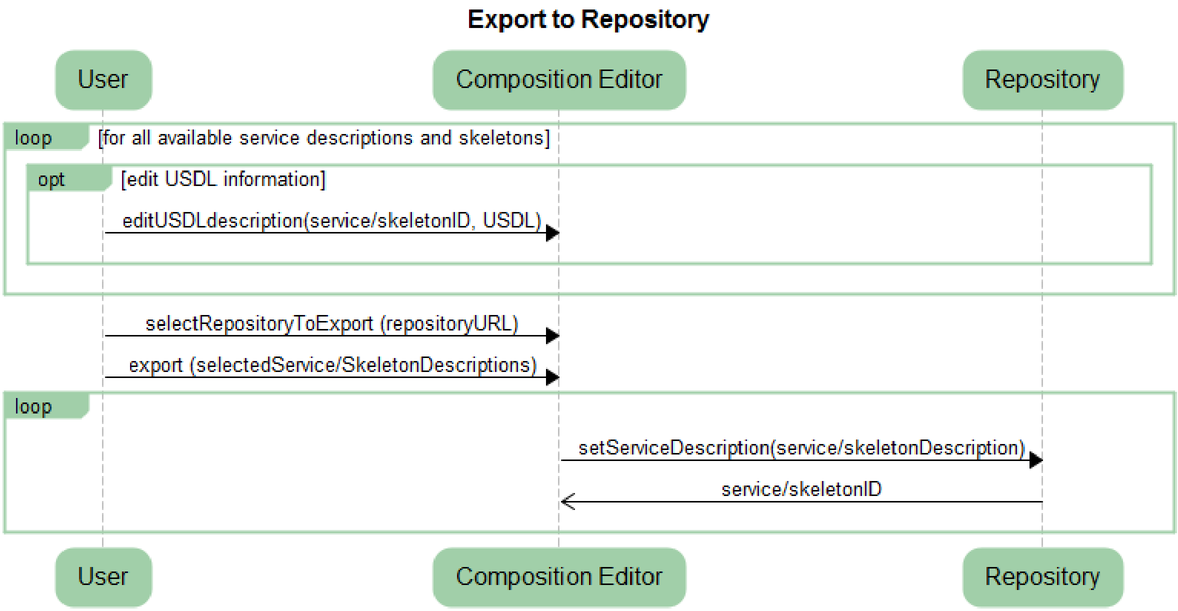
This operation imports (composed) service descriptions from a Repository GE to the local descriptions storage. Out of the list of available service descriptions and compositions only a subset may be selected. Note that from the perspective of the Repository and the USDL description part there is no differentiation between compositions (i.e. skeletons) and the other service descriptions. The Composition Editor however will make the difference and can edit and deploy the composed services in an execution engine to be run, while simple service descriptions can be used by the editor only as a component service in a skeleton and needs to be already up and running when the composition is triggered.



Import from Repository

18.7.1.3 ***Export Service Descriptions and Skeletons***

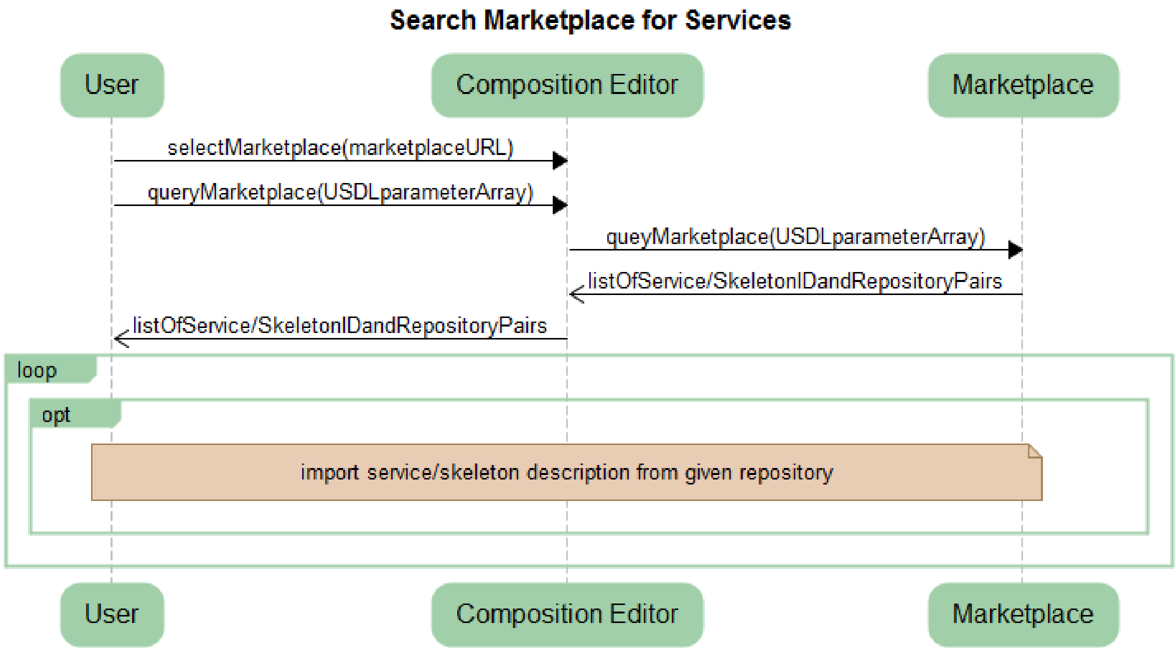
This operation exports (composed) service descriptions from the local descriptions storage to a Repository GE. Out of the list of available service descriptions and compositions only a subset may be selected. The description of a (composed) service may contain a USDL description providing a high-level business description in addition to the technical description for the use of an execution engine. The latter may provide both the description of the API technology used for exposing/using this service and the composition skeleton that describes the runtime execution of the service in a formal composition language (if applicable).



Export to Repository

18.7.1.4 ***Search Marketplace for Services***

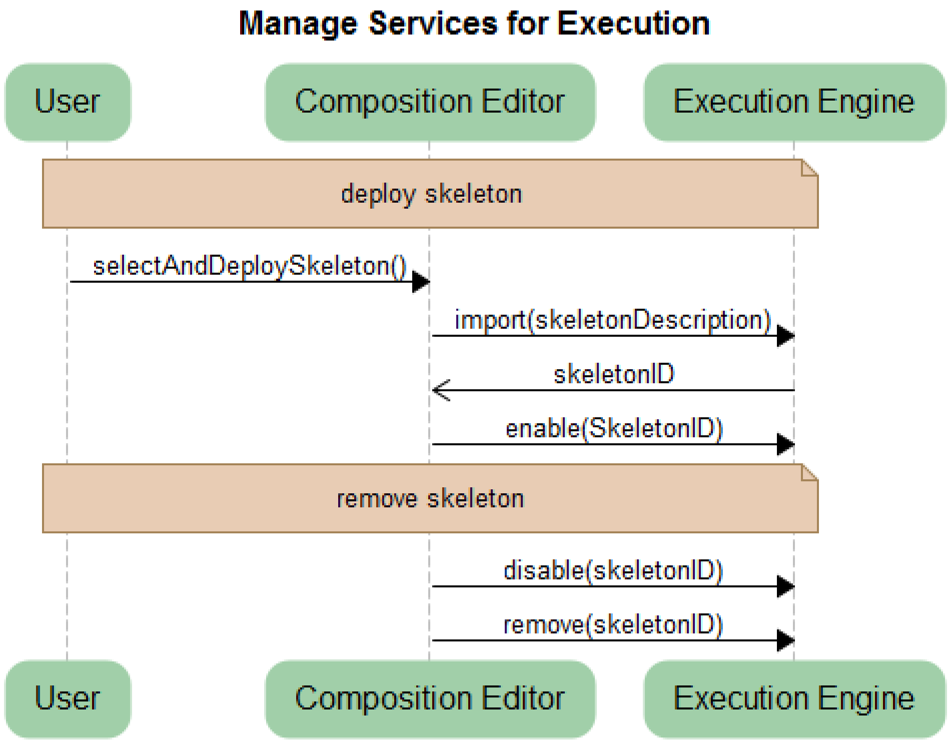
The Composition Editor may allow end users to search for the service they need. To do so, Marketplaces need to be queried, and the editor may allow detailed query construction based on constraints on USDL and other technical service description parameters.



Search in Marketplace

18.7.1.5 *Manage Services for Execution*

Through this UI the user may control how the service is deployed on the execution engine and specify execution parameters such as logging and tracing. Moreover the UI may be used to visualize results and additional information associated with previous runs.



Manage Execution Example

The interactions described below are basic functionality provided by the execution environment to an external controller. The editor is using these functions and exposes them to the end user for controlling the execution of the composed services.

- **Import**

This operation imports a service or a skeleton description (e.g. from the Repository GE) into the local descriptions storage of the execution environment.

- **Export**

This operation exports a service or a skeleton description from the local descriptions storage (e.g. to the Repository GE).

- **Remove**

This operation removes a service or a skeleton description from the local descriptions storage. Only disabled skeletons and services can be removed.

- **Enable**

This operation prepares a service or a skeleton description from the local descriptions storage for execution. In case of a skeleton it instantiates the composed application skeleton and makes it ready to be triggered for execution. Only enabled services will be considered during the skeleton execution.

- **Disable**

This operation removes a service or a skeleton description from the executable list.

18.8 Basic Design Principles

- **API Technology Independence**

  The API abstracts from the concrete implementation technology. Implementations using various kinds of platforms and frameworks should be possible.

- **Web Browsers do not have to limit the functionality of the editor**

  Modern web browsers as alternative to other GUI frameworks can and should be used fully implement the editor's capabilities.

- **User-matched interaction abstraction level**

  Editors could cater for different user expertise (from technical experts with skilled in the composition language to domain experts without technical expertise or even simple end-users with no programming or technical skills) and roles (from composed service creators, to resellers and finally to prosumers) by hiding complexity behind different types of construction blocs, trading off flexibility for simplicity.

- **The specification of the Service Composition GE is not tied to a particular technology for storing (composite) service data**

  The specific technology used for storing the inventory of services and their respective associations is not tied to any type of storage solutions, being opened to final implementations through SQL (MySQL, Oracle, ...) or No-SQL systems (MondoDB, Cassandra, ...).

- **Service execution isolation**

  Service execution does not have to interfere in the execution of other widgets.

- **Composite service exposure via different API technology**

  Depending on what CEAs are available, a composed application can be exposed to the outside world via different API technologies

- **Execution engine deployment**

  An execution engine implementation might be highly distributed and scalable, if intended to be used by many parties on a global scale.

18.9 Detailed Specifications

18.9.1 Open API Specifications

- FIWARE.OpenSpecification.Apps.ServiceCompositionREST

18.9.2 Other Relevant Specifications

none

18.10 Re-utilised Technologies/Specifications

The Composition Editor GE requires both authentication and authorization in order to safeguard the different compositions from its users.

- It is recommended to use the OAuth2 protocol: http://tools.ietf.org/html/draft-ietf-oauth-v2-30

On the other hand, Composition Editor relies on the Marketplace, Store and Repository GEs, so it must support the following technologies and specifications:

- RESTful web services
- HTTP/1.1
- JSON and XML data serialization formats
- Linked USDL

18.11 Terms and definitions

This section comprises a summary of terms and definitions introduced during the previous sections. It intends to establish a vocabulary that will be help to carry out discussions internally and with third parties (e.g., Use Case projects in the EU FP7 Future Internet PPP). For a summary of terms and definitions managed at overall FI-WARE level, please refer to FIWARE Global Terms and Definitions

- **Aggregator (Role):** A Role that supports domain specialists and third-parties in aggregating services and apps for new and unforeseen opportunities and needs. It does so by providing the dedicated tooling for aggregating services at different levels: UI, service operation, business process or business object levels.
- **Application:** Applications in FI-WARE are composite services that have a IT supported interaction interface (user interface). In most cases consumers do not buy the application, instead they buy the right to use the application (user license).
- **Broker (Role):** The business network's central point of service access, being used to expose services from providers that are delivered through the Broker's service delivery functionality. The broker is the central instance for enabling monetization.
- **Business Element:** Core element of a business model, such as pricing models, revenue sharing models, promotions, SLAs, etc.
- **Business Framework:** Set of concepts and assets responsible for supporting the implementation of innovative business models in a flexible way.
- **Business Model:** Strategy and approach that defines how a particular service/application is supposed to generate revenue and profit. Therefore, a Business Model can be implemented as a set of business elements which can be combined and customized in a flexible way and in accordance to business and market requirements and other characteristics.
- **Business Process:** Set of related and structured activities producing a specific service or product, thereby achieving one or more business objectives. An operational business process clearly defines the roles and tasks of all involved parties inside an organization to achieve one specific goal.
- **Business Role:** Set of responsibilities and tasks that can be assigned to concrete business role owners, such as a human being or a software component.
- **Channel:** Resources through which services are accessed by end users. Examples

for well-known channels are Web sites/portals, web-based brokers (like iTunes, eBay and Amazon), social networks (like Facebook, LinkedIn and MySpace), mobile channels (Android, iOS) and work centers. The access mode to these channels is governed by technical channels like the Web, mobile devices and voice response, where each of these channels requires its own specific workflow.

- **Channel Maker (Role):** Supports parties in creating outlets (the Channels) through which services are consumed, i.e. Web sites, social networks or mobile platforms. The Channel Maker interacts with the Broker for discovery of services during the process of creating or updating channel specifications as well as for storing channel specifications and channeled service constraints in the Broker.
- **Composite Service (composition):** Executable composition of business back-end MACs (see MAC definition later in this list). Common composite services are either orchestrated or choreographed. Orchestrated compositions are defined by a centralized control flow managed by a unique process that orchestrates all the interactions (according to the control flow) between the external services that participate in the composition. Choreographed compositions do not have a centralized process, thus the services participating in the composition autonomously coordinate each other according to some specified coordination rules. Backend compositions are executed in dedicated process execution engines. Target users of tools for creating Composites Services are technical users with algorithmic and process management skills.
- **Consumer (Role):** Actor who searches for and consumes particular business functionality exposed on the Web as a service/application that satisfies her own needs.
- **Desktop Environment:** Multi-channel client platform enabling users to access and use their applications and services.
- **Event-driven Composition:** Components concerned with the composition of business logic, which is driven by asynchronous events. This implies run-time selection of MACs and the creation/modification of orchestration workflows based on composition logic defined at design-time and adapted to context and the state of the communication at run-time.
- **Front-end/Back-end Composition:** Front-end compositions define a front-end application as an aggregation of visual mashable application pieces (named as widgets, gadgets, portlets, etc.) and back-end services. Front-end compositions interact with end-users, in the sense that front-end compositions consume data provided by the end-users and provide data to them. Thus the front-end composition (or mashup) will have a direct influence on the application look and feel; every component will add a new user interaction feature. Back-end compositions define a back-end business service (also known as process) as an aggregation of backend services as defined for service composition term, the end-user being oblivious to the composition process. While back-end components represent atomization of business logic and information processing, front-end components represent atomization of information presentation and user interaction.
- **Gateway (Role):** The Gateway role enables linking between separate systems and services, allowing them to exchange information in a controlled way despite different technologies and authoritative realms. A Gateway provides interoperability solutions

for other applications, including data mapping as well as run-time data store-forward and message translation. Gateway services are advertised through the Broker, allowing providers and aggregators to search for candidate gateway services for interface adaptation to particular message standards. The Mediation is the central generic enabler. Other important functionalities are eventing, dispatching, security, connectors and integration adaptors, configuration, and change propagation.

- **Hoster (Role):** Allows the various infrastructure services in cloud environments to be leveraged as part of provisioning an application in a business network. A service can be deployed onto a specific cloud using the Hoster's interface. This enables service providers to re-host services and applications from their on-premise environments to cloud-based, on-demand environments to attract new users at much lower cost.
- **Marketplace:** Part of the business framework providing means for service providers, to publish their service offerings, and means for service consumers, to compare and select a specific service implementation. A marketplace can offer services from different stores and thus different service providers. The actual buying of a specific service is handled by the related service store.
- **Mashup:** Executable composition of front-end MACs. There are several kinds of mashups, depending on the technique of composition (spatial rearrangement, wiring, piping, etc.) and the MACs used. They are called application mashups when applications are composed to build new applications and services/data mash-ups if services are composed to generate new services. While composite service is a common term in backend services implementing business processes, the term 'mashup' is widely adopted when referring to Web resources (data, services and applications). Front-end compositions heavily depend on the available device environment (including the chosen presentation channels). Target users of mashup platforms are typically users without technical or programming expertise.
- **Mashable Application Component (MAC):** Functional entity able to be consumed executed or combined. Usually this applies to components that will offer not only their main behaviour but also the necessary functionality to allow further compositions with other components. It is envisioned that MACs will offer access, through applications and/or services, to any available FI-WARE resource or functionality, including gadgets, services, data sources, content, and things. Alternatively, it can be denoted as 'service component' or 'application component'.
- **Mediator:** A mediator can facilitate proper communication and interaction amongst components whenever a composed service or application is utilized. There are three major mediation area: Data Mediation (adapting syntactic and/or semantic data formats), Protocol Mediation (adapting the communication protocol), and Process Mediation (adapting the process implementing the business logic of a composed service).
- **Monetization:** Process or activity to provide a product (in this context: a service) in exchange for money. The Provider publishes certain functionality and makes it available through the Broker. The service access by the Consumer is being accounted, according to the underlying business model, and the resulting revenue is shared across the involved service providers.
- **Premise (Role):** On-Premise operators provide in-house or on-site solutions, which are used within a company (such as ERP) or are offered to business partners under

specific terms and conditions. These systems and services are to be regarded as external and legacy to the FI-Ware platform, because they do not conform to the architecture and API specifications of FI-WARE. They will only be accessible to FI-WARE services and applications through the Gateway.

- **Prosumer:** A user role able to produce, share and consume their own products and modify/adapt products made by others.
- **Provider (Role):** Actor who publishes and offers (provides) certain business functionality on the Web through a service/application endpoint. This role also takes care of maintaining this business functionality.
- **Registry and Repository:** Generic enablers that able to store models and configuration information along with all the necessary meta-information to enable searching, social search, recommendation and browsing, so end users as well as services are able to easily find what they need.
- **Revenue Settlement:** Process of transferring the actual charges for specific service consumption from the consumer to the service provider.
- **Revenue Sharing:** Process of splitting the charges of particular service consumption between the parties providing the specific service (composition) according to a specified revenue sharing model.
- **Service:** We use the term service in a very general sense. A service is a means of delivering value to customers by facilitating outcomes customers want to achieve without the ownership of specific costs and risks. Services could be supported by IT. In this case we say that the interaction with the service provider is through a technical interface (for instance a mobile app user interface or a Web service). Applications could be seen as such IT supported Services that often are also composite services.
- **Service Composition:** in SOA domain, a service composition is an added value service created by aggregation of existing third party services, according to some predefined work and data flow. Aggregated services provide specialized business functionality, on which the service composition functionality has been split down.
- **Service Delivery Framework:** Service Delivery Framework (or Service Delivery Platform (SDP)) refers to a set of components that provide service delivery functionality (such as service creation, session control & protocols) for a type of service. In the context of FI-WARE, it is defined as a set of functional building blocks and tools to (1) manage the lifecycle of software services, (2) creating new services by creating service compositions and mashups, (3) providing means for publishing services through different channels on different platforms, (4) offering marketplaces and stores for monetizing available services and (5) sharing the service revenues between the involved service providers.
- **Service Level Agreement (SLA):** A service level agreement is a legally binding and formally defined service contract, between a service provider and a service consumer, specifying the contracted qualitative aspects of a specific service (e.g. performance, security, privacy, availability or redundancy). In other words, SLAs not only specify that the provider will just deliver some service, but that this service will also be delivered on time, at a given price, and with money back if the pledge is broken.
- **Service Orchestration:** in SOA domain, a service orchestration is a particular architectural choice for service composition where a central orchestrated process

manages the service composition work and data flow invocations of the external third party services in the order determined by the work flow. Service orchestrations are specified by suitable orchestration languages and deployed in execution engines who interpret these specifications.

- **Store:** An external component integrated with the business framework, offering a set of services that are published to a selected set of marketplaces. The store thereby holds the service portfolio of a specific service provider. In case a specific service is purchased on a service marketplace, the service store handles the actual buying of a specific service (as a financial business transaction).
- **Unified Service Description Language (USDL):** USDL is a platform-neutral language for describing services, covering a variety of service types, such as purely human services, transactional services, informational services, software components, digital media, platform services and infrastructure services. The core set of language modules offers the specification of functional and technical service properties, legal and financial aspects, service levels, interaction information and corresponding participants. USDL is offering extension points for the derivation of domain-specific service description languages by extending or changing the available language modules.

19 FIWARE OpenSpecification Apps ServiceComposition REST

You can find the content of this chapter as well in the wiki of fi-ware.

```
Disclaimer: The sustainability of this Open API Specification cannot
be guaranteed due to internal changes in the project consortium.
```

19.1 Introduction to the *Service Composition* API

Please check the FI-WARE Open Specifications Legal Notice to understand the rights to use FI-WARE Open Specifications.

19.1.1 Service Composition API Core

The execution environment of the Service Composition exposes a basic life-cycle functionality for (composed) service descriptions including import/export and enabling/disabling them to be triggered for execution. The API is a RESTful, resource-oriented API accessed via HTTP. The end user can use the editor GUI to access this functionality in conjunction with the created or managed composition specifications, however this functionality can be used also from e.g. a Store GE to automatically deploy and enable a composite service after contracting.

The editor part of the Service Composition is a tool with a graphical user interface that is used to construct new composite services. Thus it does not expose an API per se, it allows the end user to construct the composite service descriptions using the GUI, and the data structure representing the skeleton and component services is also presented.

19.1.2 Intended Audience

This specification is intended for developers of the Service Composition or external components using it. Also, users creating compositions can understand the scope of the skeleton specification. To use this information, the reader should firstly have a general understanding of the Generic Enablers for Composition and Mashup. You should also be familiar with:

- RESTful web services
- HTTP/1.1
- JSON and/or XML data serialization formats.

19.1.3 API Change History

Revision Date	Changes Summary
May 3, 2012	• Initial version
October 29, 2012	• Revised version

19.1.4 How to Read This Document

It is assumed that the reader is familiar with the REST architecture style. Within the document, some special notations are applied to differentiate some special words or concepts. The following list summarizes these special notations.

- A bold, mono-spaced font is used to represent code or logical entities, e.g., HTTP method (`GET, PUT, POST, DELETE`).
- An italic font is used to represent document titles or some other kind of special text, e.g., *URI*.
- Variables are represented between brackets, e.g. {id} and in italic font. The reader can replace the id with an appropriate value.

For a description of some terms used along this document, see Service Composition architecture.

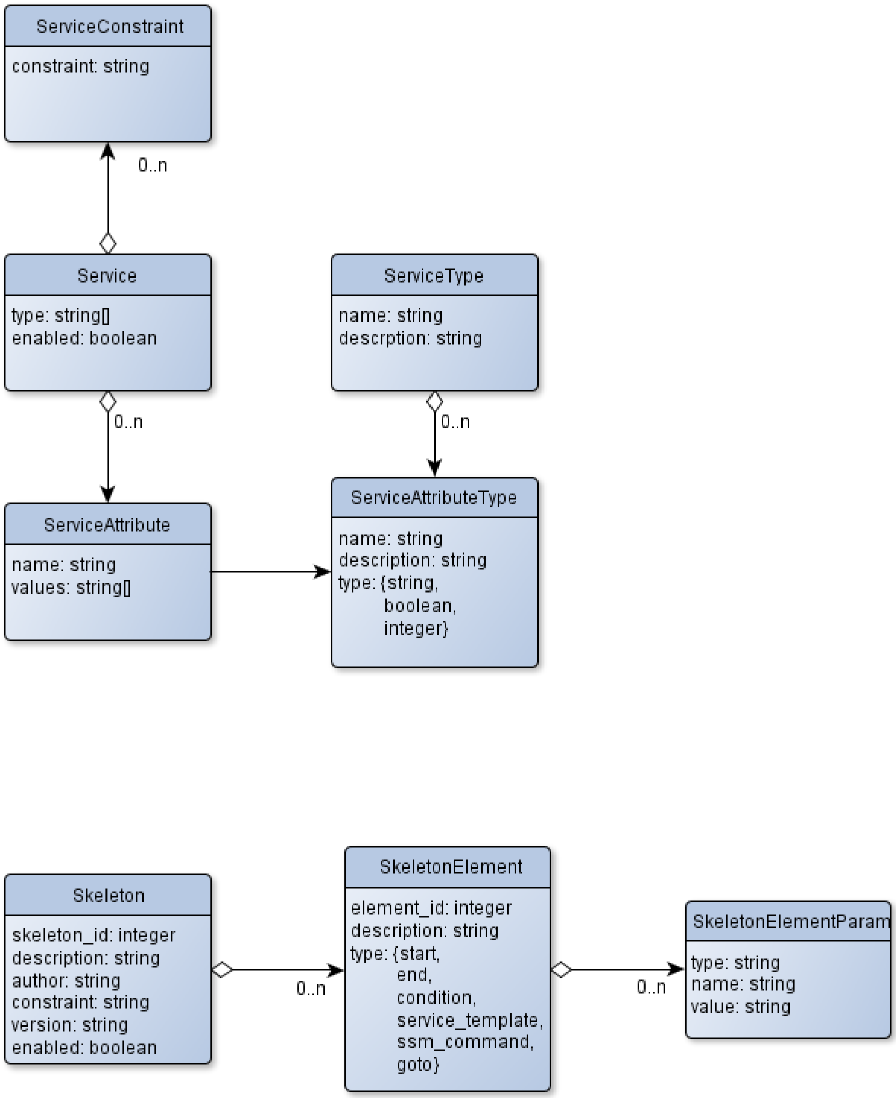
19.2 General *Service Composition* API Information

19.2.1 Resources Summary

The resources represent different skeleton and service descriptions. These can be deployed, retrieved, modified, and deleted from the execution environment. Moreover these can be enabled or disabled. Enabling a skeleton means that the service described by the skeleton can be triggered for execution. Enabling a service description means that this service can be considered as component service in the skeleton (i.e. when evaluating the service template constraints).

19.2.2 Data structure

The structure of the skeleton and services follows the model presented in the next figure. Note that constraints are specified by regular expression defining conditions under which the skeleton shall be executed during service composition. They are evaluated when the control flow reaches the



Service Composition Data Structure

Each skeleton element contains its own kind of skeleton parameters as described in the next table.

Type	**Name**	**Value**	**Used In**	Multiplicity
"call_parameter"	<name>	<value>	service template	0..n
"result_var"	-	<value>	service template	0..1
"constraint"	-	<value>	service template	0..n
"condition"	-	<value>	condition	0..1

“condition_case”	<case>	<next element>	condition	0..n
“goto”	-	<element reference>	goto	0..1
“ssmcommand_set”	<name>	<value>	ssm command	0..1
“ssmcommand_remove”	<name>	<value>	ssm command	0..1
“next”	-	<next element>	all (except end)	-

19.2.3 Authentication

Each HTTP request against the *Service Composition GE* requires the inclusion of specific authentication credentials. The specific implementation of this API may support multiple authentication schemes (OAuth, Basic Auth, Token) and will be determined by the specific provider that implements the GE. Some authentication schemes may require that the API operate using SSL over HTTP (HTTPS).

19.2.4 Authorization

It is assumed that access to the *Service Composition GE* is controlled by a authorization mechanisms in order to ensure that only authorized clients can read/modify/write specific information. The specification of a concrete authorization mechanism is out of scope for this document. Within the FI-WARE testbed, the authorization methods of the Security Chapter enablers will be supported by the Registry implementation.

19.2.5 Representation Format

The *Service Composition GE* API supports XML or JSON, for delivering information about services and skeletons. The request format is specified using the Content-Type header and is required for operations that have a request body. The response format can be specified in requests using the Accept header. Note that it is possible for a response to be serialized using a format different from the request (see example below).
If no Content-Type is specified, the content is delivered in the format that was chosen to upload the resource.
The interfaces should support data exchange through multiple formats:

- *text/html* - An human-readable HTML rendering of the results of the operation as output format.
- *application/json* - A JSON representation of the input and output
- *application/xml* - A XML description of the input and output.

19.2.6 Representation Transport

Resource representation is transmitted between client and server by using HTTP 1.1 protocol, as defined by IETF RFC-2616. Each time an HTTP request contains payload, a Content-Type header shall be used to specify the MIME type of wrapped representation. In addition, both client and server may use as many HTTP headers as they consider necessary.

19.2.7 Resource Identification

The skeleton descriptions are identified by the the following URI: /skeletons/{skeletonName}/{version} while the service descriptions are identified with the following URI: /services/{skeletonName}/{version}

19.2.8 Limits

We can manage the capacity of the system in order to prevent the abuse of the system through some limitations. These limitations will be configured by the operator and may differ from one implementation to other of the GE implementation.

19.2.8.1 *Rate Limits*

These limits are specified both in human readable wild-card and in regular expressions and will indicate for each HTTP verb which will be the maximum number of operations per time unit that a user can request. After each unit time the counter is initialized again. In the event a request exceeds the thresholds established for your account, a 413 HTTP response will be returned with a Retry-After header to notify the client when they can attempt to try again.

19.2.9 Extensions

The Registry could be extended in the future. At the moment, we foresee the following resource to indicate a method that will be used in order to allow the extensibility of the API. This allow the introduction of new features in the API without requiring an update of the version, for instance, or to allow the introduction of vendor specific functionality.

Verb	URI	Description
GET	/extensions	List of all available extensions

19.2.10 Faults

19.2.10.1 *Synchronous Faults*

Error codes are returned in the body of the response. The description section returns a human-readable message for displaying to end users.

Fault Element	Associated Error Codes	Expected in All Requests?
Unauthorized	403	YES

Not Found	404	YES
Limit Fault	413	YES
Internal Server error	50X	YES

19.3 API Operations

19.3.1 Importing descriptions

Imports skeletons and service descriptions into the local description storage of the execution environment. If a skeleton/service with the same name and version is available in the local description storage its description will be updated. Note that we can use the function to add an entire set of resources.

19.3.1.1 *Creating and Updating*

Verb	URI	Description
PUT	/{EntityType}/{Name}/{Version}	Create or update one resource
PUT	/{EntityType}/{Name}	Crate or update a set of resources with the same name
PUT	/{EntityType}	Create or update a set of resources

(1)Parameters
{EntityType} can be either "services" or "skeletons"
{Name} is the name of the service or skeleton
{Version} the version of the service or skeleton

(2)Request Body
When creating/updating a resource the request body of a PUT operation should contain the set of attributes of the entry. E.g. if content-type was "application/json":

```
{
  "{attrName1}": "attrValue1",
  "{attrName2}": "attrValue2",
  ...
}
```

When creating/updating a set of resources the request body of a PUT operation contains an array of object attributes (if we update several versions of the object) or a nested array if we update several objects with different names and versions:

```
[
  {"acme_test_skel1": [
    {"v3.7": {
      "{attrName1}": "attrValue1",
      "{attrName2}": "attrValue2",
      ...
      }
    },
    {"v4.2": {
      ...
      }
    },
    ...
    ]
  },
  {"acme_test_skel2": [
    ...
    ]
  },
  ...
]
```

(3)Status Codes

201 Created

The request has been fulfilled and resulted in a new resource being created.

204 No Content

The server successfully processed the request, but is not returning any content.

400 Bad Request

The request cannot be fulfilled due to bad syntax.

404 Not Found

The requested resource could not be found but may be available again in the future. Subsequent requests by the client are permissible.

409 Conflict

Indicates that the request could not be processed because of conflict in the request, such as an edit conflict.

500 Internal Server Error

A generic error message, given when no more specific message is suitable.

19.3.2 Exporting descriptions

Exports skeletons and service descriptions from the local description storage of the execution environment. Note that we can export also sets of resources, even distinguished by specific attribute name-value pairs.

19.3.2.1 *Reading*

Verb	URI	Description
GET	/{EntityType}/{Name}/{Version}	Read one resource
GET	/{EntityType}/{Name}	Read a set of resources with the same name
GET	/{EntityType}	Read a set of either service or skeleton descriptions
GET	/{EntityType}?{attrName}={attrValue}	Read a set of resources with specific attribute name-value pairs

(1)Parameters
{EntityType} can be either "services" or "skeletons"
{Name} is the name of the service or skeleton
{Version} the version of the service or skeleton

(2)Examples
GET /skeletons/ACME_test_skel1/v3.7
Returns the description of a specific skeleton.
GET /skeletons
Returns the description of all skeletons.
GET /services?serviceType=WSDL
Returns the descriptions of all services where serviceType is WSDL.

(3)Result Format
The result format is similar to the request body examples given when importing descriptions.

(4)Status Codes
200 OK
    The request was handled successfully and transmitted in response message.
400 Bad Request
    The request cannot be fulfilled due to bad syntax.
404 Not Found
    The requested resource could not be found but may be available again in the future. Subsequent requests by the client are permissible.
500 Internal Server Error
    A generic error message, given when no more specific message is suitable.

19.3.3 Removing descriptions

Removes skeletons and service descriptions from the local description storage of the execution environment. Note that we can remove also sets of resources, even distinguished by specific attribute name-value pairs. Only services and skeletons that are not enabled can be removed.

19.3.3.1 *Deleting*

Verb	URI	Description
DELETE	/{EntityType}/{Name}/{Version}	Delete a specific resource
DELETE	/{EntityType}/{Name}	Delete a set of resources with the same name
DELETE	/{EntityType}	Delete a set of either service or skeleton descriptions
DELETE	/{EntityType}?{attrName}={attrValue}	Delete a set of resources with specific attribute name-value pairs

(1)Parameters
{EntityType} can be either "services" or "skeletons"
{Name} is the name of the service or skeleton
{Version} the version of the service or skeleton

(2)Status Codes
200 OK
The request was handled successfully and transmitted in response message.
400 Bad Request
The request cannot be fulfilled due to bad syntax.
404 Not Found
The requested resource could not be found but may be available again in the future. Subsequent requests by the client are permissible.
500 Internal Server Error
A generic error message, given when no more specific message is suitable.

19.3.4 Enabling, disabling and checking enabled status

If a skeleton is set to enabled, it instantiates the composed application skeleton, exposes its interface and makes it ready to be triggered for execution. Only enabled skeletons will be considered during the skeleton execution. Note that by enabling a certain skeletons for execution, the GE automatically exposes the API of these compositions towards the external world, and any access to this API will trigger the execution of the respective skeleton. This is an API exposed by the execution environment, however it is created at runtime in the form specified by the composed service.
If a service is set to enabled it is considered as a potential candidate to match a "service template" when executing the skeleton.
By default all imported services and skeleton are considered disabled, and have to be enabled for use.
When disabling a skeleton the result may not be immediate if the composed service it represents is in use. Thus we need to check the enablement status before trying to remove a

19.3.4.1 *Operations*

Verb	URI	Description
PUT	/{EntityType}/{Name}/{Version}/enabled	Enable a certain service or skeleton
DELETE	/{EntityType}/{Name}/{Version}/enabled	Disable a certain service or skeleton
GET	/{EntityType}/{Name}/{Version}/enabled	Check if a certain service or skeleton is enabled

(1)Parameters
{EntityType} can be either "services" or "skeletons"
{Name} is the name of the service or skeleton
{Version} the version of the service or skeleton

(2)Request/Response Body
The request ore response body should be empty.

(3)Status Codes
200 OK
The GET/DELETE request has been fulfilled. In case of GET it signals that the object is enabled.
201 Created
The PUT has been fulfilled and object is enabled.
202 Accepted
The request has been accepted for processing, but the processing has not been completed. Can appear when disabling a skeleton in use.
400 Bad Request
The request cannot be fulfilled due to bad syntax.
404 Not Found
The requested resource could not be found but may be available again in the future. Subsequent requests by the client are permissible. In case of get it signals that the object is disabled.
409 Conflict
Indicates that the request could not be processed because of conflict in the request, such as an edit conflict.
500 Internal Server Error
A generic error message, given when no more specific message is suitable.

20 FIWARE OpenSpecification Apps LightSemanticComposition

You can find the content of this chapter as well in the wiki of fi-ware.

Name	FIWARE.OpenSpecification.Apps.Light-weighted Semantic-enabled Composition
Chapter	Apps,
Catalogue-Link to Implementation	Light-weighted Semantic-enabled Composition - COMPEL
Owner	ATOS, Jesús Gorroñogoitia

20.1 Preface

Within this document you find a self-contained open specification of a FI-WARE generic enabler, please consult as well the FI-WARE Product Vision, the website on http://www.fi-ware.org and similar pages in order to understand the complete context of the FI-WARE project.

20.2 Copyright

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20.3 Legal Notice

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20.4 Overview

Light-weighted Semantic-enabled Composition is a tool suite that aims at simplifying the development of domain-specific business process, such as service compositions, by exploiting the full potential of semantic technologies. Development of business process in BPM (Business Process Modeling) realm requires multi-disciplinary teams, to share domain specific knowledge about processes, entities, roles, etc., as well as the ICT technology required to implement them. In particular the number and complexity of SOA-related technologies may hamper the implementation of business processes when they are meant as aggregations of open and Internet-accessible services.

In this sense, it is desirable that we simplify the access to these composition technologies to the domain specific experts, as well as to the unskilled end users. This can be achieved when the technology itself is capable of producing service compositions without requiring complex information structures, which otherwise can be obtained from end users in a more human readable format.

20.4.1 Target usage

Light-weighted Semantic-enabled Composition addresses situations where domain specific business processes require to be implemented as service compositions within a certain organization. Business processes are decomposed into different tasks, each one executed by an external service (some tasks provided by entities within the same organization, but others provided by third parties). Commonly, designing and implementing a business process as a service composition requires multidisciplinary teams, ranging from domain business experts (such as modelers) to service engineers and integrators. The complexity of these teams, in terms of expertise, is required by the modeling activity itself, since modeling a business process as a service composition requires different expertise:

- Business analysts with knowledge on the concrete domain concepts, entities, agents, procedures, etc.
- Business modeling experts, with knowledge on BPM languages, methodologies and practices.
- Service engineers acting either as service providers and/or consumers, who provide or consume services on the domain, and exploit the technological infrastructure that make them possible.
- Service Integrators, who orchestrate services into compositions, which offer more complex functionality by aggregating modular functionalities.

The involvement of those multidisciplinary teams, their associated procedures and methodologies, and the required service composition technologies make service composition a complex, time consuming and prone-to-error activity.

A typical scenario of a service composition to facilitate a business process is as follows. The business analyst describes the domain specific scenario, the required business process and related concepts, entities, roles, etc. The business modeler creates a business process model which is iteratively refined by interacting with the business analyst. Ideally this activity can be performed by the same role. The business process model is implemented as a service composition by the service integrator, who aggregates services provisioned by service providers. Commonly, different interaction cycles between the business modeler and the service integrator are conducted to refine and amend the service composition implementation of the business process.

The proposed GE aims to simplify the implementation of some business processes, for instance by enabling business modelers to directly create service compositions without requiring the involvement of service integrators. In this way, the business modelers describes the service composition by using domain specific languages (DSL), vocabularies, and ontologies, to describe the semantics of the tasks into which the service composition is divided.

The technical activities conducted by the service integrator are semi-automatically performed by the GE. In other words, the GE does not prompt the business modeler to provide technical information required for implementing the executable service composition, because the GE obtains that information by exploiting the semantic descriptions attached to the service composition by the modeler from the domain specific ontologies. In this way, a full executable service composition is created without requiring a technical expertise on BPM techniques.

20.4.1.1 *User roles*

For the purpose of this description, two main roles are identified:

- Domain business modelers, who have knowledge about the domain where the business process will be executed as service composition. Therefore, they have the required domain specific knowledge, to model the business process as service composition by using domain specific vocabularies (or ontologies).
- Service providers, who will deploy and host the service composition model by the business modeler, within the execution environment. They will also take care of composition management at runtime.

20.5 Basic Concepts

This section introduces the most relevant functional concepts considered in the Light-weighted Semantic-enabled Composition GE, which are related to the functional components described in the next section about GE architecture.

Light-weighted Semantic-enabled Composition GE is a tool suite supporting the implementation of domain business processes, such as service compositions, executed in backend execution environments as SOA services. Conceptually, this approach can be decomposed in few main concepts described in the following sections:

20.5.1 BPMN Composition Edition

A domain business process is decomposed into single working units or tasks, connected logically by a work flow and a data flow, according to the BPMN (Business Process Model and Notation) specification. Each task is performed by an external service, provided by either the composition provider in the same organization, or by an external third party, accessible through open Web standards.

20.5.2 Light-weighted Semantic-enabled Composition

This approach for the modeling of a service composition describes each composition task using semantic descriptions according to standardized semantic schema (WSMO/OWL-S) and in particular to the light versions (WSMOLite /MicroWSMO). A practical procedure is to annotate each task with concepts selected from a domain specific ontology. These annotations constitute the semantic goal description of the task, that is, the intended purpose of the task. The task goal is matched against the available semantic service descriptions within a semantic knowledge base repository and the matching services are ranked, allowing the business modeler to select one of them as task binding, or let the system to select the best scored.

20.5.3 Semi-automatic Execution Composition Generation

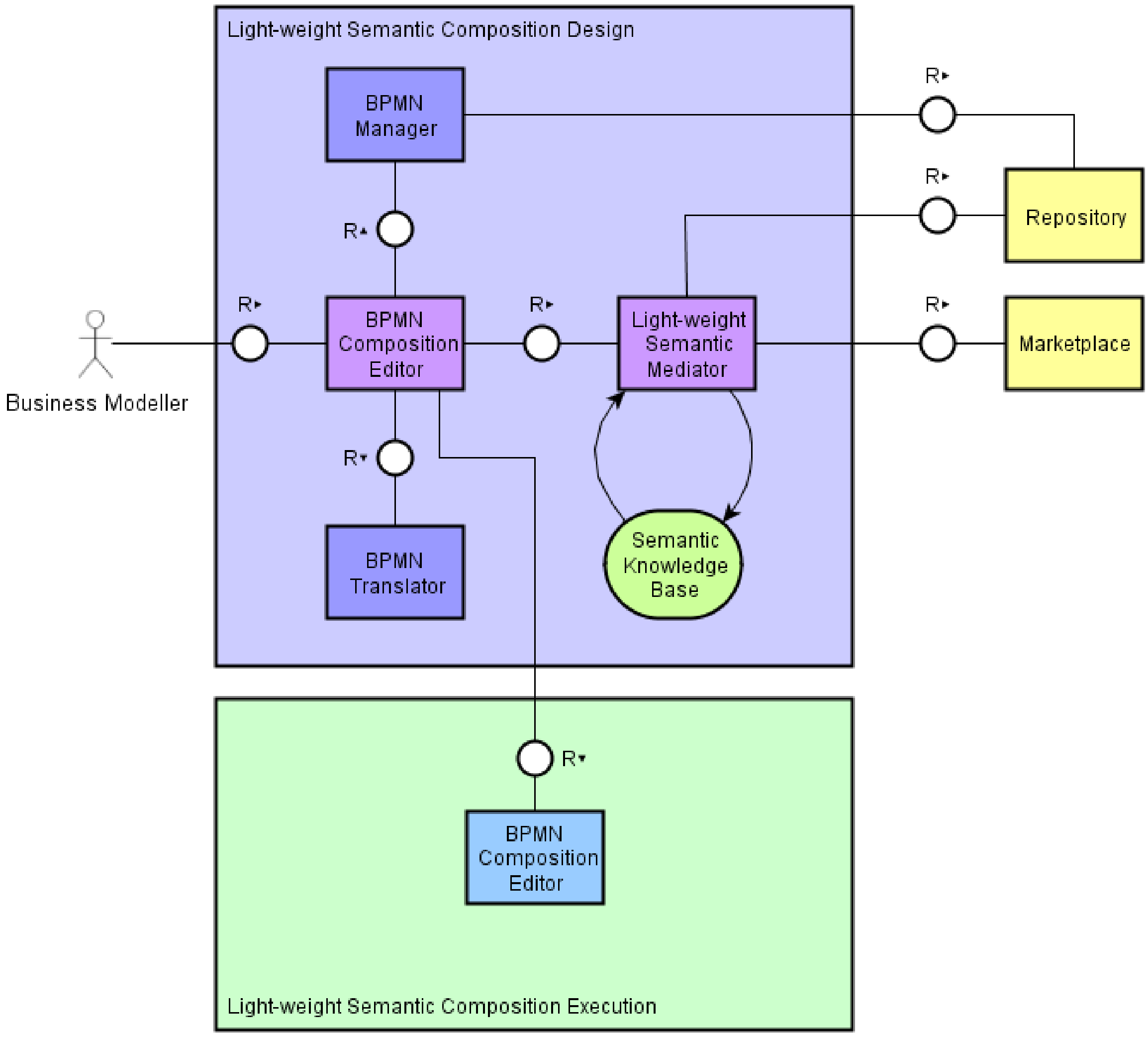
This concept refers to a semantically annotated service composition with tasks bound that cannot be executed. A complete service composition including the technical bindings and the data flow mappings needs to be generated out of the semantically annotated composition

20.5.4 Composition Deployment and Execution

The composition is ready to be consumed as soon as the service integrator takes the generated executable service composition, selects a target execution environment and deploys the composition into the target.

20.6 Light-weighted Semantic-enabled Composition Architecture

Light-weighted Semantic-enabled Composition GE architecture is depicted in the next figure. This architecture is split into two main functional layers: Design and Execution.



Light-weighted Semantic-enabled Composition GE Architecture

The Design layer provides functional support for the modeling of service compositions. The GE constrains service composition modeling to use BPMN 2.0 for both the graphical (modeling) and execution semantics. That is, the GE assumes that service composition models are instances of the BPMN 2.0 standard metamodel.
The following functional components are part of the layers of this GE:

- BPMN Composition Editor enables business modelers to create service compositions using the BPMN 2.0 Graphical notation and execution semantics. It provides a typical GUI to create, edit and manage service compositions, requiring the business modeler to have some background in BPM modeling.
- Light-weighted Semantic Mediator complements the BPMN Composition Editor by providing additional semantic-enabled modeling aids that simplifies the modeling process. These assisting features allow business modelers to describe the composition tasks, bind matching services, generate the data flow mapping, and so on.
- Semantic Knowledge Base complements the Light-weighted Semantic Mediator with a semantic repository of semantic service descriptions, domain specific vocabularies (DSL, ontologies), service composition annotations (tasks, compositions themselves), etc. This component provides content access features, including querying and reasoning.
- BPMN Manager provides BPMN model management, including features to validate and complete BPMN models with required executable information (e.g. service bindings, data flow mappings, etc.)
- BPMN Translator provides translation capabilities to other executable composition formats, such as BPEL 1.2/2.0
- Composition Deployer, which belongs to the execution engine, acts as a proxy between the Light-weighted Semantic-enabled Composition Design layer and the Composition Execution layer. It manages the service composition deployment process into the selected Composition Execution layer.

Components in the design layer interact with some other GE components such as the Marketplace and Repository:

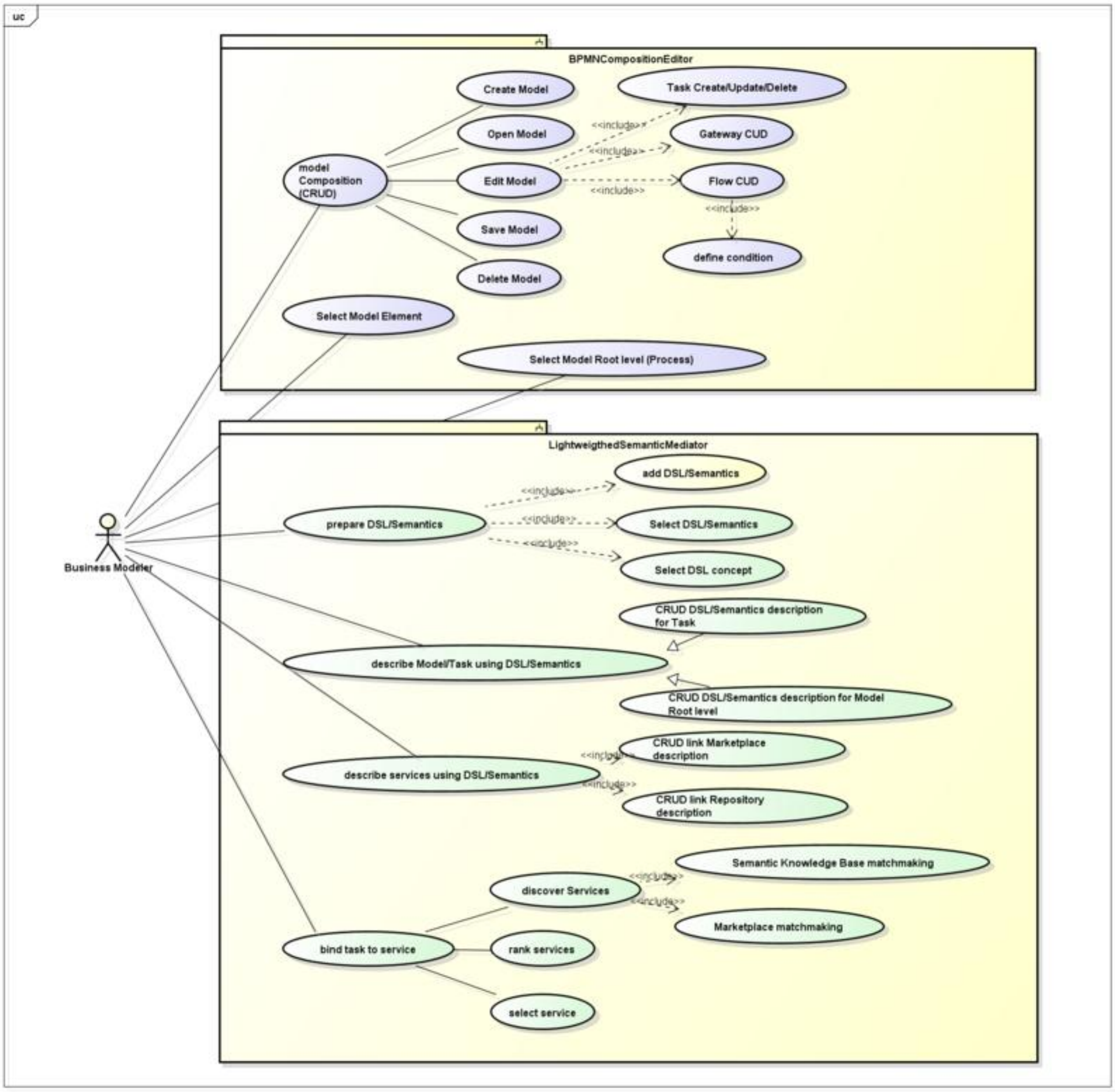
- Marketplace is used to query and retrieve USDL service descriptions for those services matched to composition tasks through semantic matchmaking, thanks to links contained within their semantic descriptions.
- Repository contains the technical descriptions (i.e. WSDL , WADL , etc.) of services aggregated in the composition and the composition models (BPMN).

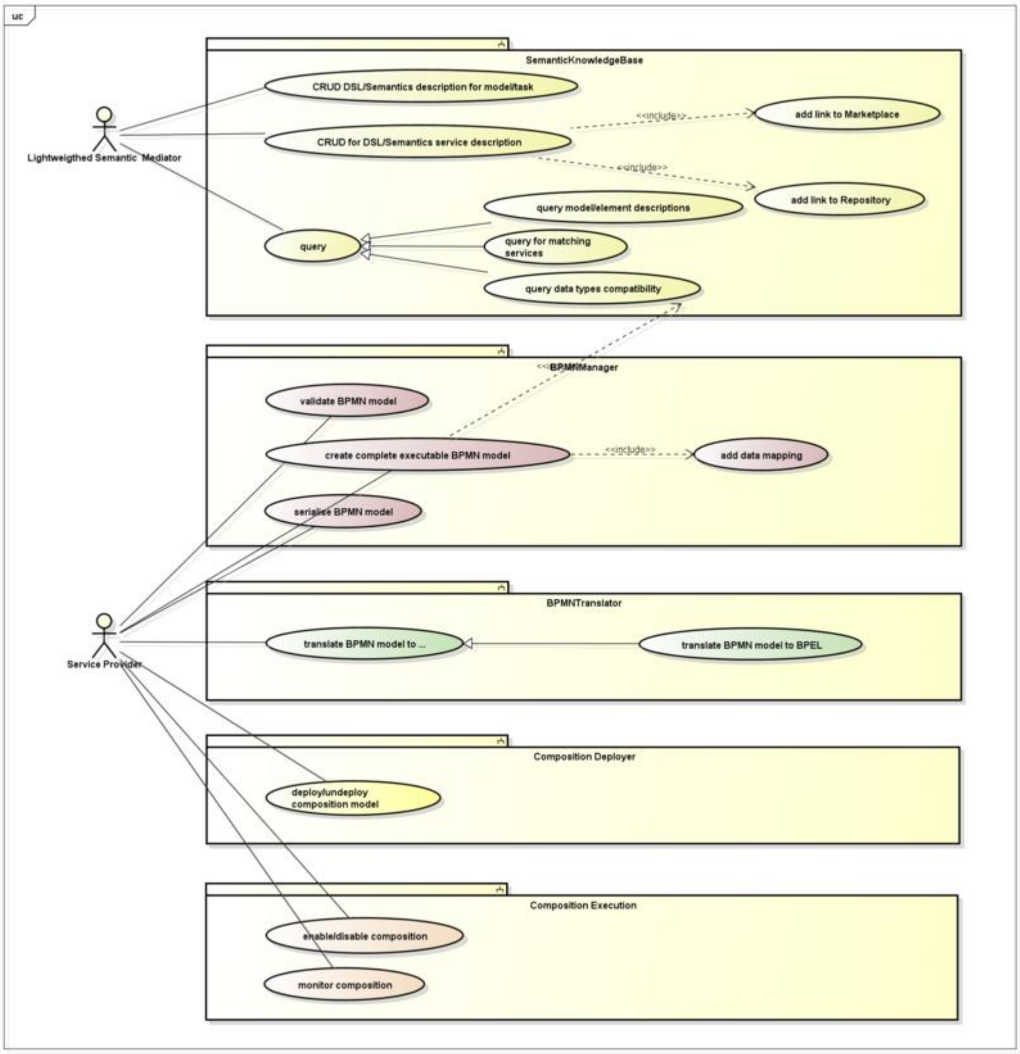
The Composition Execution layer contains the Composition Execution component, which deploys, enables and executes the service compositions, upon remote invocation by a service consumer.
Main interactions performed by the components that comprise this GE are described in next section, grouped by a functional classification.

20.7 Main Interactions

A functional classification of Light-weighted Semantic-enabled Composition GE main features is depicted in the next UML use case diagram, and described in more detail in next paragraphs.

Note: This tool defines a specific methodology and all the tasks/operations are mandatory, except when they are indicated as optional.





Light-weighted Semantic-enabled Composition GE functional classification

20.7.1 Model Composition

This GE provides support for service composition modeling, assuming BPMN 2.0 as graphical notation and execution semantics. Through the BPMN Composition Editor, business modelers can create or open composition models, modify (edit) and manage (save, delete) them. Composition models are stored within a Repository.
Composition edition also includes support for creating/updating/deleting features for composition elements, such as service tasks, gateways (exclusive, parallel), flows and events (start, end).
Composition editor allows to select the composition itself or concrete composition elements.

20.7.2 Prepare DSL/Semantics

In the adopted approach, the business modelers describe composition models and their elements by annotating them with concepts taken from concrete domain specific languages DSL (or vocabularies), which provide concrete semantics. From the operational point of view, it is common to use ontologies as DSL or vocabularies. The Light-weighted Semantic Mediator enables the business modeler to:

- Register new DSL/Ontologies within it.
- Select a concrete DSL/Ontology for a given domain modeling context and select a concrete DSL/Ontology concept within the domain ontology. These concepts are used to annotate and describe a composition model and their elements.

20.7.3 Describe Model Composition/Task using DSL/Semantics (Business modelers)

The Light-weighted Semantic Mediator enables the business modeler to describe the composition model and its elements using semantic annotations.

In the scope of a composition task, the annotations constitute a description of the goal of the task. This goal will be used in the service matchmaking process to look for services whose semantic description will match it. A semantic task description is constituted by several annotations of a certain type according to the semantic schema used to represent the goal (i.e. MSM).

In the scope of the composition itself, the annotations constitute a description of the global composition requirements, preferences and contextual information.

20.7.4 Describe Service using DSL/Semantics (Service Providers)

The Light-weighted Semantic-enabled Service Composition GE approach assumes that composable services are described using light semantics. Those semantic service descriptions are available within the Semantic Knowledge Base, and are provided by service providers. A service composition created by applying this GE approach is a service by its own, whereby the business modeler, acting as service provider, is required to provide this semantic description. The same applies to any other third party service intended to be composed by others.

The Light-weighted Semantic Mediator enables service providers to create semantic descriptions compliant to the semantic schema used by the complete GE solution. The concrete schema is left for the implementation, but it should be consistent along with all the components that use it.

The schema includes links to the business oriented description stored in the Marketplace, and the technical description stored in the Repository.

20.7.5 Task binding

One of the main jobs in service composition modeling is to bind every service task type: the composition is divided into matching services for each of the task. A business modeler can conduct this task-binding per task or for the whole composition. The Light-weighted Semantic Mediator enables the modeler to discover matching services based on task goal criteria, rank them according to preferences or non-functional requirements (NFR) and select one service, which is bound to the task. Those activities are typically performed by querying the Semantic Knowledge Base.

20.7.6 Validate, generate, translate executable BPMN composition model

Next step in service composition modeling consists on filling the missing information that the composition model requires before being shipped for deployment and execution. Examples of missing information are:

- Task binding technical description: for each BPMN 2.0 service task, a concrete task binding information has to be included, by inspecting the technical description (i.e. WSDL)
- Data flow mapping, including I/O mappings at task and composition level

Once the service composition model has been completed with missing required executable information, the composition model is validated (BPMN 2.0 compliance validation) and serialized (for storage and deployment).

Optionally, the composition model can be translated from its original BPMN 2.0 format to another compatible format, such as BPEL 1.2/2.0. This is required when the select target environment for execution is not BPMN 2.0-compatible.

20.7.7 Deploy composition model

Full executable validated composition models can be deployed into the selected target Composition Execution environment, using the Composition Deployer. Once deployed, the service composition is enabled, being ready to received incoming requests from service consumers.

Similarly, deployed service compositions can be undeployed any time.

20.7.8 Composition Execution

During the execution time, deployed services can be enabled or disabled any time through the Composition Execution UI. Besides this, running (enabled) compositions can be continuously monitored and monitoring data can be collected for given time frames.

Next paragraphs detail the main operations using UML sequence diagrams for the most relevant scenarios concerning the light-weighted semantic modeling of a service composition.

20.7.9 Modeling a BPMN Composition

A business modeler, through the BPMN Composition Editor, can either:

- Create a new BPMN composition model.

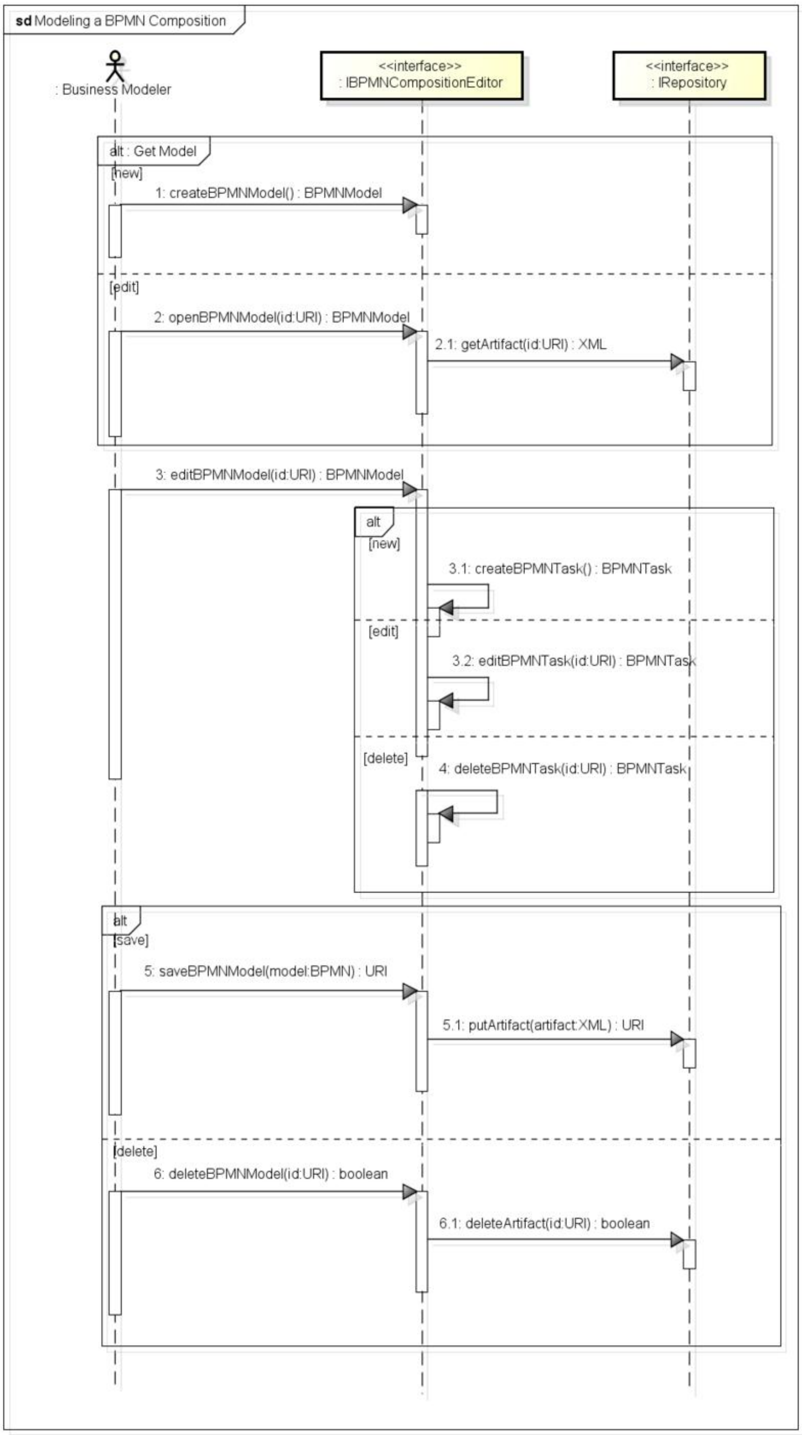
or

- Open an existing one from the Repository, using a unique model Id. The unique model Id is provided by the Repository during the model saving.

The business modeler can work on this composition model, editing the model and its elements. This activity includes create/edit/delete operations on model elements such as tasks, gateways, flows, events, etc. Each model element is uniquely identified by a unique identifier (within the model) provided by the editor upon creation.

Anytime, during the modeling of the composition, the business modeler can either:

- Save the composition model into the Repository. This process requires serializing the BPMN composition model according to the BPMN 2.0 serialization standard (XSD/XMI).
- Delete the model from the Editor and Repository (in case the model was previously saved). Models are identified within the repository by a unique identifier.



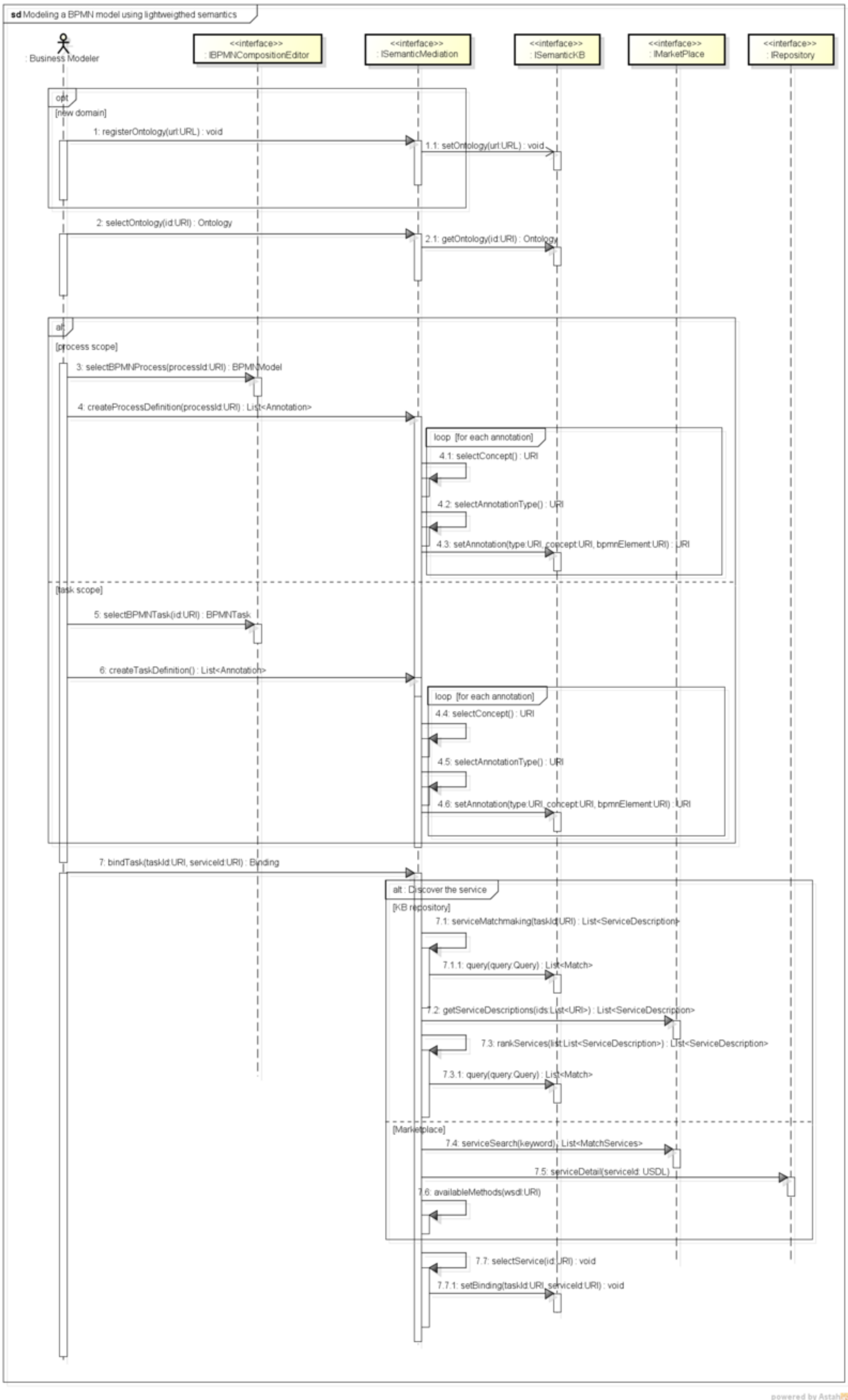
Modeling a BPMN Composition

20.7.10 Modeling a composition using light-weighted semantics

A composition work-flow and its tasks decomposition can be modeled by using the BPMN Composition Editor itself. However, once each task has to be bound to concrete services or the data flow mapping has to be designed, the light-weighted semantic composition approach comes up.

This GE encourage modelers to describe composition task by attaching light-semantic annotations, according to some pre-established task goal schema (for instance WSMOLight/MicroWSMO) which are taken from domain-specific ontologies, or any other domain specific language (DSL) or vocabulary. Based on this semantic task goal, the semantic matchmaking activity determines the best matching service and binds the task to it.

The next UML sequence diagram describes the overall process in detail, decomposed by operation and involved components.



Modeling a composition using light-weighted semantics

20.7.10.1 *Domain Ontologies preparation phase*

A business modeler selects the suitable domain specific ontology that will be used to describe the composition tasks, depending on the concrete context which the composition will be applied to.

If the domain ontology has not being previously registered within the Light-weighted Semantic Mediator, the modeler registers it by giving the ontology URL. The ontology is downloaded from that URL and stored within the Semantic Knowledge Base. The ontology has to be accessible in a compatible format with the Semantic Knowledge Base (i.e. serialization format such as RDF/XML , N3 , etc.).

Any time during the composition modeling the business modeler can switch from one domain ontology to another by selecting them in the Light-weighted Semantic Mediator. The selected ontology is loaded from the Semantic Knowledge Base. Ontologies are uniquely identified within the GE implementation by an URI.

20.7.10.2 *Lightweighted semantic composition modeling*

A business modeler can start this activity either by annotating the composition itself (global annotations) or the concrete composition elements (particular tasks).

Global annotations describe the composition global requirements, preferences and contextual constrains, as stated by the selected semantic annotation schema (i.e. WSMOLite/MSM). Any annotation is concretized by a selected ontology concept (with an URI and a type). Each annotation is stored within the Semantic Knowledge Base (with the annotation type, annotation concept and process URI).

Tasks are semantically annotated in a light weighted manner to describe them, according to the selected semantic annotation schema (i.e. WSMOLite/MSM). Each annotation is stored within the Semantic Knowledge Base, given the annotation type, annotation concept and task URI.

Once the business modeler has described all the tasks within the model using light-weighted semantic annotations, he proceeds to bind each task to a concrete external service. This can be done automatically for the whole composition, whereby all tasks are automatically bound to the best-ranked compatible service, matched by the matchmaking process, or semi automatically, task by task where selection is conducted by the business modeler. Nonetheless, this process, either manual or automatic, is similar.

There are two ways to search services:

- The Light-weighted Semantic Mediator is invoked to search for services, whose semantic descriptions match the task goal description. Using this local task goal description, a semantic query (i.e. SPARQL) is prepared and sent to the Semantic Knowledge Base, which returns a list of unranked matches (candidate service descriptions). Based on global annotations (requirements, preferences and context constrains), candidate services are filtered out (according to requirements and context constraints) and ranked (based on preferences), by querying and reasoning the Semantic Knowledge Base.
- The Marketplace GE is invoked to search services which are published by service providers in different Stores. Nevertheless, this discovering is not a semantic matchmaking and it is based on syntactic searching through keyword criteria. The Marketplace GE returns the list of services, which contain these keywords, and the rating of them. Hence, the modeler can visualize the detail of the best service to

determine if it is the appropriate. Afterwards, he can choose the method that should be bind to the analyzed task.

Finally the best-ranked candidate service is automatically selected, or the business modeler selects one by inspecting the service candidate list, using descriptions obtained from the Marketplace. The selected service is then bound to the task in the Semantic Knowledge Base.

20.7.11 Process a complete executable BPMN composition model

A semantically fully processed composition model, once its tasks have been bound to semantically annotated services, contains all the information required to create an executable composition model.

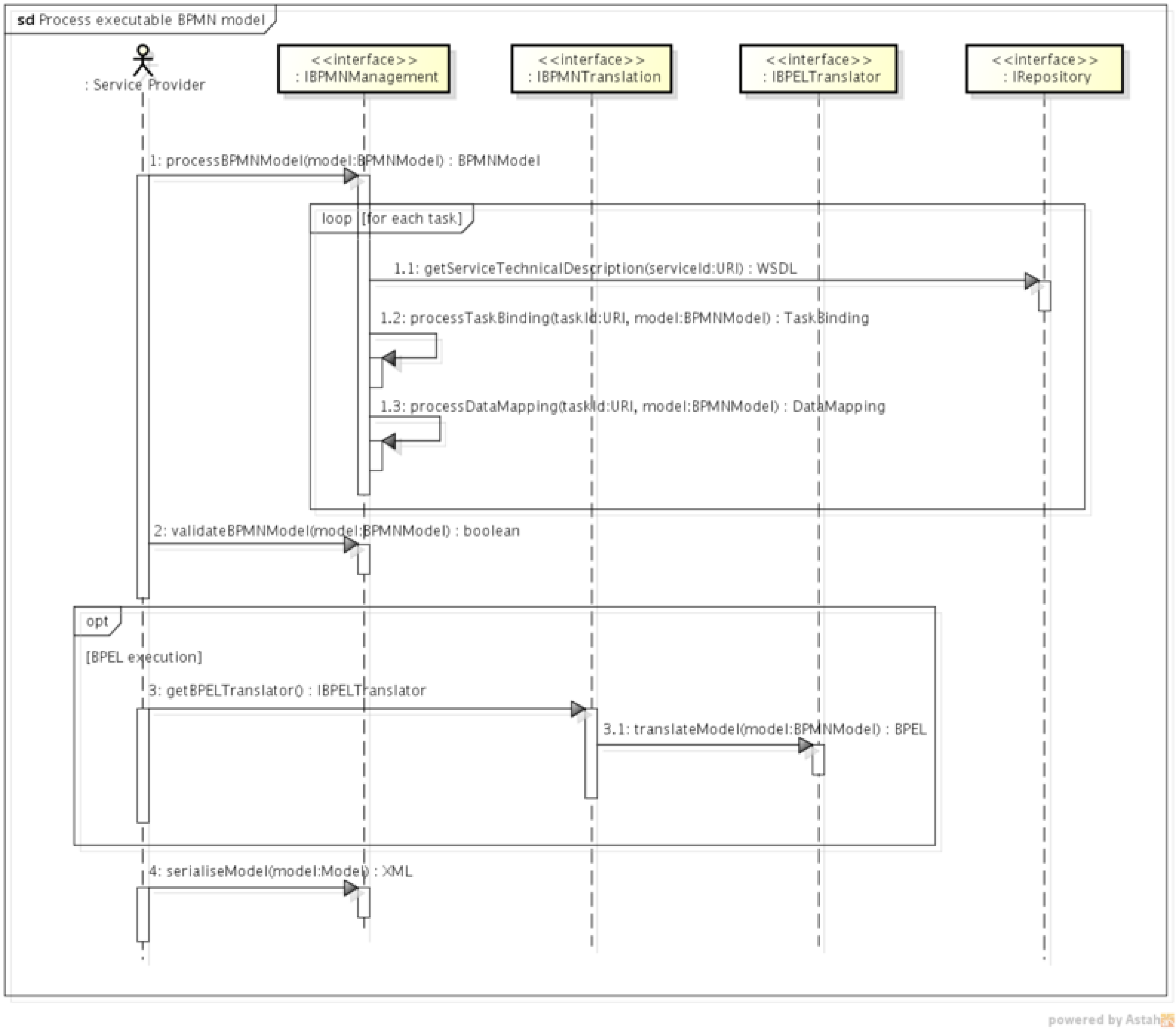
This procedure is initiated by the service provider who requests the processing of the BPMN model through the Light-weighted Semantic Composition Editor. This procedure conducts two main jobs for each composition task:

- Task binding is included in the BPMN composition model, according to the BPMN specification, by getting the technical required information from the technical description stored within the Repository.
- Task data flow mapping (IO mapping) is included in the BPMN composition model, according to the BPMN specification as well. Data flow mapping considers all data objects available before reaching this task, following in the workflow.

Once the BPMN executable composition model has been created, it is validated against the BPMN specification.

Optionally, the BPMN executable composition model can be converted into another executable model, compliant to another composition language, such as BPEL 1.2/2.0. This could be required by the target Composition Execution Environment.

Finally, the executable composition model is serialized into XML or any other standardized serialization schema for interchange, as determined by the selected target execution language (BPMN XSD/XMI, BPEL XSD, etc.).

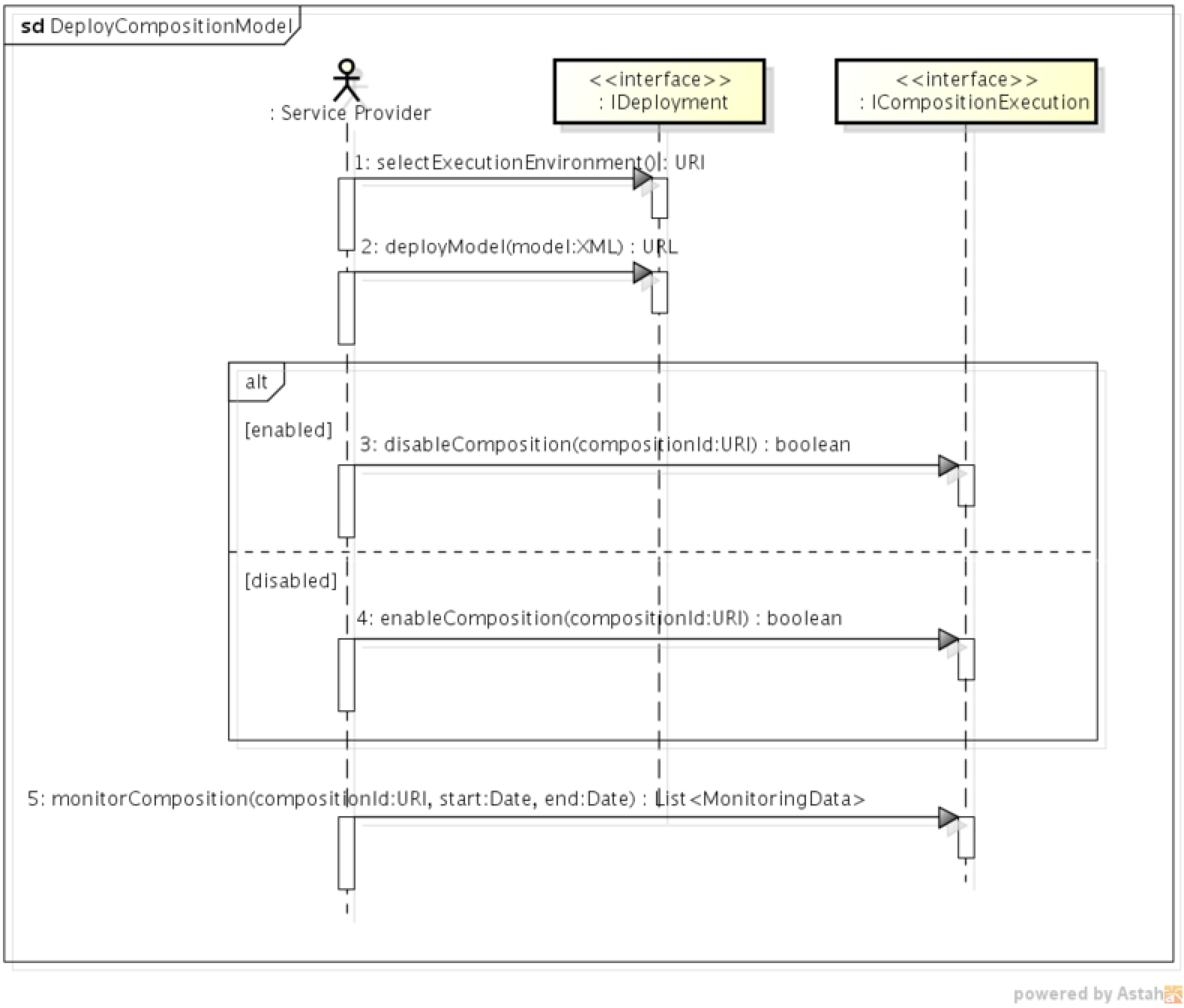


Process a complete executable BPMN composition model

20.7.12 Deploy a service composition model

A service composition model can be deployed within a selected target. A service provider selects the target execution environment and deploys the current composition model edited in the Light-weighted Semantic Composition Editor. The Deployer returns the URL where the deployed composition is listening as service or any other required information to invoke it.

Anytime after deployment, the service provider can enable or disable the composition (depending on its status) through the Composition Execution UI. Moreover, through this UI, the service provider can monitor a composition within a specified time frame.



Deploy a service composition model

20.8 Basic Design Principles

Sources:

- SOA4All D1.1.1 Design Principles for a Service Web
- Evaluation of Service Construction

This GE follows the following design principles:

- **Machine and human based computation principle**

This GE allows a semi-automatic (human and machine) service composition modeling.

- **Template-based composition**

Recently created process models (and some fragments) can be reused in future modeling tasks.

- **Reusable**

This GE is completely domain-independent concerning the knowledge intensive reusability feature.

- **Composability principle**

The GE design allows it to split a complex process-modeling problem into several smaller ones that the GE resolves separately by its specific agents.

- **Openness principle**

This GE can be easily extended either by coding/replacing architectural components.

- **Ontology based principle**

This GE extensively uses ontology-based knowledge.

20.9 Detailed Open Specifications

20.9.1 Open API Specifications

The Light-weighted Semantic-enabled Composition GE is not exposed as a service but as a Web application (GUI), accessed through the end user Web browser. Although some GE components are exposed as services, they only expose an API for internal consumption (within the GE), but it is not expected they will be integrated by other GEs.

The Light-weighted Semantic-enabled Composition GE will access the Marketplace and Repository REST APIs:

- FIWARE.OpenSpecification.Apps.MarketplaceSearchREST
- FIWARE.OpenSpecification.Apps.RepositoryREST

20.9.2 Re-utilised Technologies/Specifications

The Light-weighted Semantic-enabled Composition GE relies on following technical specifications:

- BPMN 2.0
- WSMOLite
- MicroWSMO
- BPEL 2.0
- USDL
- WSDL 2.0
- WSDL
- Minimum Service Model (MSM)
- BPMN to BPEL
- BPMN XSD/XMI serialization formats
- RDF/XML format
- N3 format
- SPARQL 1.1

20.10 Terms and definitions

This section comprises a summary of terms and definitions introduced during the previous sections. It is meant to establish a vocabulary that will be help to carry out discussions internally and with third parties (e.g., Use Case projects in the EU FP7 Future Internet PPP). For a summary of terms and definitions managed at overall FI-WARE level, please refer to FIWARE Global Terms and Definitions

- **Aggregator (Role):** A Role that supports domain specialists and third-parties in aggregating services and apps for new and unforeseen opportunities and needs. It does so by providing the dedicated tooling for aggregating services at different levels: UI, service operation, business process or business object levels.
- **Application:** Applications in FI-WARE are composite services that have a IT supported interaction interface (user interface). In most cases consumers do not buy the application, instead they buy the right to use the application (user license).
- **Broker (Role):** The business network's central point of service access, being used to expose services from providers that are delivered through the Broker's service delivery functionality. The broker is the central instance for enabling monetization.
- **Business Element:** Core element of a business model, such as pricing models, revenue sharing models, promotions, SLAs, etc.
- **Business Framework:** Set of concepts and assets responsible for supporting the implementation of innovative business models in a flexible way.
- **Business Model:** Strategy and approach that defines how a particular service/application is supposed to generate revenue and profit. Therefore, a Business Model can be implemented as a set of business elements which can be combined and customized in a flexible way and in accordance to business and market requirements and other characteristics.
- **Business Process:** Set of related and structured activities producing a specific service or product, thereby achieving one or more business objectives. An operational business process clearly defines the roles and tasks of all involved parties inside an organization to achieve one specific goal.
- **Business Role:** Set of responsibilities and tasks that can be assigned to concrete business role owners, such as a human being or a software component.
- **Channel:** Resources through which services are accessed by end users. Examples for well-known channels are Web sites/portals, web-based brokers (like iTunes, eBay and Amazon), social networks (like Facebook, LinkedIn and MySpace), mobile channels (Android, iOS) and work centers. The access mode to these channels is governed by technical channels like the Web, mobile devices and voice response, where each of these channels requires its own specific workflow.
- **Channel Maker (Role):** Supports parties in creating outlets (the Channels) through which services are consumed, i.e. Web sites, social networks or mobile platforms. The Channel Maker interacts with the Broker for discovery of services during the process of creating or updating channel specifications as well as for storing channel specifications and channeled service constraints in the Broker.
- **Composite Service (composition):** Executable composition of business back-end MACs (see MAC definition later in this list). Common composite services are either orchestrated or choreographed. Orchestrated compositions are defined by a centralized control flow managed by a unique process that orchestrates all the interactions (according to the control flow) between the external services that participate in the composition. Choreographed compositions do not have a centralized process, thus the services participating in the composition autonomously coordinate each other according to some specified coordination rules. Backend compositions are executed in dedicated process execution engines. Target users of tools for creating Composites Services are technical users with algorithmic and

process management skills.

- **Consumer (Role):** Actor who searches for and consumes particular business functionality exposed on the Web as a service/application that satisfies her own needs.
- **Desktop Environment:** Multi-channel client platform enabling users to access and use their applications and services.
- **Event-driven Composition:** Components concerned with the composition of business logic, which is driven by asynchronous events. This implies run-time selection of MACs and the creation/modification of orchestration workflows based on composition logic defined at design-time and adapted to context and the state of the communication at run-time.
- **Front-end/Back-end Composition:** Front-end compositions define a front-end application as an aggregation of visual mashable application pieces (named as widgets, gadgets, portlets, etc.) and back-end services. Front-end compositions interact with end-users, in the sense that front-end compositions consume data provided by the end-users and provide data to them. Thus the front-end composition (or mashup) will have a direct influence on the application look and feel; every component will add a new user interaction feature. Back-end compositions define a back-end business service (also known as process) as an aggregation of backend services as defined for service composition term, the end-user being oblivious to the composition process. While back-end components represent atomization of business logic and information processing, front-end components represent atomization of information presentation and user interaction.
- **Gateway (Role):** The Gateway role enables linking between separate systems and services, allowing them to exchange information in a controlled way despite different technologies and authoritative realms. A Gateway provides interoperability solutions for other applications, including data mapping as well as run-time data store-forward and message translation. Gateway services are advertised through the Broker, allowing providers and aggregators to search for candidate gateway services for interface adaptation to particular message standards. The Mediation is the central generic enabler. Other important functionalities are eventing, dispatching, security, connectors and integration adaptors, configuration, and change propagation.
- **Hoster (Role):** Allows the various infrastructure services in cloud environments to be leveraged as part of provisioning an application in a business network. A service can be deployed onto a specific cloud using the Hoster's interface. This enables service providers to re-host services and applications from their on-premise environments to cloud-based, on-demand environments to attract new users at much lower cost.
- **Marketplace:** Part of the business framework providing means for service providers, to publish their service offerings, and means for service consumers, to compare and select a specific service implementation. A marketplace can offer services from different stores and thus different service providers. The actual buying of a specific service is handled by the related service store.
- **Mashup:** Executable composition of front-end MACs. There are several kinds of mashups, depending on the technique of composition (spatial rearrangement, wiring, piping, etc.) and the MACs used. They are called application mashups when applications are composed to build new applications and services/data mash-ups if

services are composed to generate new services. While composite service is a common term in backend services implementing business processes, the term ‘mashup’ is widely adopted when referring to Web resources (data, services and applications). Front-end compositions heavily depend on the available device environment (including the chosen presentation channels). Target users of mashup platforms are typically users without technical or programming expertise.

- **Mashable Application Component (MAC):** Functional entity able to be consumed executed or combined. Usually this applies to components that will offer not only their main behaviour but also the necessary functionality to allow further compositions with other components. It is envisioned that MACs will offer access, through applications and/or services, to any available FI-WARE resource or functionality, including gadgets, services, data sources, content, and things. Alternatively, it can be denoted as ‘service component’ or ‘application component’.
- **Mediator:** A mediator can facilitate proper communication and interaction amongst components whenever a composed service or application is utilized. There are three major mediation area: Data Mediation (adapting syntactic and/or semantic data formats), Protocol Mediation (adapting the communication protocol), and Process Mediation (adapting the process implementing the business logic of a composed service).
- **Monetization:** Process or activity to provide a product (in this context: a service) in exchange for money. The Provider publishes certain functionality and makes it available through the Broker. The service access by the Consumer is being accounted, according to the underlying business model, and the resulting revenue is shared across the involved service providers.
- **Premise (Role):** On-Premise operators provide in-house or on-site solutions, which are used within a company (such as ERP) or are offered to business partners under specific terms and conditions. These systems and services are to be regarded as external and legacy to the FI-Ware platform, because they do not conform to the architecture and API specifications of FI-WARE. They will only be accessible to FI-WARE services and applications through the Gateway.
- **Prosumer:** A user role able to produce, share and consume their own products and modify/adapt products made by others.
- **Provider (Role):** Actor who publishes and offers (provides) certain business functionality on the Web through a service/application endpoint. This role also takes care of maintaining this business functionality.
- **Registry and Repository:** Generic enablers that able to store models and configuration information along with all the necessary meta-information to enable searching, social search, recommendation and browsing, so end users as well as services are able to easily find what they need.
- **Revenue Settlement:** Process of transferring the actual charges for specific service consumption from the consumer to the service provider.
- **Revenue Sharing:** Process of splitting the charges of particular service consumption between the parties providing the specific service (composition) according to a specified revenue sharing model.
- **Service:** We use the term service in a very general sense. A service is a means of delivering value to customers by facilitating outcomes customers want to achieve

without the ownership of specific costs and risks. Services could be supported by IT. In this case we say that the interaction with the service provider is through a technical interface (for instance a mobile app user interface or a Web service). Applications could be seen as such IT supported Services that often are also composite services.

- **Service Composition:** in SOA domain, a service composition is an added value service created by aggregation of existing third party services, according to some predefined work and data flow. Aggregated services provide specialized business functionality, on which the service composition functionality has been split down.
- **Service Delivery Framework:** Service Delivery Framework (or Service Delivery Platform (SDP)) refers to a set of components that provide service delivery functionality (such as service creation, session control & protocols) for a type of service. In the context of FI-WARE, it is defined as a set of functional building blocks and tools to (1) manage the lifecycle of software services, (2) creating new services by creating service compositions and mashups, (3) providing means for publishing services through different channels on different platforms, (4) offering marketplaces and stores for monetizing available services and (5) sharing the service revenues between the involved service providers.
- **Service Level Agreement (SLA):** A service level agreement is a legally binding and formally defined service contract, between a service provider and a service consumer, specifying the contracted qualitative aspects of a specific service (e.g. performance, security, privacy, availability or redundancy). In other words, SLAs not only specify that the provider will just deliver some service, but that this service will also be delivered on time, at a given price, and with money back if the pledge is broken.
- **Service Orchestration:** in SOA domain, a service orchestration is a particular architectural choice for service composition where a central orchestrated process manages the service composition work and data flow invocations of the external third party services in the order determined by the work flow. Service orchestrations are specified by suitable orchestration languages and deployed in execution engines who interpret these specifications.
- **Store:** An external component integrated with the business framework, offering a set of services that are published to a selected set of marketplaces. The store thereby holds the service portfolio of a specific service provider. In case a specific service is purchased on a service marketplace, the service store handles the actual buying of a specific service (as a financial business transaction).
- **Unified Service Description Language (USDL):** USDL is a platform-neutral language for describing services, covering a variety of service types, such as purely human services, transactional services, informational services, software components, digital media, platform services and infrastructure services. The core set of language modules offers the specification of functional and technical service properties, legal and financial aspects, service levels, interaction information and corresponding participants. USDL is offering extension points for the derivation of domain-specific service description languages by extending or changing the available language modules.

21 FIWARE OpenSpecification Apps Store

You can find the content of this chapter as well in the wiki of fi-ware.

Name	FIWARE.OpenSpecification.Apps.Store
Chapter	Apps,
Catalogue-Link to Implementation	WStore
Owner	UPM, Javier Soriano

21.1 Preface

Within this document you find a self-contained open specification of a FI-WARE generic enabler, please consult as well the FI-WARE Product Vision, the website on http://www.fi-ware.org and similar pages in order to understand the complete context of the FI-WARE project.

21.2 Copyright

21.3 Legal Notice

Please check the following **FI-WARE Open Specification Legal Notice (implicit patents license)** to understand the rights to use these specifications.
Note: UPM provides software associated to the Store specification under an EUPL v1.1. Please check the specific terms and conditions linked to this EUPL v1.1 open source license at https://github.com/conwetlab/wstore/blob/develop/LICENSE.txt

21.4 Overview

The Store GE is part of the Application/Services Ecosystem. The Store GE is mainly responsible for managing offerings and sales: it supports the publication of new offerings, manages offering payment, provides access to all purchased services and provides software downloads if the offering is part of a downloadable service (e.g. applications, widgets, etc.)
The resulting features constitute a list of the requirements that the Store GE will have to satisfy. They are defined below.

- The *Store GE* is responsible for managing service offerings. To do this, it supports the registration of offerings published by an *aggregator* and may update one or more Marketplace GEs to enter a new offering, which is linked to the *Store GE*.

Additionally, it registers the information about the offering by storing the business model of the service represented as a *Linked USDL* document in the *Repository GE*. Finally, it registers the information on service execution time, as well as any existing instances or configuration information in the *Registry GE*.

- As there is no *generic enabler* that stores code in the *Application/Services Ecosystem*, the *Store GE* will offer an endpoint from which it will be possible to download any resources that are part of a purchased and downloadable service. To do this, the *Store GE* defines an API to be implemented by the service provider. This API will be used as a mean for indirectly downloading the resources associated with the offering. Service providers that do not have an application server can also upload these resources to the *Store GE*.
- The *Store GE* will offer a web portal for visualizing, searching and purchasing offerings, although the *Marketplace GE* can be used to search and compare offers published in different *Store GE*s.
- When a customer decides to purchase an offering either via the *Store GE* web portal or by searching a *Marketplace GE*, the *Store GE* will manage offering payment, will contact the service provider to notify her the purchase of the offering, and will make sure that the customer is either given access to the web service or able to download the necessary downloadable service resources as specified above. Additionally, the *Store GE* defines an implementable API for downloadable services purchased via a client program that automatically adds the service resources to the client system. A possible example of this functionality would be the purchase of widgets via the *Mashup Application* GE.

21.5 Basic Concepts

21.5.1 User model and roles

Taking into account the different functionalities provided by *Store GE*, it is necessary to define a model that controls the privileges and possible interactions of *Store GE* users. Note that the *Identity Management GE* will maintain information about users and roles in the FI-WARE platform. Therefore, the *Store GE* will rely on the *Identity Management GE* to manage users and roles.

The *Store GE* is based on the concept of organization. An organization will be managed like a user group. As the *Store GE* operates based on the concept of organization, some offerings may be acquired by the user purchasing the offering and be accessible to all users within an organization. Just as an organization has more than one member user, one and the same user may be a member of more than one organization and may have several offerings purchased at each organization. In the *Store GE*, offerings are considered to be published by an organization rather than an individual user, and users cannot publish an offering unless they are acting on behalf of an organization. This is not, however, incompatible with membership of other organizations. As mentioned above, the *Identity Management GE* will manage organizations.

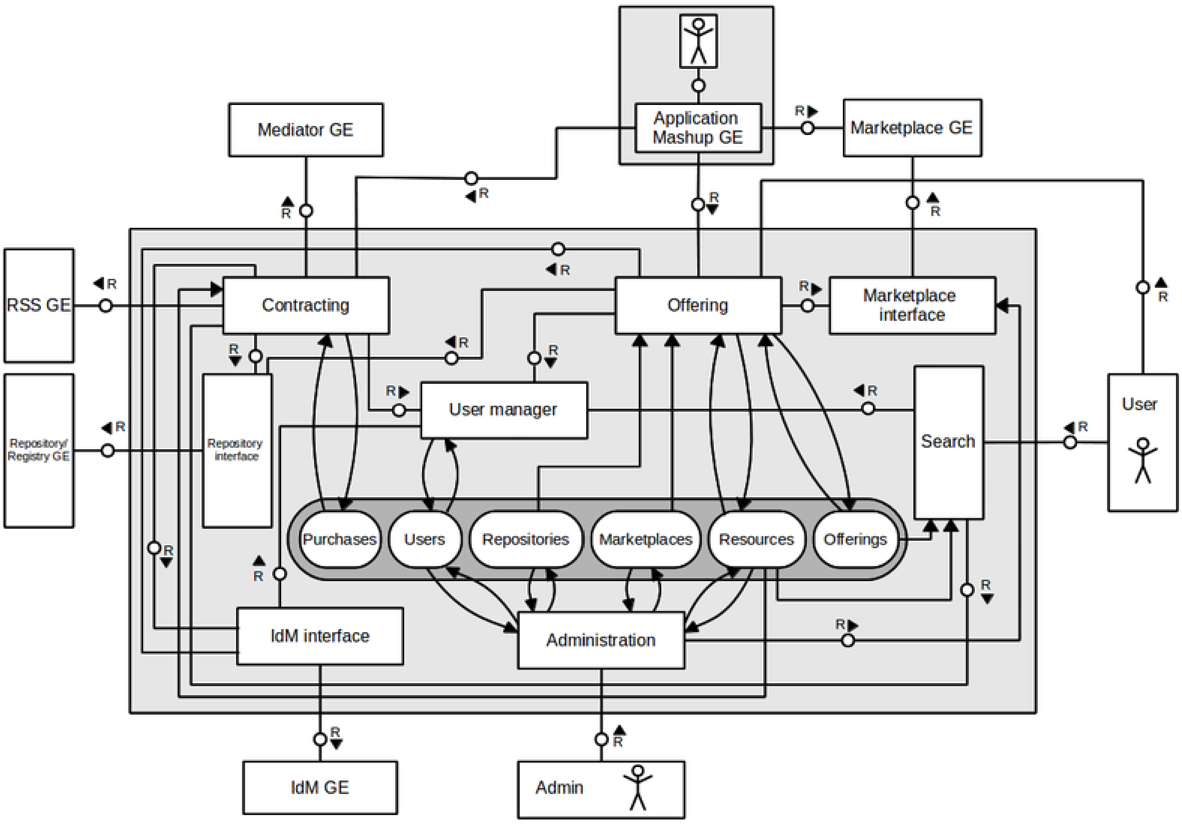
Note that users must have at least one and may have any number of roles. The user roles defined depending on the privileges and possible interactions with the *Store GE* are as follows:

- **Admin:** This role is responsible for system administration. System administration includes database administration, as well as the registration of instances of the *Repository GE* for storing the models of offered services in the *Store GE*. It is also responsible for registering the instance of the *Store GE* in the instances of *Marketplace GEs* in which the registered offers are to be published.
- **Provider**: This role has the option of publishing service offerings, which, as mentioned above, will be offered by the organization on behalf of which the provider is acting at the time of publication.
- **Customer**: This role has the option of purchasing an offering that may or may not become part of the services purchased by any of the organizations of which the customer is a member.
- **Developer**: This role has the option of purchasing an offering that define a special price plan for developers that may include a revenue sharing model between the provider and the customer.

Note at this point that no role has been defined with respect to organizations. Likewise, the *Identity Management GE,* not the *Store GE,* is responsible for managing which role a user plays on behalf of a particular organization. It will simply notify the *Store GE* of the role that users are playing at any time and on behalf of which organization they are acting.

21.6 Store Architecture

Figure below shows the Store GE architecture, which is divided into a series of functional modules, as well as the relationships between the Store GE and other generic enablers. Users will be able to use the Store GE via its web portal while other enablers and final application and services will be able to contact the defined Store API to manage and purchase offerings previously discovered in the Marketplace GE. The diagram also illustrates the connection with the Application Mashup GE, which will use the Store GE to purchase the different web components that it uses to compose the mashups and to publish the resulting composite mashups. The Store GE will also connect to the Marketplace GE, which it will use to register any new offerings that have been published, and to the Repository GE in order to store the USDL documents describing these offerings and their associated documents (WSDL, WADL, etc.).Moreover, the Store GE will also connect to the Mediator GE and the Revenue Share System GE. The Mediator GE can be used if needed to both access the payment gateway during the purchasing process and to contact and notify the provider of the purchased service, whereas the Revenue Sharing System GE will be used to divide the purchased offering payments among their respective stakeholders. Finally, the Store GE relies on the Identity management GE in order to obtain users', organizations, and roles. The Store GE also obtains from the Identity Management GE information about the different applications registered by the users and organizations for access control. See the Identity management user guide for more information on this topic.



Store GE architecture

As shown in the figure above, the Store GE is divided into modules. Each module has a specific functionality and is connected to the other modules and external systems. The functionality that each module should provide is detailed below.

The *Marketplace Interface* module is responsible for communication with the Marketplace GE in order to register and remove the Store GE instance, as well as register and remove published offerings. This module will communicate with both the Offering module, responsible for registering offers, and the Administration module, which will register the Store GE instance.

The *Repository Interface* module is responsible for communicating with the Repository GE in order to both upload and download USDL documents associated with the published offerings. This module will communicate with the Offering module in order to get the USDL documents and with the Contracting module in order to send requests to download USDL documents.

The *IdM interface* module is responsible for communicating with the Identity Management GE in order to obtain information about users and organizations, as well as the different roles of those users. This module is also in charge of obtaining applications registered for access control in the identity management GE in order to include those applications as part of an offering, allowing customers to be granted real access to those services when they purchase the offering.

The *Administration* module is used by users with the Admin role to manage the Store GE and to register the Store GE instance in the instances of the Marketplace GE. This module reads and writes to all data models and contacts the Marketplace GE module in order to register the Store GE.

The *Offering* module is used to manage user-specific offerings. This module manages the provider offerings, i.e. it creates new offerings, publishes new resources, links resources to offerings and publishes and puts offerings up for sale. This module is also responsible for purchased offerings and gives consumers access to the information on these offerings and their linked resources. This module reads and writes from the Resource and Offering models and reads from the Marketplace and Repository models to get the information required to publish the new offerings. Additionally, this module contacts the Marketplace Interface module to send requests to manage the different offerings that are published in the Marketplace GE. It also communicates with the Repository Interface module, which it uses to upload and download the USDL descriptions of the different user offerings. This module also contacts the User Manager module, which it uses to manage the roles of the users sending the requests. Finally, this module contacts the IdM interface module in order to obtain information about the applications registered in the Identity management GE that can be included in an offering.

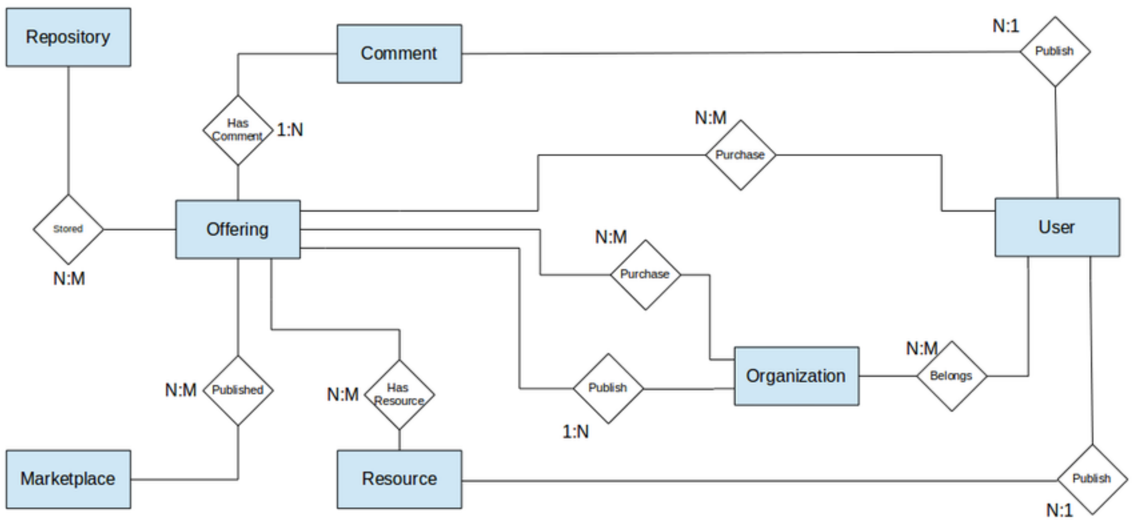
The *User Manager* module is responsible for managing users by supervising the different roles and privileges in order to control access to different functionalities of the Store GE. This module reads and writes to the user model and is contacted by all the modules that are accessible from outside the Store GE, that is, by the Offering, Search and Contracting modules. This module gets user information and roles from the idM interface.

The *Contracting* module is responsible for managing subscriptions and purchases of the different offerings published in the Store GE. This module will contact different payment gateways, receive payment confirmation, give access to the service and pass on the payment information (CDRs) to the Revenue Sharing System GE. This module will also be responsible for renewing services governed by a subscription payment model. (If service subscription is possible from outside the Store GE, then the consumer will have to explicitly notify the Store GE of subscription renewal via the purchases API.) This module will also be responsible displaying purchase information to users. In case the pricing model comprises pay-per-use models, an external accounting component will provide service use information (SDRs) to the Store GE in order to calculate the amount to be charged. The Store GE accepts no responsibility for the validity of the information offered by the service provider. However, this module will enable users to lodge formal complaints about purchased services. Additionally, the Contracting module is contacted by the Search module when users want to purchase a service that they have discovered in the Store GE, and it contacts the Repository Interface module to get the descriptions of the Repository GE offerings. This module contacts the Mediator GE in order to manage the purchase via the payment gateway and notify service providers and sends information on payments to the Revenue Sharing System GE for distribution among stakeholders. Finally, this module contacts the idM interface module, which uses to notify the Identity management GE that a customer has been granted the access to an application due to a purchase of an offering that includes it.

Finally, the Search module is responsible for searching published offerings depending on parameters and filters provided by users. This module reads from the Offering and Resource models in order to get the information required for searches and contacts the Contracting module in order to enable users to purchase an offering that they have discovered.

21.6.1 Data Model

Note firstly that the data model divides the concept of service offering. In order to manage this concept, the Store GE operates with the Offering model that represents the abstract entity of an offering including pricing, legal or service-level information. However, the Store GE also uses the Resource model that represents real components offered, such as an application or a widget.



Store GE data model

The figure above shows the overall data model defined in the *Store GE* as an entity-relationship diagram containing the main entities on which the *Store GE* is based and the relationships between these entities. Below we detail the contents of these entities and the information that they should each contain.

- **Offering**: This model contains information about the offerings registered in the *Store GE*.
  - Name: This attribute will represent the name that the provider gives to the offering.
  - Version: This attribute will contain the version of the offering.
  - Owner organization: This attribute will contain the name of the organization that owns the offering.
  - State: This attribute will represent the life-cycle state of the offering from the viewpoint of the provider.
  - URL model: This attribute will contain the link to the *USDL* offering description stored in an instance of the *Repository GE*.
  - Rating: This attribute will contain the mean score assigned by different users that have given their opinion on the offering.
  - Applications: This attribute will contain information about the Identity Management GE applications included in the offering.
  - TAGs: This attribute will contain a series of *tags* used to classify the offering.

  - Image: This attribute will contain the graphical image associated with the offering.
  - Related images: This attribute will contain a series of graphical images related to the service, such as screenshots, diagrams, etc.
  - USDL information: This attribute will contain the same information as the *USDL* document stored in an instance of the *Repository GE* and will be used to access the information on the offering and the business model without having to constantly contact the instance of the *Repository GE*.

Note importantly that the *Offering* model should contain a unique combination of the *Owner Organization, Name* and *Version* attributes, as these three attributes will be used to identify the offering. This assures that two offerings owned by two different organizations will have different names and allows one and the same organization to have two different versions of the same offering. Note that the service provider's name is not used to identify the offering, as it is the organization that is considered to make the offerings.

- **Resource**: This model contains information about the different resources that have been registered in the *Store GE* to be linked to an offering.
  - Name: This attribute will represent the name that the service provider gives to the resource.
  - Version: This attribute will represent the version of the resource.
  - State: This attribute will contain the state of the resource specifying whether it is active. This attribute will be used mainly if the resource provider decides to delete a resource and this is already part of a published offering or has even purchased by a consumer. In this case, the resource will be simply marked as deleted, because it will have to remain accessible and cannot be removed.
  - Mime type: This attribute specifies the type of the resource to be downloaded.
  - Download link: This attribute will contain the information necessary to access the resource. It will contain the download link.
  - Description: This attribute will contain a resource description.

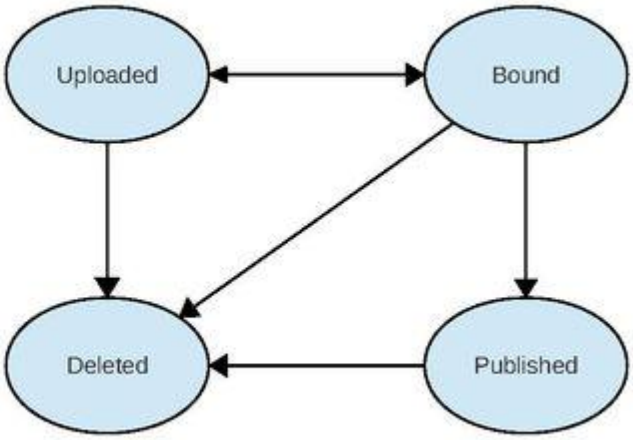
Note that the resources in the *Store GE* will be identified using the resource provider name, the *Name* attribute and the *Version* attribute. Therefore, the combination of these three elements has to be unique.

- **User**: This model will contain the *Store GE* user information that is not necessarily managed by the *Identity Management GE*.
  - User Name: This attribute will contain the user name that identifies the user.
  - Name: This attribute will contain the user's full name.
  - Organizations: This attribute will contain the organizations of which the user is a member.
  - Roles: This attribute will contain the current roles played by the user depending on the current organization.
  - Current organization: This attribute will contain the organization the user is acting on behalf.
  - Default Tax Address: This attribute will contain the default tax address provided by the user.
- **Organization**: this model will contain the *Store GE* organizations information that is not necessarily managed by the *Identity Management GE*.

  - Name: This attribute will contain the name of the organization.
  - Private: This boolean attribute specifies whether this organization is a private organization, that is, an organization owned by a single user.
  - Default tax address: This attribute will contain the default tax address provided by the organization.
- **Purchase**: This relationship will contain information about the purchases made via the *Store GE* including some attributes.
  - Reference: This attribute will contain the purchase reference and will be used to identify the purchase.
  - Date: This attribute will contain the date on which the purchase was made.
  - State: This attribute will contain the state of the purchase, specifying whether or not payment has been made.
  - Bills: This attribute will contain the different invoice references generated when charging are made.
  - Tax Address: This attribute will contain the effective tax address used by the user that purchases the offering.
  - Contract: This attribute will contain information about the concrete contract that applies to the purchase, including the pricing models, renovation dates, etc.
- **Marketplace**: This model will contain the information on the instances of the *Marketplace GE* in which the instance of the *Store GE* has been registered for the purpose of providers selecting the *Marketplace GE* in which their offering is to be published.
  - Name: This attribute will contain the name that the administrator responsible for having registered the instance of the *Store GE* gives to the instance of the *Marketplace GE*.
  - Host: This attribute will contain the *Endpoint* of the instance of the *Marketplace GE* in which the instance of the *Store GE* has been registered.
- **Repository**: This model will contain information on instances of the *Repository GE* that have been registered in the instance of the *Store GE* for the purpose of selecting which instances of the *Repository GE* are to store the *USDL* documents that describe the service.
  - Name: This attribute will contain the name that the administrator responsible for having registered the instance of the *Repository GE* gives to this instance.
  - Host: This attribute will contain the *Endpoint* of the instance of the *Repository GE* registered in the instance of the *Store GE*.
- **Comment**: This model will contain information on comments made by users about different offerings.
  - Comment: This attribute will contain the comment made by the user about the offering.
  - Date: This attribute will contain the date on which the comment was made.
  - Rating value: This attribute will contain the score assigned to the offering by the user.

21.6.2 Offering Life Cycle

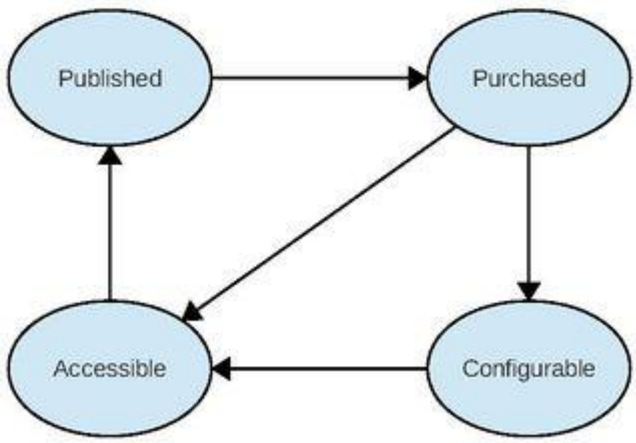
In order to specify all the different offering states in the Store GE, it is necessary to show the life cycle of an offering from two different viewpoints: the offering provider and the offering consumer.



Offering life cycle from provider viewpoint

The figure above shows all the possible offering states from the viewpoint of the provider. First, the service provider creates the offering, whose state will be Uploaded. An Uploaded offering is still not up for sale, and is visible only to the user who created it, so the provider can register any number of resources in the Store GE without having to modify an offering that might have been purchased. The information associated with the Uploaded offering is editable, and the USDL document that defines the information about it can be modified. The offering moves to the Bound state when resources are linked to an offering. The offering will be Bound for as long as it is not put up for sale and it is linked with resources. If all the resources of the offering are unlinked, it will return to the Uploaded state. When the provider decides to put the offering up for sale, it moves to the Published state. This is when the Store GE registers the offering in the Marketplace GE specified by the provider. Note that a Published offering is no longer editable, nor is it possible to modify the information of the USDL document, or link or unlink resources. If the service provider wishes to modify information about a Published offering, a new offering has to be created. This means that there might be multiple offerings linked to a given service, both in parallel and over time (in this latter case working like versioning). Finally, the service provider can delete the offering at any time. However, this action will have different effects depending on the state of the offering. If the offering has not yet been put up for sale, that is, it is Uploaded or Bound, the offering is simply removed from the Store GE as it is available to the provider only. If the offering state is Published, it moves to the Deleted state and is no longer visible to future buyers. Note that any buyers that have already purchased the offering would still have access to its resources.

The figure below this paragraph shows all the possible offering states from the viewpoint of the consumer. Published is the first state of an offering from the viewpoint of a consumer. In this state, consumers can view all the information associated with the offering, which they use to decide whether or not to purchase it. An offering that a consumer decides to purchase moves to the Purchased state. This state indicates that the consumer has purchased the offering. If the purchased service requires configuration before use, the consumer will have the option of deciding when to do the configuration. This will move the offering to the Configurable state. Offerings of services that do not require configuration will move directly to the Accessible state. An offering will likewise move to this state after configuration. In the Accessible state, the purchasing process is complete, and the consumer can access or download the resources associated with the offering depending on the type of service that is being offered. Finally, a service that consumers no longer require, for example, a subscription service to which they no longer want to subscribe, will return to the Published state and can be repurchased by a consumer.



Offering life cycle from consumer viewpoint

21.6.3 Charging

The Store GE is responsible for charging customers depending on the pricing model defined in the USDL document that describes the offering. The Store GE supports charging based on three main pricing models:

- *Single payment*: Defines a charge that is made once. In this case the Store GE charges the customer at the time of purchasing
- *Subscription*: Defines a periodic charge. In this case the Store GE makes the first charge at the time of purchasing and then waits for an explicit renewal.

- *Pay-per-use*: Defines a charge that depends on the use that the customer makes of the offered service. In this case the Store GE does not charge the customer at purchasing time, but receives service usage information from an external accounting component included in an SDR document (described below). It is necessary to take into account that different types of pay-per-use models exists. The Store GE supports pay-per-use based on events (i.e. invocations, sessions, etc.), pay-per-use based on time (i.e. seconds, minutes, etc.), and pay-per-use based on quantity (i.e. Megabytes, CPU instructions, etc.).

These pricing models can be arbitrarily combined in the USDL document (as price components) to create complex pricing models. Moreover, pay-per-use models can be specified as price functions that depend on more than one usage parameter. It is also possible to include usage-based discounts using the syntax defined in the Linked USDL specification.

21.6.3.1 *Service detailed record*

The *Service Detailed Record* (SDR) contains information related to the use that the customer has made of a concrete service offered in a purchased service offering. The SDR documents are sent to the Store GE, using the provided push-oriented API, by an external accounting component every time the service is used in order to allow the customer to know the consumption done so far. This document is used by the Store GE to calculate the amount to be charged in pay-per-use models. The SDR contains the following fields:

- *Offering identification*: This field must include the needed information to identify the offering that offers the service in use. That includes the organization that owns the offerings, the offering name and the offering version.
- *Customer*: The user that is going to be charged.
- *TimeStamp*: Date and time in the moment of sending.
- *VariableLabel*: Identifier of the usage variable or price component included in the USDL document.
- *Correlation number*: Sequence number.
- *RecordType*: Type of pay-per-use that has been monitored (i.e. event, time, and quantity).
- *Unit*: Unit of the included value (i.e. seconds in a pay-per-use time or Megabytes in a pay-per-use quantity).
- *Value*: Use that has been made of the service (i.e. number of seconds, number of invocations, etc.).
- *Additional info*: Any info that the accounting component wants to include.

21.6.4 Example Scenarios

This section describes the operation of the Store GE from the viewpoint of users, without taking into account the interactions between different Generic Enablers. To do this, we propose some specific use cases that refer to prospective real interactions of Store GE users from both the Store GE web portal and from other Generic Enablers that use the Store GE RESTful API.

21.6.4.1 *Creating and publishing offerings*

This use case describes the process that service providers would enact from when they decide to put a new service up for sale until the service is published in the Marketplace GE instance. To illustrate how the Store GE can be combined with other FI-WARE GEs and illustrate the concept of downloadable resources associated to an offering, we will define a use case where the user playing the Provider role has created a new Mashup using the Application Mashup GE. In this case, the offering to be published will have a set of downloadable resources linked to the different Widgets linked to the mashup. Additionally, the Store GE will be accessed from the Web portal provided by the Application Mashup GE.

First, the user will compose the Mashup using the tools provided by the Application Mashup GE. The user will then create a USDL document describing all the relevant information about the service that he or she is going to put up for sale, including basic service information (name, date last modified, etc.), pricing information, terms and conditions of use and service-level information. The user can then create the offering attaching images related to the service such as diagrams or screenshots of the mashup in action, as well as a service icon. Note that at this point the offering has been created but is still not up for sale and is only visible to its creator. The next step will be to register the created resource (Mashup code) within the Store GE. During this step, the provider can either offer a URL from which this resource can be downloaded or upload the resource directly to the Store GE specifying that it is a downloadable resource. The next step will be to link the offering and the resource, thereby identifying the specific code that is being offered. Finally, the user will put the offering up for sale, specifying the instances of the Marketplace GE in which the offering is to be published.

21.6.4.2 *Searching and purchasing offerings*

This use case describes the process that a user playing the Customer role would enact as of when he or she searches offerings via the web portal provided by the Store GE to when he or she purchases an offering. In this use case, the user is assumed to be using the Store GE web portal to purchase an offering that requires an initial subscription payment. Additionally, the user is assumed to have rights to purchase offerings for his or her entire organization.

First the user will login to the FIWARE platform. This will identify the user, as well as the organization of which he or she is a member, within the Store GE. The logged in user will access the Store GE web portal and select the advanced search option. This way, he or she will be able to filter the search by the type of resources associated with the offering. The search will return a series of offerings that meet the requested parameters, and the user will select the one that best satisfies his or her needs and preferences. When the user has decided which offering to purchase, he or she will select the option to purchase the offering for the entire organization. The Store GE will then request the information necessary to make the payment (account number, card number, PayPal account, etc.). After payment confirmation, the Store GE will download the transaction invoice and reroute the user to the service provider to get access credentials from the provider. When this process is complete, this offering and its associated resources will be part of the offerings owned by all the users of the organization from where they will be able to download the invoice and get access credentials.

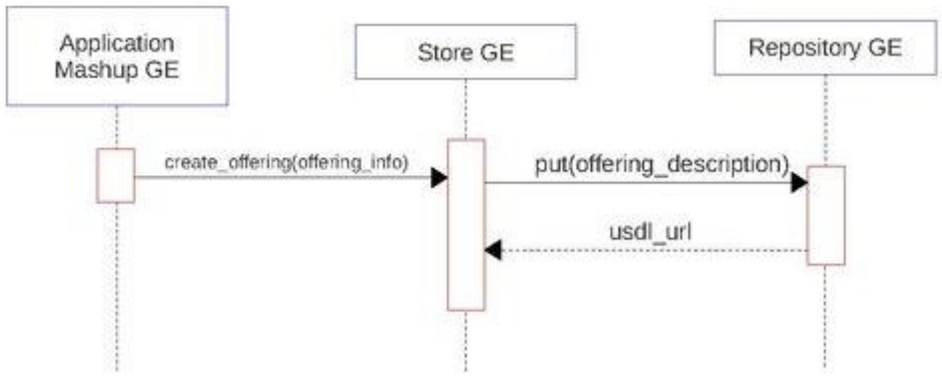
21.7 Main Interactions

21.7.1 Interaction diagrams

This section details the main interactions among the different Generic Enablers and Store GE in order to illustrate how the Store GE fits into the existing FIWARE platform architecture and the main functionality that it provides for other Generic Enablers.

21.7.1.1 *Creating an offering*

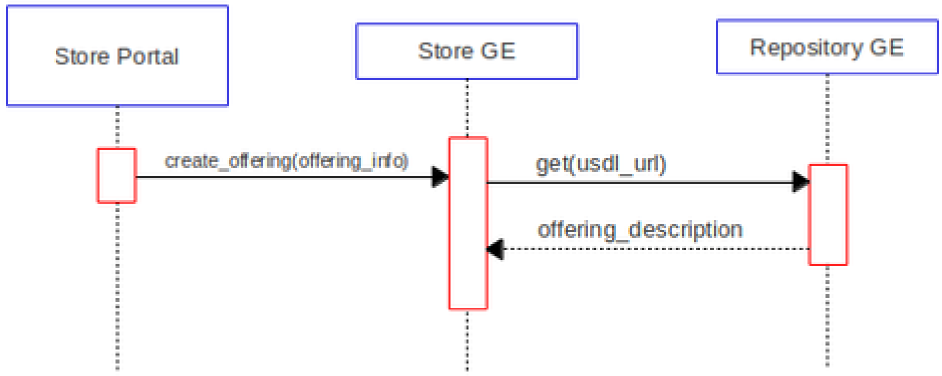
The next figure shows the interactions required to create a new offering within the Store GE. In this diagram, the Application Mashup GE is assumed to be a client.



Creating an offering

It shows how just one request is required to create a new offering. This request provides the offering information, which will be composed of the USDL description of the offering, as well as a series of images related to the offering and the offering icon. The Store GE receives the request to create the new offering and then requests the Repository GE to store the USDL document, getting a URL that points to the resource and will be used later to access this document and register the offering in the Marketplace GE.

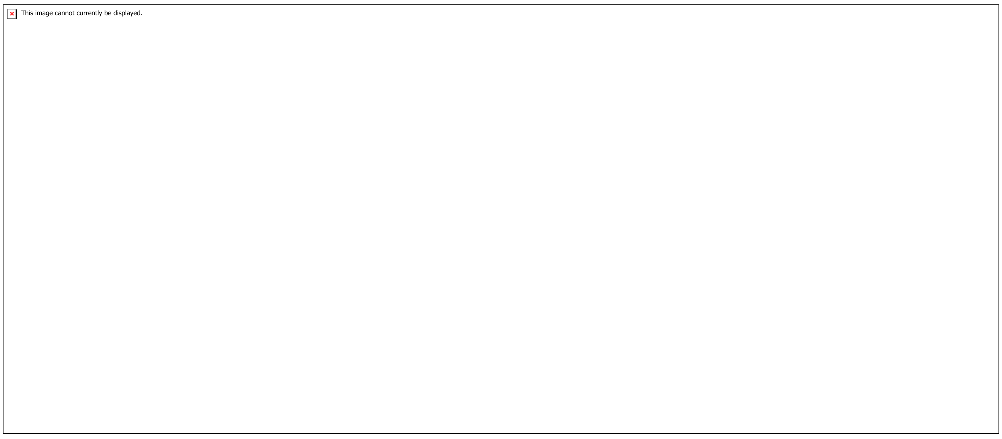
It is also possible to create an offering whose USDL description has been previously uploaded to the Repository GE by the service provider. In that case, the request contains the URL to the USDL description that is used by the Store GE to obtain the offering information. These interactions are shown in the following diagram:



Creating an offering using USDL URL

21.7.1.2 *Adding and linking a resource*

The figure below shows the interactions required to register and link a new resource. In this diagram, the user is assumed to be using the Store GE web portal.

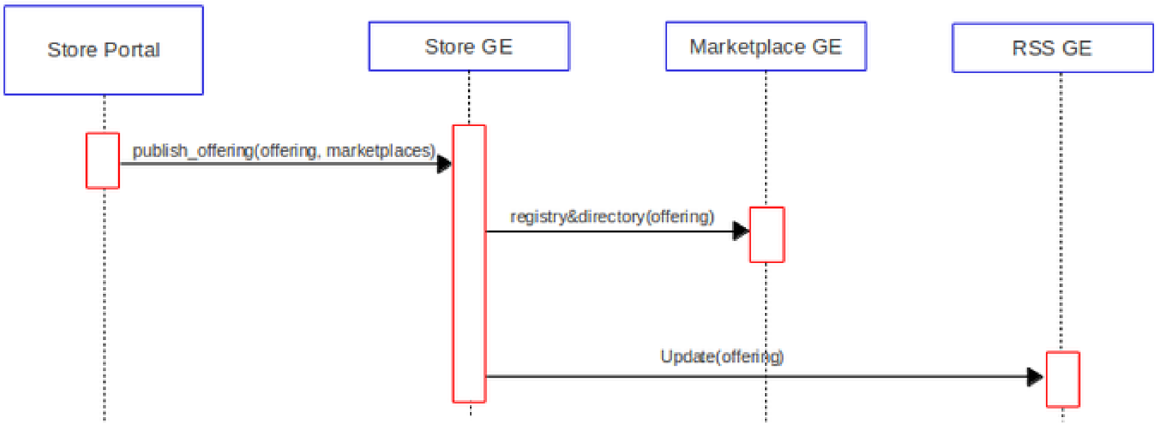


Registering and linking a resource

It illustrates that registering and linking a resource to an offering are simple operations composed of a single request. The request to create the resource will include the resource name, version description, resource type and resource access information, which could be an Endpoint for an API access resource, or a download link or the actual resource for a downloadable resource. On the other hand, the request to link the resource to an offering will include first the information identifying the resource, that is, the provider name, the resource name and the resource version and second the information identifying the offering, that is, the organization to which it belongs, the offering name and the offering version.

21.7.1.3 *Publishing an offering*

The figure below shows the interactions required to publish an offering that has been created in the Store GE in an instance of a Marketplace GE. In this diagram, the user is assumed to be using the Store GE web portal.

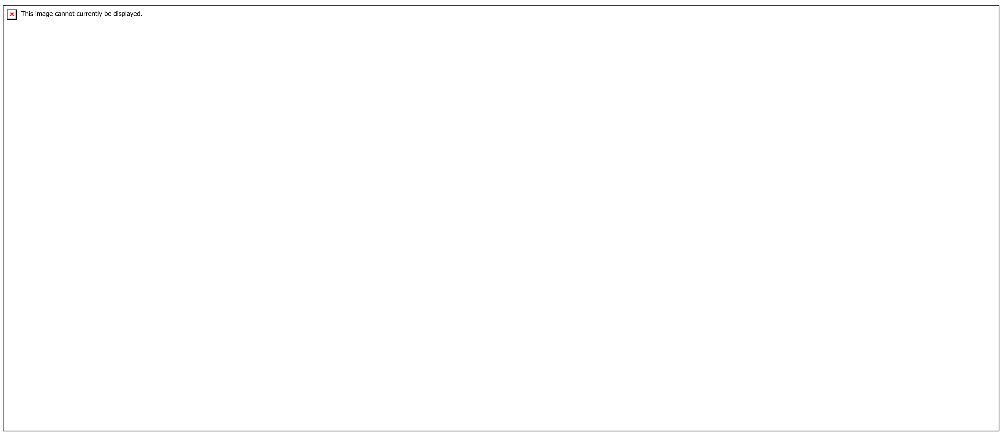


Publishing an offering

It shows how an offering is published using a Store GE request. This request will contain first the information required to identify the offering, that is, the organization to which it belongs, its name and its version. It will also contain a list of instances of the Marketplace GE in which the offering is to be published. These instances will be identified by the name that they were given by the administrator when he or she registered the instance of the Store GE. The Store GE receives the request to publish the offering and contacts the Marketplace GE Registry & Directory service, which will contain the offering name and the URL of its USDL description stored in an instance of the Repository GE. Finally, the Store GE notifies the RSS that a new offering has been published. The notification includes the URL of its USDL description, which is used by the RSS GE to retrieve the Revenue Sharing model.

21.7.1.4 *Removing an offering*

The figure below shows the interactions required to remove an offering created in the Store GE and published in a Marketplace GE. The user is assumed to be using the Store GE web portal.

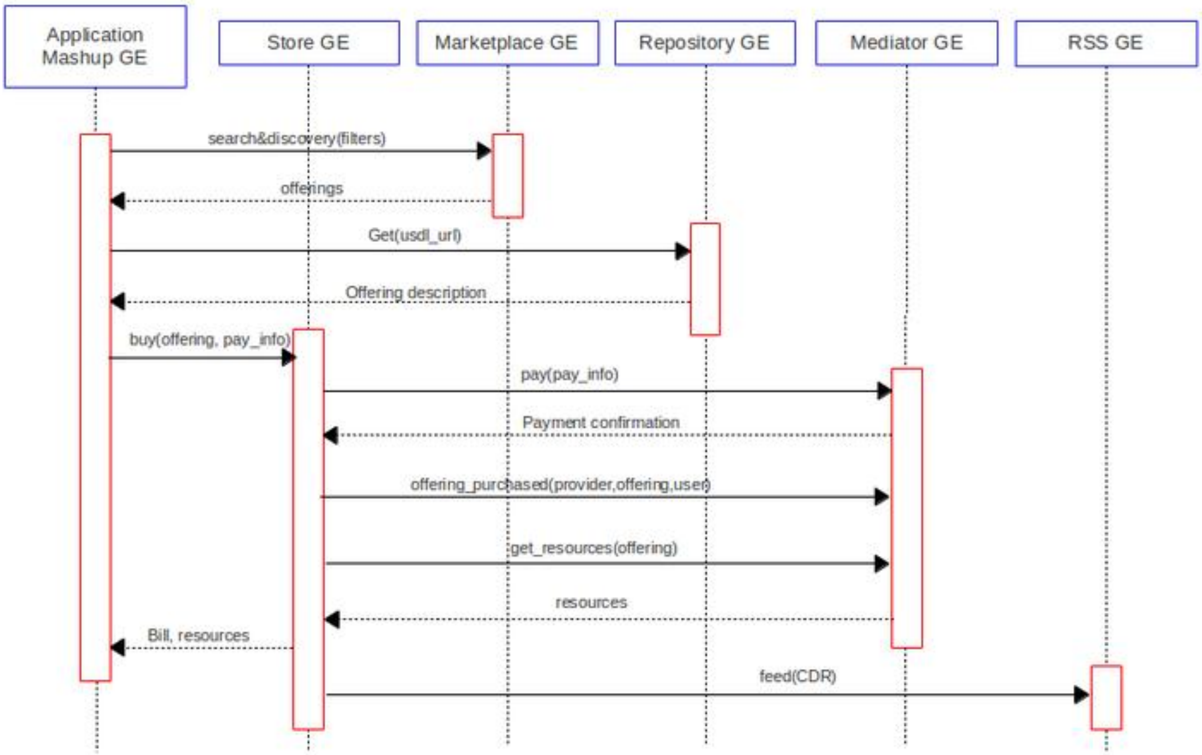


Removing an offering

It shows how an offering is removed by means of a Store GE request. This request will contain the information required to identify the offering, that is, the organization to which it belongs, its name and its version. The Store GE receives the request to remove the offering and will first contact the instances of the Marketplace GE publishing the offering, instructing them to remove the offering. The offerings are identified in the Marketplace GE by their name only, and this will be the only information that these requests contain. After the offering has been removed from the instances of the Marketplace GE, the Store GE will contact the different instances of the Repository GE (using the URL contained in the USDL document) to remove this description.

21.7.1.5 *Searching the Marketplace GE and purchasing an offering*

The figure below shows the interactions that take place when searching the Marketplace GE for offerings and purchasing an offering. These interactions consider that the offering is based on a series of downloadable resources registered in the Store GE and a price plan based on single payments. In the diagram, the search and purchase operations are assumed to be performed from the Application Mashup GE.

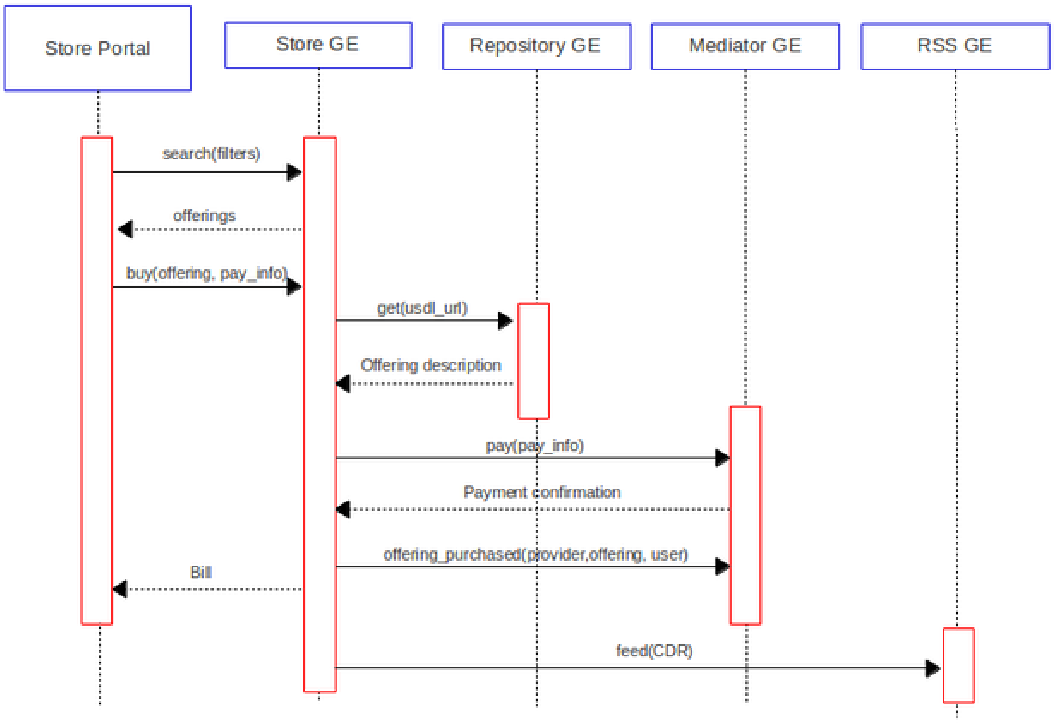


Searching the Marketplace GE and purchasing an offering

It shows how the Application Mashup GE sends a request to the Marketplace GE Search & Discovery service, which contains a series of filters to constrain the search. The Marketplace GE will return the available information on a series of offerings, namely the offering name and the URL of the USDL descriptions. The Application Mashup GE will then use the information returned by the search operation to download and visualize the USDL descriptions of the offerings, enabling the user to select an offering. When the user has decided which offering to purchase, the Application Mashup GE sends a request to the Store GE containing the information identifying the offering, that is, the URL of its description (the information available in the Marketplace GE), and the payment information (account number, card number, PayPal account, etc.). The Store GE receives the purchase request and immediately contacts the respective payment gateway via the Mediator GE, dealing with the payment. The Store GE receives the payment confirmation and contacts and notifies the service provider of the purchase. It uses the resource download links to get the resources. Note that these two interactions will be carried out via the Mediator GE. Then, the Store GE sends the purchase invoice, along with the associated resources, to the Application Mashup GE. Finally, the Store GE feeds the RSS GE with a CDR document containing the payment information (see RSS Open Spec). This information is used by the RSS to compute the Revenue Sharing.

21.7.1.6 *Searching the Store GE and purchasing an offering*

The figure below shows the interactions that take place when searching the Store GE for an offering with subscription resources and purchasing the offering. The scenario assumes that the offering is based on a series of services (there is no need to download components, as they are accessible via API). In this diagram, the user is assumed to be using the Store GE web portal.

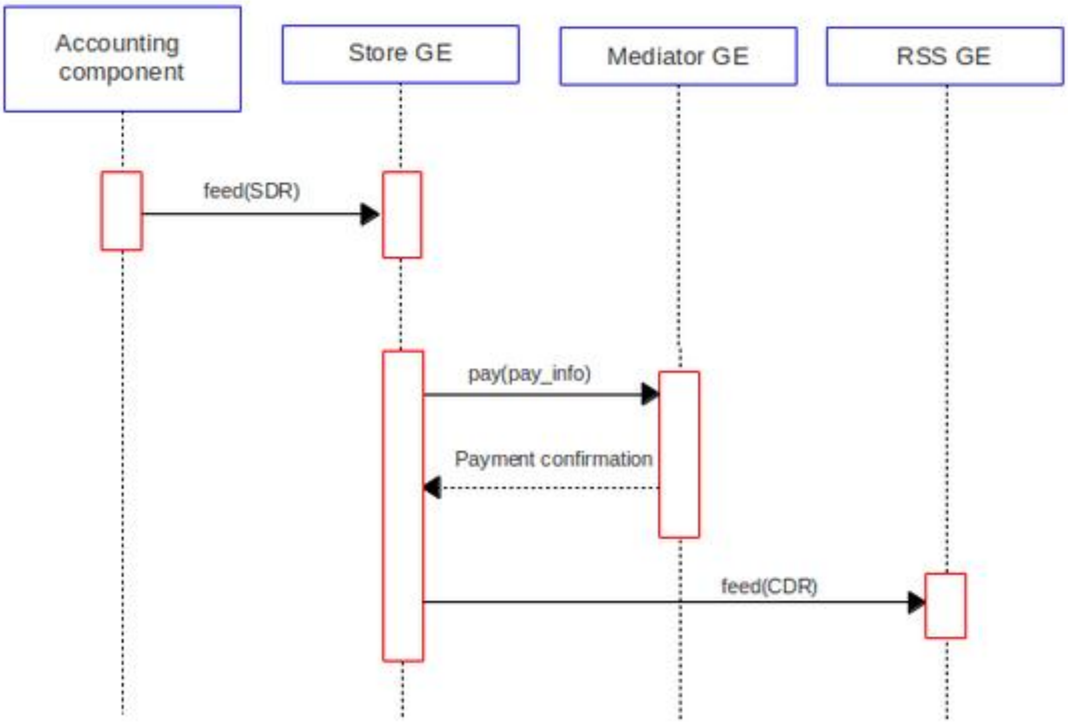


Searching the Store GE and purchasing an offering

It shows how to send a Store GE search request, passing a series of parameters to constrain the search. In response, the Store GE will return a list of offerings that satisfy the searching criteria. When the user decides to purchase an offering, a purchase request will be sent to the Store GE including the information necessary to identify the offering, that is, the organization, name and version, and the necessary payment information (account number, card number, PayPal account, etc.). The Store GE receives the purchase request and contacts the Repository GE using the URL of the description of the selected offering to download the USDL document and check the information on offering pricing. Then, the Store GE will bill the customer by contacting the respective customer payment gateway via the Mediator GE, using the previously accessed pricing information. The Store GE receives customer payment confirmation and contacts and notifies the service provider that a user or organization now has acquired access to use the application or service APIs associated to the offering resources. Then, the Store GE will send the purchase invoice. Finally, the Store GE feeds the RSS GE with a CDR document containing the payment information.

21.7.1.7 *Feeding the Store GE with accounting information*

The figure below shows the interactions that take place when feeding the Store GE with accounting information related to the use of a service whose offering implied a pay-per-use pricing model. This figure shows also the interactions that would take place periodically to charge the customer. It is assumed that the accounting information is provided by an accounting component, which can be any component in charge of monitoring the use of services.



Feeding the Store GE with accounting info

It shows how the Accounting component feeds the Store GE with a SDR document. This SDR document contains the accounting information for an offering. When the SDR is received, the Store GE calculates the charge associated with that document and stores the generated info. Periodically, the Store GE aggregates the charging info and computes the total amount to be charged to a customer. Then, the Store GE bills the customer by contacting the respective customer payment gateway via the Mediator GE. For making this payment, the Store GE uses the billing information contained in the customer profile. The Store GE receives the billing confirmation and feeds the RSS with a CDR document containing the aforementioned billing information, which will be taken into account for payment of providers.

21.8 Basic Design Principles

- **API Technology Independence**

  The API abstracts from the specific implementation technology. Implementations using more than one type of platform and framework should be possible.

- **Web Browsers should not limit the functionalities of the Store GE**

  HTML5, CSS and JavaScript must be used to fully exploit the brand new Web applications capabilities.

21.9 Detailed Specifications

21.9.1 Open API Specifications

The Store GE offers the following RESTFul API:

- Store Open API RESTful Specification

The Store GE will access the Repository, Marketplace and RSS via their RESTful APIs:

- Repository Open RESTful API Specification
- FIWARE.OpenSpecification.Apps.MarketplaceRegistrationREST
- FIWARE.OpenSpecification.Apps.MarketplaceOfferingsREST
- FIWARE.OpenSpecification.Apps.MarketplaceSearchREST
- RSS GE Open RESTful API Specification

21.9.2 Other Open Specifications

The Store GE will use information from the Repository and the Marketplace using the Linked USDL specifications:

- Linked USDL Core Vocabulary
- Linked USDL Pricing Vocabulary
- Linked USDL Service Level Agreements Vocabulary
- Linked USDL Security Vocabulary

- **Aggregator (Role):** A Role that supports domain specialists and third-parties in aggregating services and apps for new and unforeseen opportunities and needs. It does so by providing the dedicated tooling for aggregating services at different levels: UI, service operation, business process or business object levels.
- **Application:** Applications in FI-WARE are composite services that have a IT supported interaction interface (user interface). In most cases consumers do not buy the application, instead they buy the right to use the application (user license).

- **Broker (Role):** The business network's central point of service access, being used to expose services from providers that are delivered through the Broker's service delivery functionality. The broker is the central instance for enabling monetization.
- **Business Element:** Core element of a business model, such as pricing models, revenue sharing models, promotions, SLAs, etc.
- **Business Framework:** Set of concepts and assets responsible for supporting the implementation of innovative business models in a flexible way.
- **Business Model:** Strategy and approach that defines how a particular service/application is supposed to generate revenue and profit. Therefore, a Business Model can be implemented as a set of business elements which can be combined and customized in a flexible way and in accordance to business and market requirements and other characteristics.
- **Business Process:** Set of related and structured activities producing a specific service or product, thereby achieving one or more business objectives. An operational business process clearly defines the roles and tasks of all involved parties inside an organization to achieve one specific goal.
- **Business Role:** Set of responsibilities and tasks that can be assigned to concrete business role owners, such as a human being or a software component.
- **Channel:** Resources through which services are accessed by end users. Examples for well-known channels are Web sites/portals, web-based brokers (like iTunes, eBay and Amazon), social networks (like Facebook, LinkedIn and MySpace), mobile channels (Android, iOS) and work centers. The access mode to these channels is governed by technical channels like the Web, mobile devices and voice response, where each of these channels requires its own specific workflow.
- **Channel Maker (Role):** Supports parties in creating outlets (the Channels) through which services are consumed, i.e. Web sites, social networks or mobile platforms. The Channel Maker interacts with the Broker for discovery of services during the process of creating or updating channel specifications as well as for storing channel specifications and channeled service constraints in the Broker.
- **Composite Service (composition):** Executable composition of business back-end MACs (see MAC definition later in this list). Common composite services are either orchestrated or choreographed. Orchestrated compositions are defined by a centralized control flow managed by a unique process that orchestrates all the interactions (according to the control flow) between the external services that participate in the composition. Choreographed compositions do not have a centralized process, thus the services participating in the composition autonomously coordinate each other according to some specified coordination rules. Backend compositions are executed in dedicated process execution engines. Target users of tools for creating Composites Services are technical users with algorithmic and process management skills.
- **Consumer (Role):** Actor who searches for and consumes particular business functionality exposed on the Web as a service/application that satisfies her own needs.
- **Desktop Environment:** Multi-channel client platform enabling users to access and use their applications and services.
- **Event-driven Composition:** Components concerned with the composition of

business logic, which is driven by asynchronous events. This implies run-time selection of MACs and the creation/modification of orchestration workflows based on composition logic defined at design-time and adapted to context and the state of the communication at run-time.

- **Front-end/Back-end Composition:** Front-end compositions define a front-end application as an aggregation of visual mashable application pieces (named as widgets, gadgets, portlets, etc.) and back-end services. Front-end compositions interact with end-users, in the sense that front-end compositions consume data provided by the end-users and provide data to them. Thus the front-end composition (or mashup) will have a direct influence on the application look and feel; every component will add a new user interaction feature. Back-end compositions define a back-end business service (also known as process) as an aggregation of backend services as defined for service composition term, the end-user being oblivious to the composition process. While back-end components represent atomization of business logic and information processing, front-end components represent atomization of information presentation and user interaction.
- **Gateway (Role):** The Gateway role enables linking between separate systems and services, allowing them to exchange information in a controlled way despite different technologies and authoritative realms. A Gateway provides interoperability solutions for other applications, including data mapping as well as run-time data store-forward and message translation. Gateway services are advertised through the Broker, allowing providers and aggregators to search for candidate gateway services for interface adaptation to particular message standards. The Mediation is the central generic enabler. Other important functionalities are eventing, dispatching, security, connectors and integration adaptors, configuration, and change propagation.
- **Hoster (Role):** Allows the various infrastructure services in cloud environments to be leveraged as part of provisioning an application in a business network. A service can be deployed onto a specific cloud using the Hoster's interface. This enables service providers to re-host services and applications from their on-premise environments to cloud-based, on-demand environments to attract new users at much lower cost.
- **Marketplace:** Part of the business framework providing means for service providers, to publish their service offerings, and means for service consumers, to compare and select a specific service implementation. A marketplace can offer services from different stores and thus different service providers. The actual buying of a specific service is handled by the related service store.
- **Mashup:** Executable composition of front-end MACs. There are several kinds of mashups, depending on the technique of composition (spatial rearrangement, wiring, piping, etc.) and the MACs used. They are called application mashups when applications are composed to build new applications and services/data mash-ups if services are composed to generate new services. While composite service is a common term in backend services implementing business processes, the term 'mashup' is widely adopted when referring to Web resources (data, services and applications). Front-end compositions heavily depend on the available device environment (including the chosen presentation channels). Target users of mashup platforms are typically users without technical or programming expertise.
- **Mashable Application Component (MAC):** Functional entity able to be consumed

executed or combined. Usually this applies to components that will offer not only their main behaviour but also the necessary functionality to allow further compositions with other components. It is envisioned that MACs will offer access, through applications and/or services, to any available FI-WARE resource or functionality, including gadgets, services, data sources, content, and things. Alternatively, it can be denoted as ‘service component’ or ‘application component’.

- **Mediator:** A mediator can facilitate proper communication and interaction amongst components whenever a composed service or application is utilized. There are three major mediation area: Data Mediation (adapting syntactic and/or semantic data formats), Protocol Mediation (adapting the communication protocol), and Process Mediation (adapting the process implementing the business logic of a composed service).
- **Monetization:** Process or activity to provide a product (in this context: a service) in exchange for money. The Provider publishes certain functionality and makes it available through the Broker. The service access by the Consumer is being accounted, according to the underlying business model, and the resulting revenue is shared across the involved service providers.
- **Premise (Role):** On-Premise operators provide in-house or on-site solutions, which are used within a company (such as ERP) or are offered to business partners under specific terms and conditions. These systems and services are to be regarded as external and legacy to the FI-Ware platform, because they do not conform to the architecture and API specifications of FI-WARE. They will only be accessible to FI-WARE services and applications through the Gateway.
- **Prosumer:** A user role able to produce, share and consume their own products and modify/adapt products made by others.
- **Provider (Role):** Actor who publishes and offers (provides) certain business functionality on the Web through a service/application endpoint. This role also takes care of maintaining this business functionality.
- **Registry and Repository:** Generic enablers that able to store models and configuration information along with all the necessary meta-information to enable searching, social search, recommendation and browsing, so end users as well as services are able to easily find what they need.
- **Revenue Settlement:** Process of transferring the actual charges for specific service consumption from the consumer to the service provider.
- **Revenue Sharing:** Process of splitting the charges of particular service consumption between the parties providing the specific service (composition) according to a specified revenue sharing model.
- **Service:** We use the term service in a very general sense. A service is a means of delivering value to customers by facilitating outcomes customers want to achieve without the ownership of specific costs and risks. Services could be supported by IT. In this case we say that the interaction with the service provider is through a technical interface (for instance a mobile app user interface or a Web service). Applications could be seen as such IT supported Services that often are also composite services.
- **Service Composition:** in SOA domain, a service composition is an added value service created by aggregation of existing third party services, according to some predefined work and data flow. Aggregated services provide specialized business

functionality, on which the service composition functionality has been split down.

- **Service Delivery Framework:** Service Delivery Framework (or Service Delivery Platform (SDP)) refers to a set of components that provide service delivery functionality (such as service creation, session control & protocols) for a type of service. In the context of FI-WARE, it is defined as a set of functional building blocks and tools to (1) manage the lifecycle of software services, (2) creating new services by creating service compositions and mashups, (3) providing means for publishing services through different channels on different platforms, (4) offering marketplaces and stores for monetizing available services and (5) sharing the service revenues between the involved service providers.
- **Service Level Agreement (SLA):** A service level agreement is a legally binding and formally defined service contract, between a service provider and a service consumer, specifying the contracted qualitative aspects of a specific service (e.g. performance, security, privacy, availability or redundancy). In other words, SLAs not only specify that the provider will just deliver some service, but that this service will also be delivered on time, at a given price, and with money back if the pledge is broken.
- **Service Orchestration:** in SOA domain, a service orchestration is a particular architectural choice for service composition where a central orchestrated process manages the service composition work and data flow invocations of the external third party services in the order determined by the work flow. Service orchestrations are specified by suitable orchestration languages and deployed in execution engines who interpret these specifications.
- **Store:** An external component integrated with the business framework, offering a set of services that are published to a selected set of marketplaces. The store thereby holds the service portfolio of a specific service provider. In case a specific service is purchased on a service marketplace, the service store handles the actual buying of a specific service (as a financial business transaction).
- **Unified Service Description Language (USDL):** USDL is a platform-neutral language for describing services, covering a variety of service types, such as purely human services, transactional services, informational services, software components, digital media, platform services and infrastructure services. The core set of language modules offers the specification of functional and technical service properties, legal and financial aspects, service levels, interaction information and corresponding participants. USDL is offering extension points for the derivation of domain-specific service description languages by extending or changing the available language modules.

22 FIWARE OpenSpecification Apps Store REST

You can find the content of this chapter as well in the wiki of fi-ware.

22.1 Introduction to the *Store* API

Please check the following **FI-WARE Open Specification Legal Notice (implicit patents license)** to understand the rights to use this open specification.
UPM strives to make the specifications of this Generic Enabler available under IPR rules that allow for a exploitation and sustainable usage both in Open Source as well as proprietary, closed source products to maximize adoption.
This Open Specification is exploitable for proprietary 3rd party products and is exploitable for open source 3rd party products. This GE specification should be implementable without requiring patent pledges. However, the Copyright Holder of this spec (UPM) is not responsible for identifying patents for which a license may be required for any implementation of this specification.

22.1.1 Store API Core

The Store API is a RESTful, resource-oriented API accessed via HTTP that uses various representations for information interchange. The Store Enabler is used to the manage of service offers and is responsible for supporting the purchasing process.

22.1.2 Intended Audience

This specification is intended for both software developers and implementers of the FI-WARE Business Framework. For the former, this document provides a full specification of how to interoperate with products that implement the Store API. For the latter, this specification indicates the interface to be implemented and provided to clients. Software developers intending to build applications on top of FI-WARE Enablers will implement a client of the interface specification. Implementers of the GE will implement a service of the interface specification.
To use this information the reader should firstly have a general understanding of the Generic Enabler service Store. You should also be familiar with:

- RESTful web services
- HTTP/1.1
- JSON and/or XML data serialization formats.
- RDF and TURTLE

22.1.3 API Change History

This version of the Store API Guide replaces and obsoletes all previous versions. The most recent changes are described in the table below:

Revision Date	Changes Summary
Feb 06, 2014	• Revised version

Jun 28, 2013	• Revised version
Jan 16, 2013	• Initial version

22.1.4 How to Read This Document

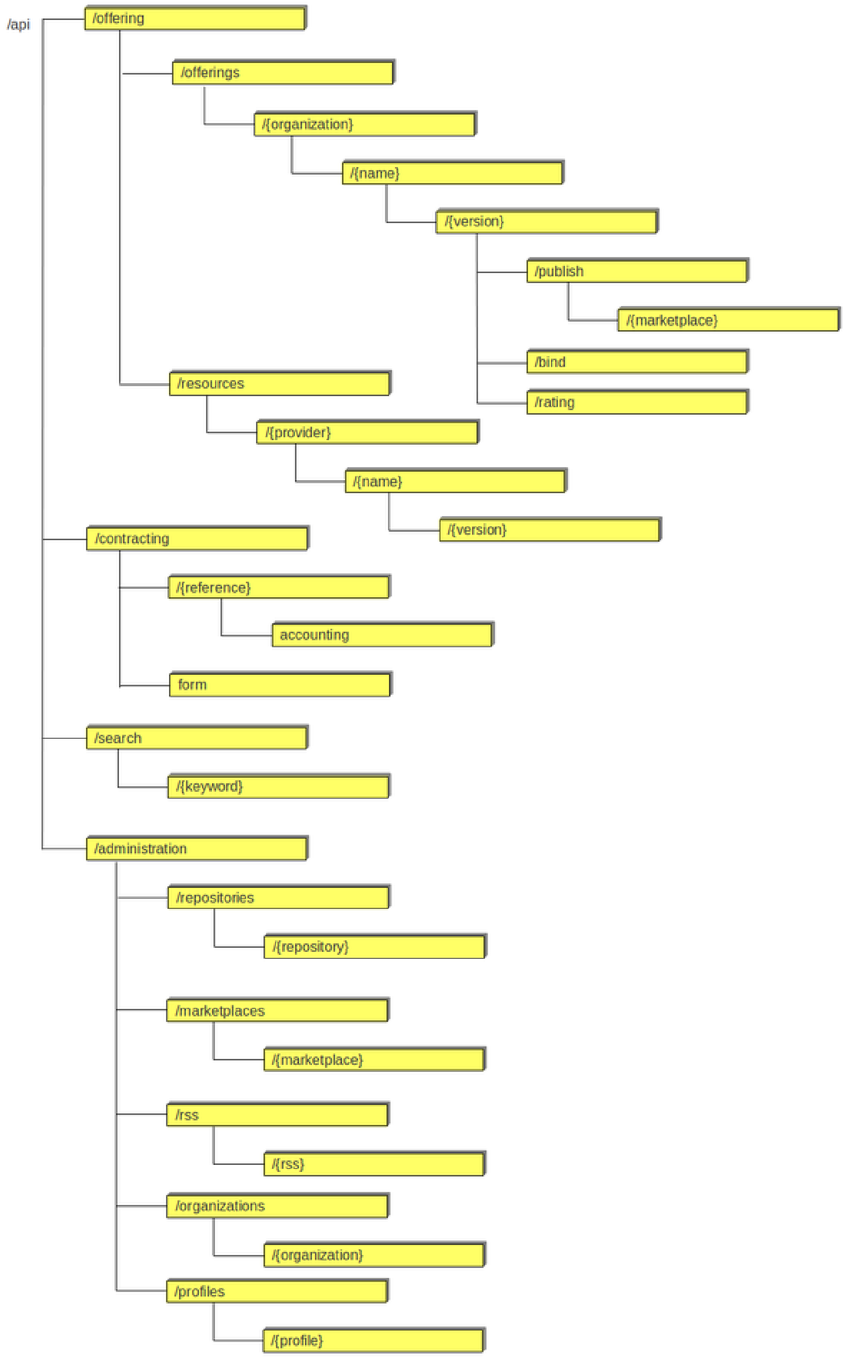
It is assumed that the reader is familiar with the REST architecture style. Within the document, some special notations are applied to differentiate some special words or concepts. The following list summarizes these special notations.

- A bold, mono-spaced font is used to represent code or logical entities, e.g., HTTP method (`GET, PUT, POST, DELETE`).
- An italic font is used to represent document titles or some other kind of special text, e.g.,*URI*.
- Variables are represented between brackets, e.g. {id} and in italic font. The reader can replace the id with an appropriate value.

For a description of some terms used along this document, see Store.

22.2 General *Store* API Information

22.2.1 Resources Summary



22.2.2 Authentication

Each HTTP request against the *Store API* requires the inclusion of specific authentication credentials. The specific implementation of this API may support multiple authentication schemes (OAuth, Basic Auth, Token) and will be determined by the specific provider that implements the GE. Please contact with it to determine the best way to authenticate against this API. Remember that some authentication schemes may require that the API operate using SSL over HTTP (HTTPS).

22.2.3 Representation Format

The *Store API* supports at least JSON for delivering any kind of resources, it may also support simple text, XML and HTML output format. The request format is specified using the Content-Type header and is required for operations that have a request body. The response format can be specified in requests using the Accept header. Note that it is possible for a response to be serialized using a format different from the request.

The interfaces should support data exchange through multiple formats:

- *text/html* - An human-readable HTML rendering of the results of the operation as output format.
- *application/json* - A JSON representation of the input and output.
- *application/xml* - A XML description of the input and output.
- *application/x-www-form-urlencoded* - May be used for submitting using HTML forms.
- *multipart/form-data* - Should be used for submitting HTML forms containing files.

22.2.4 Representation Transport

Resource representation is transmitted between client and server by using HTTP 1.1 protocol, as defined by IETF RFC-2616. Each time an HTTP request contains payload, a Content-Type header shall be used to specify the MIME type of wrapped representation. In addition, both client and server may use as many HTTP headers as they consider necessary.

22.2.5 Resource Identification

The resource identification for HTTP transport is made using the mechanisms described by HTTP protocol specification as defined by IETF RFC-2616.

22.2.6 Links and References

The *Store API* is relying on Web principles:

- consistent URI structure based on REST style protocol
- HTTP content negotiation to allow the client to choose the appropriate data format supporting XML, JSON, ...

22.2.7 Limits

The capacity of the system can be managed in order to prevent the abuse of the system through some limitations. These limitations will be configured by the operator and may differ from one implementation to other of the GE implementation.

22.2.7.1 *Rate Limits*

These limits are specified both in human readable wild-card and in regular expressions and will indicate for each HTTP verb which will be the maximum number of operations per time unit that a user can request. After each unit time the counter is initialized again.
In the event a request exceeds the thresholds established for your account, a 413 HTTP response will be returned with a Retry-After header to notify the client when they can attempt to try again.

22.2.8 Faults

22.2.8.1 *Synchronous Faults*

Error responses will be encoded using the most appropriated content-type in base to the Accept header of the request. In any case, the response will provide an human-readable message for displaying to end users.
XML Example:

```
<error>Offering already exists</error>
```

JSON Example:

```
{
    "error": "Offering already exists"
}
```

Fault Element	Associated Error Codes	Expected in All Requests?
Bad Request	400	YES
Forbidden	403	YES
Not Found	404	YES
Request Entity Too Large	413	YES
Internal Server error	50X	YES

22.3 API Operations

22.3.1 Managing Repositories

Here we start with the description of the operation following the next table:

Verb	URI	Description	Mandatory/Optional

GET	/api/administration/repositories	Gets a list of all registered repositories	Mandatory
POST	/api/administration/repositories	Registers a repository	Mandatory
GET	/api/administration/repositories/{repository}	Gets repository info	Mandatory
DELETE	/api/administration/repositories/{repository}	Unregisters a repository	Mandatory
PUT	/api/administration/repositories/{repository}	Updates repository info	Mandatory

22.3.1.1 *Getting repositories*

Example request

```
GET /api/administration/repositories HTTP/1.1
Accept: application/json
```

Example response

```
HTTP/1.1 200 OK
Content-Type: application/json
Vary: Cookie

{
   [
        "name": "Example_repository",
        "host": "http://examplerepository.com"
   ]
}
```

22.3.1.2 *Registering repositories*

Example request

```
POST /api/administration/repositories HTTP/1.1
```

```
Content-type: application/json


{
    "name": "Example_repository",
    "host": "http://examplerepository.com"
}
```

Example response

```
HTTP/1.1 201 Created
Vary: Cookie
```

22.3.1.3 *Unregistering repositories*

Example request

```
DELETE /api/administration/repositories/example_repository HTTP/1.1
Accept: application/json
```

Example response

```
HTTP/1.1 204 No content
Vary: Cookie
```

22.3.1.4 *Updating repositories*

Example request

```
PUT /api/administration/repositories/example_repository HTTP/1.1
Content-type: application/json


{
    "name": "example_repository",
    "host": "http://examplerepository.com"
}
```

Example response

```
HTTP/1.1 200 OK
Vary: Cookie
```

22.3.2 Managing Marketplaces

Here we start with the description of the operation following the next table:

Verb	URI	Description	Mandatory/Optional
GET	/api/administration/marketplaces	Gets a list of all marketplaces on which the Store is registered	Mandatory
POST	/api/administration/marketplaces	Registers the Store on a Marketplace	Mandatory
GET	/api/administration/marketplaces/{marketplace}	Gets marketplace info	Mandatory
DELETE	/api/administration/marketplaces/{marketplace}	Unregisters the Store on a Marketplace	Mandatory
PUT	/api/administration/marketplaces/{marketplace}	Updates Marketplace info	Mandatory

22.3.2.1 *Getting Marketplaces*

Example request

```
GET /api/administration/marketplaces HTTP/1.1
Accept: application/json
```

Example response

```
HTTP/1.1 200 OK
Content-Type: application/json
Vary: Cookie
```

```
{
    [
        "name": "Example_marketplace",
        "host": "http://examplemarketplace.com"
    ]
}
```

22.3.2.2 *Registering the Store on Marketplaces*

Example request

```
POST /api/administration/marketplaces HTTP/1.1
Content-type: application/json

{
    "name": "Example_marketplace",
    "host": "http://examplemarketplace.com"
}
```

Example response

```
HTTP/1.1 201 Created
Vary: Cookie
```

22.3.2.3 *Unregistering the Store on Marketplaces*

Example request

```
DELETE /api/administration/marketplaces/example_marketplace HTTP/1.1
Accept: application/json
```

Example response

```
HTTP/1.1 204 No content
Vary: Cookie
```

22.3.2.4 *Updating Marketplaces*

Example request

```
PUT /api/administration/marketplaces/example_marketplace HTTP/1.1
Content-type: application/json

{
    "name": "Example_marketplace",
    "host": "http://examplemarketplace.com"
}
```

Example response

```
HTTP/1.1 200 OK
Vary: Cookie
```

22.3.3 Managing Revenue Sharing Systems

Here we start with the description of the operation following the next table:

Verb	URI	Description	Mandatory/Optional
GET	/api/administration/rss	Gets a list of all registered RSSs	Mandatory
POST	/api/administration/rss	Registers a RSS	Mandatory
GET	/api/administration/rss/{rss}	Gets RSS info	Mandatory
DELETE	/api/administration/rss/{rss}	Unregisters a RSS	Mandatory
PUT	/api/administration/rss/{rss}	Updates RSS info	Mandatory

22.3.3.1 *Getting RSSs*

Example request

```
GET /api/administration/rss HTTP/1.1
Accept: application/json
```

Example response

```
HTTP/1.1 200 OK
Content-Type: application/json
```

```
Vary: Cookie

{
   [
         "name": "Example_rss",
         "host": "http://examplerss.com"
   ]
}
```

22.3.3.2 *Registering RSSs*

Example request

```
POST /api/administration/rss HTTP/1.1
Content-type: application/json


{
    "name": "Example_rss",
    "host": "http://examplerss.com"
}
```

Example response

```
HTTP/1.1 201 Created
Vary: Cookie
```

22.3.3.3 *Unregistering RSSs*

Example request

```
DELETE /api/administration/rss/example_rss HTTP/1.1
Accept: application/json
```

Example response

```
HTTP/1.1 204 No content
Vary: Cookie
```

22.3.3.4 *Updating RSSs*

Example request

```
PUT /api/administration/rss/example_rss HTTP/1.1
Content-type: application/json


{
    "name": "example_rss",
    "host": "http://examplerss.com"
}
```

Example response

```
HTTP/1.1 200 OK
Vary: Cookie
```

22.3.4 Managing Organizations

Here we start with the description of the operation following the next table:

Verb	URI	Description	Mandatory/Optional
GET	/api/administration/organizations	Gets a list of all registered organizations	Mandatory
POST	/api/administration/organizations	Registers an organization	Mandatory
GET	/api/administration/organizations/{organization}	Gets organization info	Mandatory
DELETE	/api/administration/organizations/{organization}	Unregisters an organization	Mandatory
PUT	/api/administration/organizations/{organization}	Updates organization info	Mandatory

22.3.4.1 *Getting Organizations*

Example request

```
GET /api/administration/organizations HTTP/1.1
Accept: application/json
```

Example response

```
HTTP/1.1 200 OK
Content-Type: application/json
Vary: Cookie

{
   [
        "CoNWeT", "UPM"
        "tax_address": {
            "street": "C/ Los alamos n 17",
            "postal": "39011",
            "city": "Santander"
            "country": "Spain"
        },
        "payment_info": {
            "type": "MasterCard",
            "number": "5473836409374456",
            "expire_year": "2018",
            "expire_month": "5",
            "cvv2": "111"
        }
   ]
}
```

22.3.4.2 *Registering Organizations*

Example request

```
POST /api/administration/organizations HTTP/1.1
Content-type: application/json
```

```
{
    "name": "CoNWeT",
    "tax_address": {
        "street": "C/ Los alamos n 17",
         "postal": "39011",
         "city": "Santander"
         "country": "Spain"
    },
    "payment_info": {
         "type": "MasterCard",
         "number": "5473836409374456",
         "expire_year": "2018",
         "expire_month": "5",
         "cvv2": "111"
    }
}
```

Example response

```
HTTP/1.1 201 Created
Vary: Cookie
```

22.3.4.3 *Unregistering Organizations*

Example request

```
DELETE /api/administration/organizations/CoNWeT HTTP/1.1
Accept: application/json
```

Example response

```
HTTP/1.1 204 No content
Vary: Cookie
```

22.3.4.4 *Updating Organizations*

Example request

```
PUT /api/administration/organizations/CoNWeT HTTP/1.1
```

```
Content-type: application/json


{
    "name": "CoNWeT-UPM",
    "tax_address": {
        "street": "C/ Los alamos n 17",
        "postal": "39011",
        "city": "Santander"
        "country": "Spain"
    },
    "payment_info": {
        "type": "MasterCard",
        "number": "5473836409374456",
        "expire_year": "2018",
        "expire_month": "5",
        "cvv2": "111"
    }
}
```

Example response

```
HTTP/1.1 200 OK
Vary: Cookie
```

22.3.5 Managing User Profiles

Here we start with the description of the operation following the next table:

Verb	URI	Description	Mandatory/Optional
GET	/api/administration/profiles	Gets a list of all registered users	Mandatory
POST	/api/administration/profiles	Registers an user	Mandatory
GET	/api/administration/profiles/{profile}	Gets user profile info	Mandatory
DELETE	/api/administration/profiles/{profile}	Unregisters an user	Mandatory
PUT	/api/administration/profiles/{profile}	Updates user profile info	Mandatory

22.3.5.1 *Getting User Profiles*

Example request

```
GET /api/administration/profiles HTTP/1.1
Accept: application/json
```

Example response

```
HTTP/1.1 200 OK
Content-Type: application/json
Vary: Cookie

{
   [
       {
           "username": "app_provider",
           "first_name": "Antonio",
           "last_name": "Suarez Farola",
           "organization": "CoNWeT",
           "roles": ["provider", "customer"],
           "tax_address": {
               "street": "C/ Los alamos n 17",
               "postal": "39011",
               "city": "Santander"
               "country": "Spain"
           },
           "payment_info": {
               "type": "MasterCard",
               "number": "5473836409374456",
               "expire_year": "2018",
               "expire_month": "5",
               "cvv2": "111"
           }
       }
   ]
}
```

22.3.5.2 *Registering User Profiles*

Example request

```
POST /api/administration/profiles HTTP/1.1
Content-type: application/json


{
    "username": "app_provider",
    "first_name": "Antonio",
    "last_name": "Suarez Farola",
    "organization": "CoNWeT",
    "roles": ["provider", "customer"],
    "tax_address": {
        "street": "C/ Los alamos n 17",
        "postal": "39011",
        "city": "Santander"
        "country": "Spain"
    },
    "payment_info": {
        "type": "MasterCard",
        "number": "5473836409374456",
        "expire_year": "2018",
        "expire_month": "5",
        "cvv2": "111"
     }
}
```

Example response

```
HTTP/1.1 201 Created
Vary: Cookie
```

22.3.5.3 *Unregistering User Profiles*

Example request

```
DELETE /api/administration/profiles/app_provider HTTP/1.1
```

```
Accept: application/json
```

Example response

```
HTTP/1.1 204 No content
Vary: Cookie
```

22.3.5.4 *Updating User Profiles*

Example request

```
PUT /api/administration/profiles/app_provider HTTP/1.1
Content-type: application/json

{
    "username": "app_provider",
    "first_name": "Antonio",
    "last_name": "Suarez Farola",
    "organization": "CoNWeT",
    "roles": ["provider", "customer"],
    "tax_address": {
        "street": "C/ Los alamos n 17",
        "postal": "39011",
        "city": "Santander"
        "country": "Spain"
    },
    "payment_info": {
        "type": "MasterCard",
        "number": "5473836409374456",
        "expire_year": "2018",
        "expire_month": "5",
        "cvv2": "111"
     }
}
```

Example response

```
HTTP/1.1 200 OK
Vary: Cookie
```

22.3.6 Managing Offerings

Here we start with the description of the operation following the next table:

Verb	URI	Aditional Parameters	Description	Mandatory/Optional
GET	/api/offering/offerings	filter, start, limit, action, sort	Get a list of all offerings	Mandatory
POST	/api/offering/offerings		Creates a new offering	Mandatory
GET	/api/offering/offerings/{organization}	filter, start, limit, action, sort	Get a list of all offerings of an organization	Mandatory
GET	/api/offering/offerings/{organization}/{name}	filter, start, limit, action, sort	Get a list of all versions of an offering	Mandatory
GET	/api/offering/offerings/{organization}/{name}/{version}		Get an offering	Mandatory
DELETE	/api/offering/offerings/{organization}/{name}/{version}		Delete an offering	Mandatory
PUT	/api/offering/offerings/{organization}/{name}/{version}		Updates an offering	Mandatory
POST	/api/offering/offerings/{organization}/{name}/{version}/publish		Publish the offering	Mandatory
POST	/api/offering/offerings/{organization}/{name}/{version}/bind		Binds the offering with resources	Mandatory
POST	/api/offering/offerings/{organization}/{name}/{version}/rating		Rate and comment an offering	Mandatory

It is possible to provide additional parameters in GET requests in order to limit and filter responses:

- filter: Optional expresion to select offerings by their state.
- start: First offering to be returned
- limit: Number of offerings to be returned
- action: Changes the behaviour of the request, i.e count offerings.
- sort: Optional expression to select the expected order for the offerings, i.e date, popularity, name.

```
GET /api/offering/offerings?filter=purchased&start=1&limit=10
```

22.3.6.1 *Getting Offerings*

Example request:

```
GET /api/offering/offering HTTP/1.1
Accept: application/json
```

Example response:

```
HTTP/1.1 200 OK
Content-Type: application/json
Vary: Cookie



[
    {
        "name":"SmartCityLights",
        "owner_organization": "CoNWeT",
        "owner_admin_user": "app_provider",
        "version": "1.0",
        "state": "published",
        "description_url":
"http://examplerepository.com/storeCollection/SmartCityLights",
        "marketplaces": [example_marketplace],
        "applications": [{
            "name": "Example idM application",
            "description":   "An   example   idM   app   for   access
controling",
            "url": "https://exampleapp.com/app"
        }],
        "resources": [{
             “name”: “Smart City Lights Mashup”,
             “version”: “1.0”,
             “description”:  “This  resource  contains  a  mashup  for
Smart City Lights”,
        }],
```

```
        "rating": "5",
        "comments": [{
             "date": "2013/01/16",
             "user": "admin",
             "rating": "5",
             "comments": "Good offering"
        }],
        "tags": [smart, city],
        "image_url": "http://examplestore.com/media/image",
        "related_images": [],
        "offering_description": {parsed USDL description info},
    }
]
```

22.3.6.2 *Creating Offerings*

Example requests:

```
POST /api/offering/offering HTTP/1.1
Content-Type: application/json
Accept: application/json

{
   "name": "SmartCityLigths",
   "version": "1.0",
   "image": {
       "name": "catalogue.png",
       "data": <encoded_data>,
   },
   "related_images": [],
   "applications": [{
       "name": "Example idM application",
       "description": "An example idM app for access controling",
       "url": "https://exampleapp.com/app"
   }],
   "resources": [{
       "name": "Smart City Lights Mashup",
```

```
        “version”: “1.0”,
        “description”: “This resource contains a mashup for Smart City Lights”,
    }],
    "repository": "testbed_repository",
    "offering_description": {
        “content_type”: “text/turtle”,
        “data”: "raw USDL document (RDF XML, N3 , Turtle)"
    }

}

POST /api/offering/offering HTTP/1.1
Content-Type: application/json
Accept: application/json
{
    "name": "example_offering",
    "version": "1.0",
    "image": {
        “name”: “catalogue.png”,
        “data”: <encoded_data>,
    },
    "applications": [{
        "name": "Example idM application",
        "description": "An example idM app for access controling",
        "url": "https://exampleapp.com/app"
    }],
    "resources": [{
        “name”: “Smart City Lights Mashup”,
        “version”: “1.0”,
        “description”: “This resource contains a mashup for Smart City Lights”,
    }],
    "related_images": [],
    "description_url”: “http://examplerepository/collection/SmartCity.rdf”
}
```

```
POST /api/offering/offering HTTP/1.1
Content-Type: application/json
Accept: application/json
{
   "name": "example_offering",
   "version": "1.0",
   "image": {
       "name": "catalogue.png",
       "data": <encoded_data>,
   },
   "applications": [{
       "name": "Example idM application",
       "description": "An example idM app for access controling",
       "url": "https://exampleapp.com/app"
   }],
   "resources": [{
       "name": "Smart City Lights Mashup",
       "version": "1.0",
       "description": "This resource contains a mashup for Smart
City Lights",
   }],
   "related_images": [],
   "offering_description": {
       "description": "an example offering",
       "pricing": {
           "model": "single payment"
           "price": "1",
           "currency": "EUR"
       },
       "legal": {
           "title": "terms and conditions",
           "text": "terms and conditions that apply to the offering"
       }
   }
}
```

Example response:

```
HTTP/1.1 201 Created
Vary: Cookie
```

22.3.6.3 *Deleting Offerings*

Example request

```
DELETE /api/offering/offerings/UPM/example/1.0 HTTP/1.1
Accept: application/json
```

Example response

```
HTTP/1.1 204 No Content
Vary: Cookie
```

22.3.6.4 *Updating Offerings*

Example requests

```
PUT /api/offering/offerings/UPM/example/1.0 HTTP/1.1
Content-type: application/json
Accept: application/json
{
   "image": {
       “name”: “catalogue.png”,
       “data”: <encoded_data>,
   },
   "related_images": [],
   "repository": "example_repository",
   "offering_description":  {
       “content_type”: “text/turtle”,
       “data”: "raw USDL document (RDF XML, N3 , Turtle)"
   }
}


PUT /api/offering/offerings/UPM/example/1.0 HTTP/1.1
```

```
Content-type: application/json
Accept: application/json
{
   "image": {
       “name”: “catalogue.png”,
       “data”: <encoded_data>,
   },
   "related_images": [],
   "repository": "example_repository",
   "description_url":
"http://examplerepository/collection/SmartCity.rdf"
}


PUT /api/offering/offerings/UPM/example/1.0 HTTP/1.1
Content-type: application/json
Accept: application/json
{
   "image": {
       “name”: “catalogue.png”,
       “data”: <encoded_data>,
   },
   "related_images": [],
   "repository": "example_repository",
   "offering_description”: {
       "description": "an example offering",
       "pricing": {
           "model": "single payment"
           "price": "1",
           "currency": "EUR"
       },
       "legal": {
           "title": "terms and conditions",
           "text": "terms and conditions that apply to the offering"
       }
   }
}
```

Example response

```
HTTP/1.1 200 OK
Vary: Cookie
```

22.3.6.5 *Publishing Offerings*

Example request

```
POST /api/offering/offerings/UPM/example/1.0/publish HTTP/1.1
Content-type: application/json
Accept: application/json

{
    marketplaces: [example_marketplace,]
}
```

Example response

```
HTTP/1.1 200 OK
Vary: Cookie
```

22.3.6.6 *Binding Offerings*

Example request

```
POST /api/offering/offerings/UPM/example/1.0/bind HTTP/1.1
Accept: application/json

{
    resources: [{
        "provider": "example_provider",
        "name": "example_resource",
        "version": "1.0"
    }]
}
```

Example response

```
HTTP/1.1 200 OK
```

```
Vary: Cookie
```

22.3.6.7 *Rating Offerings*

Example request

```
POST /api/offering/offerings/UPM/example/1.0/rating HTTP/1.1
Accept: application/json

{
    "rating": "5",
    "title": "Comment tittle",
    "comment": "Good offering"
}
```

Example response

```
HTTP/1.1 201 Created
Vary: Cookie
```

22.3.7 Managing Resources

Here we start with the description of the operation following the next table:

Verb	URI	Description	Mandatory/Optional
GET	/api/offering/resource	Get a list of all resources	Mandatory
POST	/api/offering/resource	Creates a new resource	Mandatory
GET	/api/offering/resource/{provider}	Get a list of all the resources of a provider	Mandatory
GET	/api/offering/resource/{provider}/{name}	Get a list of all versions of a resource	Mandatory
GET	/api/offering/resource/{provider}/{name}/{version}	Get a resource	Mandatory
DELETE	/api/offering/resource/{provider}/{name}/{version}	Delete a resource	Mandatory

PUT	/api/offering/resource/{provider}/{name}/{version}	Updates a resource	Mandatory

22.3.7.1 *Getting Resources*

Example request:

```
GET /api/offering/resources HTTP/1.1
Accept: application/json
```

Example response:

```
HTTP/1.1 200 OK
Content-Type: application/json
Vary: Cookie
[
    {
        "content_type":   "application/x-mashup+mashable-application-
component"
        "description": "Smart City Lights is an app"
        "name": "Smart City Management"
        "version": "1.0"
    }


]
```

22.3.7.2 *Registering Resources*

(1)Providing the resource

Example requests:

```
GET /api/offering/resources HTTP/1.1
Content-type: multipart/form-data
Accept: application/json
{

   "name": "Smart City Lights Mashup",
   "version": "1.0",
```

```
   "description": "This resource contains a mashup for Smart City Lights",
   "content_type": "application/x-mashup+mashable-application-component"

}
+ FILE



GET /api/offering/resources HTTP/1.1
Content-type: application/json
Accept: application/json
{

   "name": "Smart City Lights Mashup",
   "version": "1.0",
   "description": "This resource contains a mashup for Smart City Lights",
   "content_type": "application/x-mashup+mashable-application-component",
   "content": {
       "name": "SmartCityLights.wgt",
       "data": "encoded_data"
   }
}
```

Example response:

```
HTTP/1.1 201 Created
Content-Type: application/json
Vary: Cookie
```

(2)Providing a link
Example request

```
GET /api/offering/resources HTTP/1.1
Content-type: application/json
Accept: application/json
{
    "name": "Smart City Lights Mashup",
```

```
    "version": "1.0",
    "description": "This resource contains a mashup for Smart City Lights",
    "content_type": "application//x-mashup+mashable-application-component",
    "link": "https://downloadmashuplink.com/smartcity"
}
```

Example response:

```
HTTP/1.1 201 Created
Content-Type: application/json
Vary: Cookie
```

22.3.7.3 *Deleting Resources*

Example request:

```
DELETE /api/offering/resources/admin/example_resource/1.0 HTTP/1.1
Accept: application/json
```

Example response:

```
HTTP/1.1 204 No Content
Vary: Cookie
```

22.3.7.4 *Updating Resources*

Example request:

```
PUT /api/offering/resources/admin/example_resource/1.0 HTTP/1.1
Accept: application/json

{

    "name": "Smart City Lights Mashup",
    "version": "1.0",
    "description": "This resource contains a mashup for Smart City Lights",
```

```
    “content_type":      “application//x-mashup+mashable-application-
component",
    “link": “https://downloadmashuplink.com/smartcity"
}
```

Example response:

```
HTTP/1.1 200 OK
Vary: Cookie
```

22.3.8 Managing purchases

Here we start with the description of the operation following the next table:

Verb	URI	Description	Mandatory/Optional
POST	/api/contracting	Creates a new purchase (Buy an offering)	Mandatory
GET	/api/contracting/{reference}	Get a purchase info	Mandatory
POST	/api/contracting/{reference}/accounting	Provide accounting info for pay-per-use offerings	Mandatory
POST	/api/contracting/form	Get an endpoint for purchase an offering using the web GUI	Mandatory

22.3.8.1 *Purchasing an Offering*

Example request:

```
POST /api/contracting HTTP/1.1
Content-type: application/json
Accept: application/json
{
   “offering": {
       “organization": "CoNWeT"
       “name": "SmartCityLights"
       “version": "1.0"
   },
   “tax_address": {
       “street": "C/Los alamos n 17",
```

```
        "city": "Santander",
        "postal": "39011",
        "country": "Spain"
    }
    "payment_info": {
        "payment_method": "credit card",
        "credit_card": {
            "number": "546798367265",
            "type": "MasterCard",
            "expire_year": "2018",
            "expire_month": "5",
            "cvv2": "111"
        }
    }
}
```

Example response:

```
HTTP/1.1 201 Created
Vary: Cookie
```

Example request

```
POST /api/contracting HTTP/1.1
Content-type: application/json
Accept: application/json
{
    "offering": {
        "organization": "CoNWeT"
        "name": "SmartCityLights"
        "version": "1.0"
    },
    "tax_address": {
        "street": "C/Los alamos n 17",
        "city": "Santander",
        "postal": "39011",
```

```
        “country”: "Spain"
    }
    “payment_info”: {
        “payment_method”: “paypal”
    }
}
```

Example response

```
HTTP/1.1 201 Created
Vary: Cookie
{
    "redirection_link": "http://paypalredirectionlink.com/"
}
```

22.3.8.2 ***Getting a Purchase info***

Example request

```
GET /api/contracting/12345678 HTTP/1.1
Accept: application/json
```

Example response:

```
HTTP/1.1 201 Created
Vary: Cookie



{
   {
       "reference": "12345678",
       "offering": {
            "organization": "UPM",
            "name": "example_offering",
            "version": "1.0"
```

```
        },
        "user": "admin",
        "tax_address": "Example street",
        "bill": "http://examplestore.com/bills/12345678",
    }
}
```

22.3.8.3 *Providing Accounting info*

Example request

```
POST /api/contracting/12345678/accounting HTTP/1.1
Content-type: application/json
Accept: application/json
{
    “offering”: {
        “name”: “offering_name”
        “version”: “1.0”
        “organization”: “organization”
    },
    “customer”: “test_user”,
    “correlation_number”: “1”,
    “time_stamp”: “2013-07-01T10:00:00-0”
    “record_type”: “event”,
    “value”: “1”,
    “unit”: “issue”
}
```

Example response

```
HTTP/1.1 200 OK
Vary: Cookie
```

22.3.8.4 *Getting a Purchase Endpoint*

Example request

```
POST /api/contracting/form HTTP/1.1
Accept: application/json
{
    "offering": {
        "organization": "CoNWeT",
        "name": "SmartCityLights",
        "version": 1.0,
    },
    "redirect_uri": "http://customerredirecturi.com"
}
```

Example response:

```
HTTP/1.1 201 Created
Vary: Cookie
{
    "url":                                    "http://wstore.lab.fi-
ware.eu/contracting/form?ID=63865adf6c2ca6f7"
}
```

22.3.9 Managing searches

Here we start with the description of the operation following the next table:

Verb	URI	Description	Mandatory/Optional
GET	/api/search/{keyword}	Gets a list of offerings depending on keyword value	Mandatory

22.3.9.1 *Searching offerings*

Example request:

```
GET /api/search/example HTTP/1.1
Accept: application/json
```

Example response:

```
HTTP/1.1 200 OK
Content-Type: application/json
```

```
Vary: Cookie

{
    [
        {
            "name":"example_offering",
            "owner_organization": "UPM",
            "owner_admin_user": "admin",
            "version": "1.0",
            "state": "published",
            "description_url":
"http://examplerepository.com/example_offering",
            "marketplaces": [example_marketplace],
            "resources": [],
            "applications": [{
                "name": "Example idM application",
                "description": "An example idM app for access
controling",
                "url": "https://exampleapp.com/app"
            }],
            "rating": "5",
            "comments": [{
                "date": "2013/01/16",
                "user": "admin",
                "rating": "5",
                "comments": "Good offering"
            }],
            "tags": [example,],
            "image_url": "http://examplestore.com/media/image",
            "related_images": [],
            "offering_description": {parsed USDL description info},
}
    ]
}
```


22.3.10 Status Codes

200 OK

The request was handled successfully and transmitted in response message.

201 Created

The request was fulfilled and resulted in a new resource being created.

204 No Content

The server successfully processed the request, but is not returning any content.

304 Not Modified

Indicates the resource has not been modified since last requested. Typically, the HTTP client provides a header like the If-Modified-Since header to provide a time against which to compare. Using this saves bandwidth and reprocessing on both the server and client, as only the header data must be sent and received in comparison to the entirety of the page being re-processed by the server, then sent again using more bandwidth of the server and client.

400 Bad Request

The request could not be fulfilled due to bad syntax.

403 Forbidden

The request could not be fulfilled due to an authorization problem.

404 Not Found

The requested resource could not be found but may be available again in the future. Subsequent requests by the client are permissible.

500 Internal Server Error

A generic error message, given when no more specific message is suitable.

502 Bad gateway

An error message showing an error in a request made by the server.

23 FIWARE OpenSpecification Apps RSS

You can find the content of this chapter as well in the wiki of fi-ware.

Name	FIWARE.OpenSpecification.Apps.RSS
Chapter	Apps,
Catalogue-Link to Implementation	Revenue Settlement and Sharing System (RSSS)
Owner	Telefónica I+D, Javier Lucio

23.1 Preface

Within this document you find a self-contained open specification of a FI-WARE generic enabler, please consult as well the FI-WARE Product Vision, the website on http://www.fi-ware.org and similar pages in order to understand the complete context of the FI-WARE project.

23.2 Copyright

23.3 Legal Notice

Please check the following FI-WARE Open Specification Legal Notice (implicit patents license) to understand the rights to use these specifications.

23.4 Overview

The Revenue Sharing System (RSS) GE is in charge of distributing the revenues originated by the usage of a given service among the involved stakeholders. In particular, it focuses on distributing part of the revenue generated by a service between the Marketplace Provider and the Service Provider(s) responsible for the service. With the term "service" we refer to both final applications and backend application services (typically exposed through an API). Note that, in the case of composite services, more than one service provider may have to receive a share of the revenues.

Revenue sharing is based on a set of business models (revenue sharing models) which dictate how to distribute revenues. The RSS GE must be fed, via available APIs, with these models and additional information regarding service providers. In addition, Charging Data Records (CDRs), based on service usage information, must be periodically fed to the RSS GE to enable the revenue sharing process. CDRs must be created by another GE (e.g., the

Store GE) and/or external system based on per service specified price models and accounting information.

There are different charging events that may generate revenue sharing, the most important ones being:

- Service download
- Subscription
- Service usage (pay per use)

Different revenue sharing models can be assigned to Service Providers, each of them based on a combination of parameters such as services used, type of application and charging event. For instance, the revenue sharing model used to calculate payments to a given Service Provider for subscriptions may be different from the one used for pay per use.

The RSS GE exposes an API for other components to send charging information. It also features a GUI which can be used by RSS and Store administrators to manage revenue sharing models, access reporting information and perform additional administration tasks.

Additionally to this functionality the RSS GE must offer the possibility to consult reports, regarding the CDR received, to both RSS and Store administrators. Example of these reports can be the quantity of amounts received in a period, number of transactions per application provider, or information regarding the most purchased applications.

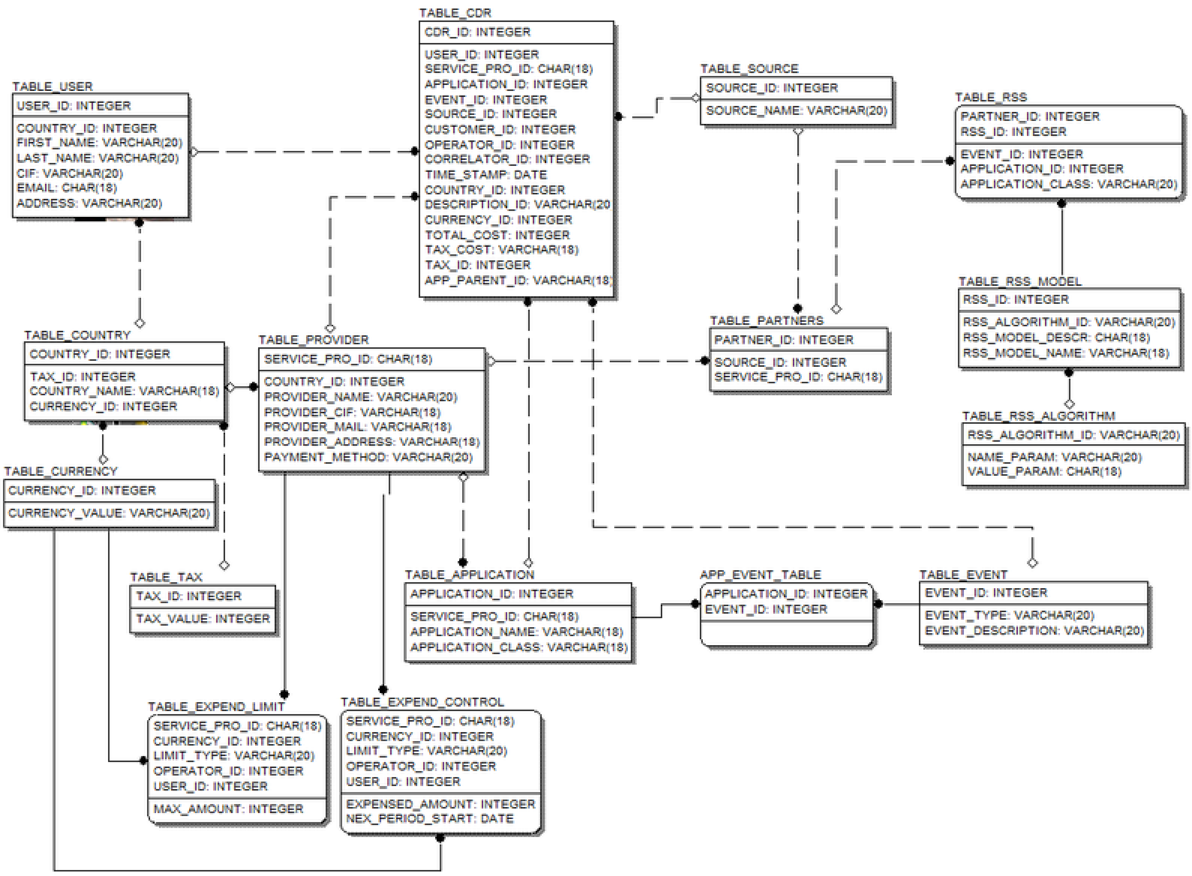
Finally as a supplementary functionality, expenditure limits functionality must be offered in this GE. The expenditure limit API provides a mechanism through which an application provider can limit the amount of money spent by a customer using the services, along a specific time interval. Once this limit is exceeded, it will not be possible to purchase anything until next period of time.

This API exposes the functionality that a provider will use to check the balance and accumulated expenses of a given customer, previously to accept a purchase.

23.5 Basic Concepts

23.5.1 Data Model

The RSS GE data model is depicted in the diagram below (note not all actual details are shown):



RSS GE data model

The main data artifacts are described in the following paragraphs. Note that the parameters for these artifacts are distributed between different related tables of the above data model.

23.5.1.1 *Revenue Sharing models*

Revenue Sharing (RS) models describe the way to distribute revenues between the different stakeholders involved in a given service. A Revenue Share model is defined by:

- *Identifier*. A unique model identifier.
- *Description*. A textual description of the model.
- *Revenue source*: The system that is originating charging information.
- *Event id*: Event that is being charged (pay per use, subscription, etc.).
- *Service provider id*: Provider of the service charged.
- *Application id*: Application or service which is being charged.
- *Application Class*: Type of application or service which is being charged.
- *An algorithm*. It defines how the share is calculated. The algorithm consists of:
    - *Textual description*. Short explanation of the algorithm.
    - *Algorithm type*. Type of algorithm applied to calculate revenue shares such as fixed percentage, functions with an increasing slope, intervals with fixed share per interval, etc.
    - *Parameters*. A set of values for the parameters associated to the algorithm (e.g. for the fixed percentage algorithm, the specific percentage).

23.5.1.2 *CDRs*

CDRs provide charging information related to the usage of services available. Therefore they should provide information about the actual service being used, the application which uses the service, the Service Provider, the costs incurred, etc. Thus it should contain, at least, the following parameters:

- *CDR source*: The system that is providing CDRs (marketplace, e-store, charging application, etc.).
- *CDR type*: Type of CDR (charge, refund, etc.).
- *Operator id:* Mobile Network Code (ITU MNC).
- *Correlation id*: CDR sequence number - must be unique for each source.
- *Time Stamp*: Time/date.
- *Country id*: Mobile Country Code (ITU MCC).
- *Application id*: Application or service which is being charged.
- *Parent Application Id (optional)*: Application which uses the service being charged.
- *Event id*: Event that is being used for charging (subscription, pay per use, etc.).
- *Purchase Code:* Identifier, in the source system, of the actual purchase operation.
- *Description:* Additional textual description.
- *Cost*: Amount of a given currency charged in this CDR.
- *Taxes*: Taxes charged in this CDR in a given currency.
- *Currency*: Actual currency used for charges.
- *User id*: Consumer of the service.
- *Service Provider id*: Provider of the service.
- *Product class*: Application category.
- *Refund reason*: Free text describing reason for refund CDRs.

23.5.1.3 *Service Providers*

RSS GE needs to know the following information about Service Providers:

- *Identifier*: Unique Service Provider reference.
- *Name*: Legal name of the Service Provider.
- *Country id*: Country where the Service Provider is established (ITU MCC).
- *Payment currency*: Currency in which the Service Provider will receive the payments.
- *Payment method chosen to receive the revenues*. Different payment methods are supported, like:
  - *Credit card*. Note a Service Provider may have several credit cards. Parameters required:
    - *Card number*
    - *Card name*
    - *Security code*
    - *Description*
    - *Expiration date*
    - *Credit card provider* (VISA, MasterCard, etc.).
  - *Paypal*. Parameters required:
    - *Email address*
  - *Bank account*. Note a Service Provider may have several accounts. Parameters required:
    - *Account number*

- *Account name*
- *Description*
- *Swift code* (US accounts)
- *IBAN* (EU accounts)
- *Bank office address* (EU accounts).

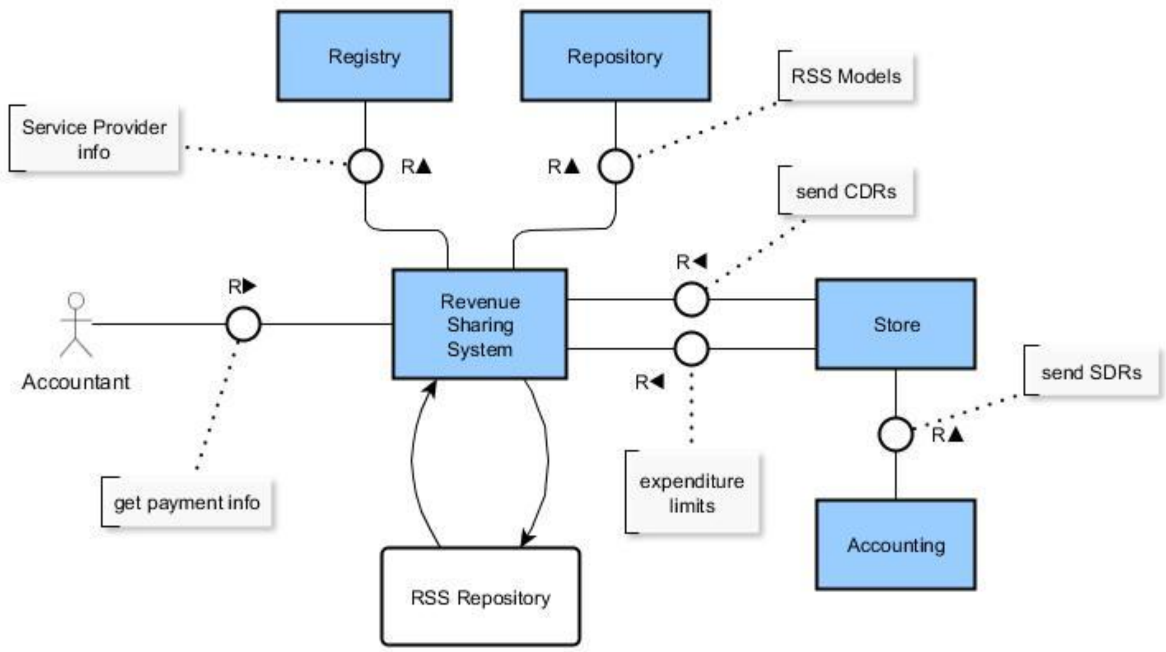
23.5.1.4 *Expenditure limit information*

In order to create and manage the information of expenditure limits and accumulated expenses of a customer, the RSS needs to know:

- *Limit Type*: Type of period to check the expenses of a customer (diary, weekly, etc...).
- *Currency*: Currency in which the amount must be paid.
- *Max Amount*: Maximum expenses allowed along the period of time.
- *Service Provider id*: Provider of the service.
- *User id*: User identifier.
- *Expensed amount*: Spent amount in the current period of time.
- *Next period start*: Beginning of the next period of accumulation.

23.6 RSS Architecture

The following diagram gives an overview of how the RSS GE interfaces with the rest of the GEs that make up the FI-WARE marketplace's business framework.



Architecture of the RSS GE

The main interactions between RSS and other GEs are based on REST services. The origin of the arrow is the module using the REST service offered by the arrow end.

- Store GE

    - Reception of CDRs. The Store GE will feed the RSS GE with detailed charging information related to applications and services traded in FI-WARE.
    - Expenditure limits
        - Expenditure limits management. The Store GE is able to create/update/delete expenditure limits for customers in a any service provider or for a particular one. The limits could be by transaction or periodically: daily, weekly or monthly.
        - Expenditure limits control. The Store GE will ask the RSS GE if the customer will not exceed the expenditure limit because of the current transaction and will feed the RSS GE to update the new expenditure balance once the charge has been produced.
- Repository GE: revenue sharing models, created by the Business Modeler GE, are be read by the RSS GE from the Repository GE. At least the following information should be available:
    - RSS Models mapping an algorithm and a set of parameters to the service providers subject to revenue sharing.
- Registry GE: Information about Service Providers will be read from this GE.
- Identity Manager as a Service (IDMaaS) GE: authentication & authorization of users accessing the RSS GE will be handled by the IDMaaS GE.
- Payment Broker (external component)
    - In order to actually pay service providers it is necessary to rely on an external payment broker. However, the integration of such actor is out of the scope of FI-WARE.

23.7 Main Interactions

23.7.1 Receiving CDRs

In order to calculate revenue shares, RSS must be fed with CDRs by the Store GE using the following operation:

- *ReceiveCDRs*
- *Parameters:*
    - *CRDList*. List of CDRs. Each CDR must include the parameters described in the RSS Architecture document:
        - http://forge.fi-ware.eu/plugins/mediawiki/wiki/fiware/index.php?title=FIWARE.ArchitectureDescription.Apps.RSS#CDRs

23.7.2 Expenditure Limits

In order to manage, check and update the expenses of a customer along a period of time, the Store GE will have to interact with the RSS GE to create/update/delete expenditure limits and maintain up to date the accumulated expenses of a customer. For this purpose it will use the API exposed by the RSS GE with the operations:

- *createLimit, updateLimit and deleteLimit* for customers or providers
- *Parameters:*

  - *appProviderId*. Identifier of the provider.
  - *user id*. Identifier of the customer.
  - *type*. Type of the limit (per transaction, daily, weekly or monthly).
  - *maxAmount*. Amount of the limit.
  - *currency*. Identifier of the currency to be charged in.
- *checkAccumulated and updateAccumulated*
- *Parameters:*
  - *appProviderId*. Identifier of the provider.
  - *user id*. Identifier of the customer.
  - *amount*. Amount of the last expense to be checked or charged.
  - *currency*. Identifier of the currency to be charged in.

23.7.3 User Management

The RSS GE will get information about its users (basically administrators) from the IdM GE of the FI-WARE Security chapter. This information should include a user's identity, role and other relevant parameters. Besides, the RSS GE relies on the IDM GE for the authentication and authorization of users accessing the RSS GE.

23.7.4 Service Providers management

The RSS GE will read information about Service Providers from the Registry GE.

23.7.5 RSS Models management

The RSS GE will read information about RSS models created by the BE&BM GE from the Service Repository GE.

23.7.6 Payment Management

In order to distribute the revenue shares to all stakeholders, the RSS GE generates a file, in csv format, with the information needed by an external payment broker. The RSS GE can then send the file to the external broker to conducts the actual payment process.

23.8 Basic Design Principles

The RSS GE exposes all its functionalities as Web Services to facilitate integration with other GE and external components. Besides, it provides a web based GUI for operation and management. The type of algorithms the RSS can use for calculating revenue shares can be easily extended by adding new algorithms.

23.9 Detailed Open Specifications

- FIWARE.OpenSpecification.Apps.RSS.RSS-Models
- FIWARE.OpenSpecification.Apps.RSSRest

23.10 Re-utilised Technologies/Specifications

- RESTful web services.
- HTTP/1.1.
- XML data serialization formats.
- W3C WS-*.

23.11 Terms and definitions

This section comprises a summary of terms and definitions introduced during the previous sections. It intends to establish a vocabulary that will be help to carry out discussions internally and with third parties (e.g., Use Case projects in the EU FP7 Future Internet PPP). For a summary of terms and definitions managed at overall FI-WARE level, please refer to FIWARE Global Terms and Definitions

- **Aggregator (Role):** A Role that supports domain specialists and third-parties in aggregating services and apps for new and unforeseen opportunities and needs. It does so by providing the dedicated tooling for aggregating services at different levels: UI, service operation, business process or business object levels.
- **Application:** Applications in FI-WARE are composite services that have a IT supported interaction interface (user interface). In most cases consumers do not buy the application, instead they buy the right to use the application (user license).
- **Broker (Role):** The business network's central point of service access, being used to expose services from providers that are delivered through the Broker's service delivery functionality. The broker is the central instance for enabling monetization.
- **Business Element:** Core element of a business model, such as pricing models, revenue sharing models, promotions, SLAs, etc.
- **Business Framework:** Set of concepts and assets responsible for supporting the implementation of innovative business models in a flexible way.
- **Business Model:** Strategy and approach that defines how a particular service/application is supposed to generate revenue and profit. Therefore, a Business Model can be implemented as a set of business elements which can be combined and customized in a flexible way and in accordance to business and market requirements and other characteristics.
- **Business Process:** Set of related and structured activities producing a specific service or product, thereby achieving one or more business objectives. An operational business process clearly defines the roles and tasks of all involved parties inside an organization to achieve one specific goal.
- **Business Role:** Set of responsibilities and tasks that can be assigned to concrete business role owners, such as a human being or a software component.
- **Channel:** Resources through which services are accessed by end users. Examples for well-known channels are Web sites/portals, web-based brokers (like iTunes, eBay and Amazon), social networks (like Facebook, LinkedIn and MySpace), mobile channels (Android, iOS) and work centers. The access mode to these channels is governed by technical channels like the Web, mobile devices and voice response, where each of these channels requires its own specific workflow.
- **Channel Maker (Role):** Supports parties in creating outlets (the Channels) through

which services are consumed, i.e. Web sites, social networks or mobile platforms. The Channel Maker interacts with the Broker for discovery of services during the process of creating or updating channel specifications as well as for storing channel specifications and channeled service constraints in the Broker.

- **Composite Service (composition):** Executable composition of business back-end MACs (see MAC definition later in this list). Common composite services are either orchestrated or choreographed. Orchestrated compositions are defined by a centralized control flow managed by a unique process that orchestrates all the interactions (according to the control flow) between the external services that participate in the composition. Choreographed compositions do not have a centralized process, thus the services participating in the composition autonomously coordinate each other according to some specified coordination rules. Backend compositions are executed in dedicated process execution engines. Target users of tools for creating Composites Services are technical users with algorithmic and process management skills.
- **Consumer (Role):** Actor who searches for and consumes particular business functionality exposed on the Web as a service/application that satisfies her own needs.
- **Desktop Environment:** Multi-channel client platform enabling users to access and use their applications and services.
- **Event-driven Composition:** Components concerned with the composition of business logic, which is driven by asynchronous events. This implies run-time selection of MACs and the creation/modification of orchestration workflows based on composition logic defined at design-time and adapted to context and the state of the communication at run-time.
- **Front-end/Back-end Composition:** Front-end compositions define a front-end application as an aggregation of visual mashable application pieces (named as widgets, gadgets, portlets, etc.) and back-end services. Front-end compositions interact with end-users, in the sense that front-end compositions consume data provided by the end-users and provide data to them. Thus the front-end composition (or mashup) will have a direct influence on the application look and feel; every component will add a new user interaction feature. Back-end compositions define a back-end business service (also known as process) as an aggregation of backend services as defined for service composition term, the end-user being oblivious to the composition process. While back-end components represent atomization of business logic and information processing, front-end components represent atomization of information presentation and user interaction.
- **Gateway (Role):** The Gateway role enables linking between separate systems and services, allowing them to exchange information in a controlled way despite different technologies and authoritative realms. A Gateway provides interoperability solutions for other applications, including data mapping as well as run-time data store-forward and message translation. Gateway services are advertised through the Broker, allowing providers and aggregators to search for candidate gateway services for interface adaptation to particular message standards. The Mediation is the central generic enabler. Other important functionalities are eventing, dispatching, security, connectors and integration adaptors, configuration, and change propagation.

- **Hoster (Role):** Allows the various infrastructure services in cloud environments to be leveraged as part of provisioning an application in a business network. A service can be deployed onto a specific cloud using the Hoster's interface. This enables service providers to re-host services and applications from their on-premise environments to cloud-based, on-demand environments to attract new users at much lower cost.
- **Marketplace:** Part of the business framework providing means for service providers, to publish their service offerings, and means for service consumers, to compare and select a specific service implementation. A marketplace can offer services from different stores and thus different service providers. The actual buying of a specific service is handled by the related service store.
- **Mashup:** Executable composition of front-end MACs. There are several kinds of mashups, depending on the technique of composition (spatial rearrangement, wiring, piping, etc.) and the MACs used. They are called application mashups when applications are composed to build new applications and services/data mash-ups if services are composed to generate new services. While composite service is a common term in backend services implementing business processes, the term 'mashup' is widely adopted when referring to Web resources (data, services and applications). Front-end compositions heavily depend on the available device environment (including the chosen presentation channels). Target users of mashup platforms are typically users without technical or programming expertise.
- **Mashable Application Component (MAC):** Functional entity able to be consumed executed or combined. Usually this applies to components that will offer not only their main behaviour but also the necessary functionality to allow further compositions with other components. It is envisioned that MACs will offer access, through applications and/or services, to any available FI-WARE resource or functionality, including gadgets, services, data sources, content, and things. Alternatively, it can be denoted as 'service component' or 'application component'.
- **Mediator:** A mediator can facilitate proper communication and interaction amongst components whenever a composed service or application is utilized. There are three major mediation area: Data Mediation (adapting syntactic and/or semantic data formats), Protocol Mediation (adapting the communication protocol), and Process Mediation (adapting the process implementing the business logic of a composed service).
- **Monetization:** Process or activity to provide a product (in this context: a service) in exchange for money. The Provider publishes certain functionality and makes it available through the Broker. The service access by the Consumer is being accounted, according to the underlying business model, and the resulting revenue is shared across the involved service providers.
- **Premise (Role):** On-Premise operators provide in-house or on-site solutions, which are used within a company (such as ERP) or are offered to business partners under specific terms and conditions. These systems and services are to be regarded as external and legacy to the FI-Ware platform, because they do not conform to the architecture and API specifications of FI-WARE. They will only be accessible to FI-WARE services and applications through the Gateway.
- **Prosumer:** A user role able to produce, share and consume their own products and modify/adapt products made by others.

- **Provider (Role):** Actor who publishes and offers (provides) certain business functionality on the Web through a service/application endpoint. This role also takes care of maintaining this business functionality.
- **Registry and Repository:** Generic enablers that able to store models and configuration information along with all the necessary meta-information to enable searching, social search, recommendation and browsing, so end users as well as services are able to easily find what they need.
- **Revenue Settlement:** Process of transferring the actual charges for specific service consumption from the consumer to the service provider.
- **Revenue Sharing:** Process of splitting the charges of particular service consumption between the parties providing the specific service (composition) according to a specified revenue sharing model.
- **Service:** We use the term service in a very general sense. A service is a means of delivering value to customers by facilitating outcomes customers want to achieve without the ownership of specific costs and risks. Services could be supported by IT. In this case we say that the interaction with the service provider is through a technical interface (for instance a mobile app user interface or a Web service). Applications could be seen as such IT supported Services that often are also composite services.
- **Service Composition:** in SOA domain, a service composition is an added value service created by aggregation of existing third party services, according to some predefined work and data flow. Aggregated services provide specialized business functionality, on which the service composition functionality has been split down.
- **Service Delivery Framework:** Service Delivery Framework (or Service Delivery Platform (SDP)) refers to a set of components that provide service delivery functionality (such as service creation, session control & protocols) for a type of service. In the context of FI-WARE, it is defined as a set of functional building blocks and tools to (1) manage the lifecycle of software services, (2) creating new services by creating service compositions and mashups, (3) providing means for publishing services through different channels on different platforms, (4) offering marketplaces and stores for monetizing available services and (5) sharing the service revenues between the involved service providers.
- **Service Level Agreement (SLA):** A service level agreement is a legally binding and formally defined service contract, between a service provider and a service consumer, specifying the contracted qualitative aspects of a specific service (e.g. performance, security, privacy, availability or redundancy). In other words, SLAs not only specify that the provider will just deliver some service, but that this service will also be delivered on time, at a given price, and with money back if the pledge is broken.
- **Service Orchestration:** in SOA domain, a service orchestration is a particular architectural choice for service composition where a central orchestrated process manages the service composition work and data flow invocations of the external third party services in the order determined by the work flow. Service orchestrations are specified by suitable orchestration languages and deployed in execution engines who interpret these specifications.
- **Store:** An external component integrated with the business framework, offering a set of services that are published to a selected set of marketplaces. The store thereby

holds the service portfolio of a specific service provider. In case a specific service is purchased on a service marketplace, the service store handles the actual buying of a specific service (as a financial business transaction).

- **Unified Service Description Language (USDL):** USDL is a platform-neutral language for describing services, covering a variety of service types, such as purely human services, transactional services, informational services, software components, digital media, platform services and infrastructure services. The core set of language modules offers the specification of functional and technical service properties, legal and financial aspects, service levels, interaction information and corresponding participants. USDL is offering extension points for the derivation of domain-specific service description languages by extending or changing the available language modules.

24 FIWARE OpenSpecification Apps RSS Rest

You can find the content of this chapter as well in the wiki of fi-ware.

24.1 Introduction to the *RSS* API

24.1.1 RSS API Core

The RSS GE offers a series of RESTful API: it is resource oriented, accessed via HTTP and using XML or JSON representation for information interchange depending on the case.
The RSS GE API allows:

- Other components to send charging information to the RSS GE.
- To create expenditure limits for providers and customers.
- To control that customers do not overpass the expenditure limits previously created.

24.1.2 Intended Audience

This specification is intended for both software developers and implementers of the FI-WARE Business Framework. For the former, this document provides a full specification of how to interoperate with products that implement the RSS APIs. For the latter, this specification indicates the interface to be implemented and provided to clients.
In order to use this specification, the reader should firstly have a general understanding of the RSS Enabler. You should also be familiar with:

- RESTful web services.
- HTTP/1.1.
- XML data serialization formats.
- W3C WS-*.

24.1.3 API Change History

This version of the RSS API Guide replaces and obsoletes all previous versions. The most recent changes are described in the table below:

Revision Date	Changes Summary
Apr 09, 2013	• Initial version
Jan 30, 2014	• Add New API functionality

24.1.4 How to Read This Document

All FI-WARE RESTful API specifications will follow the same list of conventions and will support certain common aspects. Please check Common aspects in FI-WARE Open Restful API Specifications.

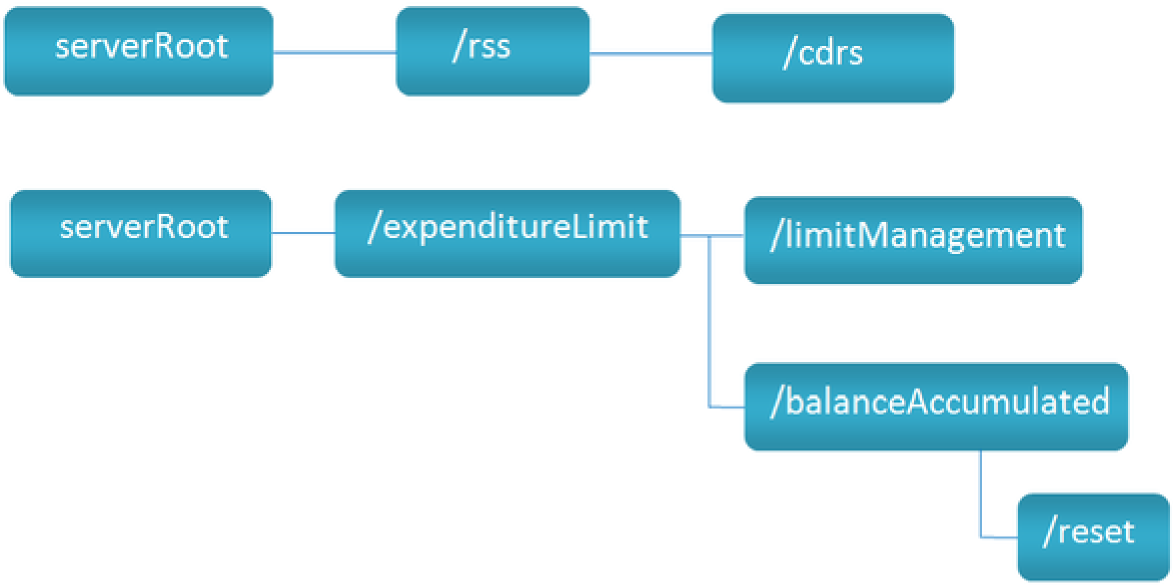
For a description of some terms used along this document, see RSS Enabler.

24.1.5 Additional Resources

You can download the most current version of this document from the FI-WARE API specification website at RSS API . For more details about the RSS GE that this API is based upon, please refer to the High Level Description. Related documents, including an Architectural Description, are available at the same site.

24.2 General *RSS* API Information

24.2.1 Resources Summary



24.2.2 Authentication

Each HTTP request against the *RSS GE* requires the inclusion of specific authentication credentials. The specific implementation of this API may support multiple authentication schemes (OAuth, Basic Auth, Token, etc.) and will be determined by the specific provider that implements the GE. Please contact with them to determine the best way to authenticate against this API. Some authentication schemes may require that the API operate using SSL over HTTP (HTTPS).

24.2.3 Representation Format

The *RSS* API supports XML and JSON for delivering metadata resources. The request format is specified using the Content-Type header and is required for operations that have a request body. The response format can be specified in requests using the Accept header (application/xml) or (application/json).

24.2.4 Representation Transport

Resource representation is transmitted between client and server by using HTTP 1.1 protocol, as defined by IETF RFC-2616. Each time an HTTP request contains payload, a Content-Type header shall be used to specify the MIME type of wrapped representation. In addition, both client and server may use as many HTTP headers as they consider necessary.

24.2.5 Resource Identification

In order to identify unambiguously the resources, for HTTP transport is used the mechanisms described by HTTP protocol specification as defined by IETF RFC-2616 (http://www.w3.org/Protocols/rfc2616/rfc2616.html).

24.2.6 Links and References

24.2.6.1 *Web citizen*

The RSS GE is relying on Web principles:

- URI to identify resources
- consistent URI structure based on REST style protocol

24.2.7 Paginated Collections

The RSS API will not limit the number of elements returned, because RSS services don't require the exchange of large data sets.

24.3 API Operations

The following sections explain the generic API operations. For complete examples of API requests and responses you can refer to the User's and Programmers Guide manual at https://forge.fi-ware.org/plugins/mediawiki/wiki/fiware/index.php/RSS_-_User_and_Programmer_Guide

24.3.1 RSS API REST

24.3.1.1 *Processing RSS Information*

(1)Creating RSS entries from CDRs

This API exposes the functionality that a partner (usually a store) will use to send its CDRs (Charging Data Record) to the RSS enabler for their processing.

Verb	URI	Description
POST	/rss/cdrs	Process one or more CDRs resources received

This API is related to the method detailed in https://forge.fi-

ware.org/plugins/mediawiki/wiki/fiware/index.php/FIWARE.OpenSpecification.Apps.RSS#Receiving_CDRs

Request Body

The request body of a POST operation should contain either the full set of fields of a single CDR. E.g.:

```
<?xml version="1.0" encoding="UTF-8"?>
<cdrs>
 <cdr>
  <id_service_provider> FieldValue </id_service_provider>
  <id_application> FieldValue </id_application>
  <id_event> FieldValue </id_event>
  <id_correlation> FieldValue </id_correlation>
  <purchase_code> FieldValue </purchase_code>
  <parent_app_id> FieldValue </parent_app_id>
  <product_class> FieldValue </product_class>
  <description> FieldValue </description>
  <cost_currency> FieldValue </cost_currency>
  <cost_units> FieldValue </cost_units>
  <tax_currency> FieldValue </tax_currency>
  <tax_units> FieldValue </tax_units>
  <cdr_source> FieldValue </cdr_source>
  <id_operator> FieldValue </id_operator>
  <id_country> FieldValue </id_country>
  <time_stamp> FieldValue </time_stamp>
  <id_user> FieldValue </id_user>
 </cdr>
</cdrs>
```

or of a CDRs list:

```
<?xml version="1.0" encoding="UTF-8"?>
<cdrs>
 <cdr> ... </cdr>
 ...
 <cdr> ... </cdr>
</cdrs>
```

24.3.2 Expenditure Limits API REST

These APIs are related to the methods detailed in https://forge.fi-ware.org/plugins/mediawiki/wiki/fiware/index.php/FIWARE.ArchitectureDescription.Apps.RSS#Expenditure_Limits

24.3.2.1 *Expenditure limit management*

(1)Get existing limits of a provider

This operation allows getting the limits information of a provider.

Verb	URI	Description
GET	/expenditureLimit/limitManagement/{providerId}	Get the existing limits for a provider

Query parameters

Optional parameters that could be sent, to filter the information received:

- type: type of limit.
- currency: identifier of the currency.

(2)Create or update limits of a provider

This operation allows creating or updating the general data related to the expenditure limit for any user in a given application provider.

Verb	URI	Description
POST	/expenditureLimit/limitManagement/{providerId}	Create or update limits for a provider

Request Body

The request body of a POST operation should contain a set of fields. E.g.:

```
{ "service": "fiware",
 "limits": [
  {"type": "perTransaction",
   "currency": "EUR",
   "maxAmount": 100,
},
{ "type": "weekly",
  "currency": "GBP",
  "maxAmount": 500
},
{ "type":"daily",
  "currency": "EUR",
  "maxAmount": 200
},
```

```
{ "type":"monthly",
  "currency": "EUR",
  "maxAmount": 5000
},
{ "type":"monthly",
  "currency": "GBP",
  "maxAmount": 3000
}
]
}
```

(3)Delete limits of a provider
This operation allows deleting the user expenditure limit information and implies the cascade deletion of the pairs Provider-user where the application provider is providerId.

Verb	URI	Description
DELETE	/expenditureLimit/limitManagement/{providerId}	Delete existing limits of a provider

Query parameters

Optional parameters that could be sent, to filter the results over which the delete operation will be performed

- type: type of limit.
- currency: identifier of the currency

(4)Get limits of a customer
This operation allows getting the expenditure limits information of a customer.

Verb	URI	Description
GET	/expenditureLimit/limitManagement/{providerId}/{userId]	Get the existing limits for a customer

Query parameters

Optional parameters that could be sent, to filter the information received:

- type: type of limit.
- currency: identifier of the currency

(5)Create or update limits of a customer
This operation allows the creation or update of the expenditure limit data related to a specific user and a specific application provider.

Verb	URI	Description
POST	/expenditureLimit/limitManagement/{providerId}/{userId}	Create or update limits for a customer

Request Body

The request body of a POST operation should contain a set of fields. E.g.:

```
{ "service": "fiware",
 "limits": [
  {"type": "perTransaction",
   "currency": "EUR",
   "maxAmount": 100,
},
{ "type": "weekly",
  "currency": "GBP",
  "maxAmount": 500
},
{ "type":"daily",
  "currency": "EUR",
  "maxAmount": 200
},
{ "type":"monthly",
  "currency": "EUR",
  "maxAmount": 5000
},
{ "type":"monthly",
  "currency": "GBP",
  "maxAmount": 3000
}
]
}
```


(6)Delete limits of a customer

This operation delete the expenditure limit data related to a specific user and a specific application provider.

Verb	URI	Description
DELETE	/expenditureLimit/limitManagement/{providerId}/{userId}	Delete existing limits of a customer

Query parameters

Optional parameters that could be sent, to filter the results over which the delete operation will be performed:

- type: type of limit.

- currency: identifier of the currency.

24.3.2.2 *Balance and Accumulated management*

(1)Get user accumulated expenses
This operation allows getting the cumulative expenses of a customer.

Verb	URI	Description
GET	/expenditureLimit/balanceAccumulated/{userId}?QueryParameters	Get the current accumulated expenses of a customer

Query parameters

Optional parameters that could be sent, to filter the information received:

- type: type of limit.

(2)Check user balance
This operation allows checking if the customer has enough balance to purchase an application without exceeding the expenses limit.

Verb	URI	Description
POST	/expenditureLimit/balanceAccumulated/{userId}	Check the balance of a customer

Request Body

The request body of a POST operation should contain a set of fields. E.g.:

```
{"service": "fiware",
 "appProvider": "conwet",
 "currency": "EUR",
 "chargeType":"C",
 "amount": 1000
}
```

(3)Update user accumulated expenses
This operation allows updating the cumulative expenses of a customer after performing a purchase.

Verb	URI	Description
PUT	/expenditureLimit/balanceAccumulated/{userId}	Update the cumulative expenses of a customer

Request Body

The request body of a PUT operation should contain a set of fields. E.g.:

```
{  "service": "fiware",
  "appProvider": "conwet",
  "currency": "EUR",
  "chargeType":"C",
  "amount": 1000
 }
```

(4)Delete user accumulated expenses
This operation resets the cumulative expenses of a customer.

Verb	URI	Description
PUT	/expenditureLimit/balanceAccumulated/{userId}/reset	Delete the cumulative expenses of a customer

Request Body

The request body of a PUT operation should contain a set of fields. E.g.:

```
{ "service": "fiware",
  "appProvider": "conwet",
  "currency": "EUR",
  "type": "monthly"
}
```

24.3.3 Status Codes

200 OK

Standard response for successful HTTP requests. The actual response will depend on the request method used. The response will contain an entity describing or containing the result of the action.

201 Created

The request has been fulfilled and resulted in a new resource being created

202 Accepted

The request has been accepted for processing, but the processing has not been completed. The request might or might not eventually be acted upon, as it might be disallowed when processing actually takes place.

204 No Content

The server successfully processed the request, but is not returning any content.

400 Bad Request

The request cannot be fulfilled due to bad syntax.

401 Unauthorized

Specifically for use when authentication is required and has failed or has not yet been provided.

404 Not Found

The requested resource could not be found but may be available again in the future. Subsequent requests by the client are permissible.

409 Conflict

Indicates that the request could not be processed because of conflict in the request, such as an edit conflict.

500 Internal Server Error

A generic error message, given when no more specific message is suitable.

25 FIWARE OpenSpecification Apps RSS RSS-Models

You can find the content of this chapter as well in the wiki of fi-ware.

25.1.1.1 *Introduction*

The RSS GE needs valid RSS models to properly calculate payment files for each service provider. There can be several RSS models per service provider, with different combinations of parameters. For a given service provider, the RSS GE always uses the most restrictive model uploaded to its engine.

RSS models are created by the BM&BE GE and stored in the Registry GE, where the RSS GE reads them from.

25.1.1.2 *Format*

RSS Models have three fields:

- **appprovider_id**: Unique identification of the application provider which has to be paid for.
- **perc_revenue_share**: Percentage of the revenues which must be paid to the provider.
- **product_class** *(Optional)*: Class of products to which the RSS model applies. If this field is empty, the RS model applies to all products offered by the appprovider_id.

A generic example of a valid RSS Model format is as follows:

```
<rss_model>
  <appprovider_id> value </appprovider_id>
  <perc_revenue_share> value </perc_revenue_share>
  <product_class> value </product_class>
</rss_model>
```

26 FIWARE OpenSpecification Apps BusinessModeler

You can find the content of this chapter as well in the wiki of fi-ware.

Name	FIWARE.OpenSpecification.Apps.BusinessModeler
Chapter	Apps,
Catalogue-Link to Implementation	Business Modeler
Owner	iMinds, Camille Reynders

26.1 Preface

Within this document you find a self-contained open specification of a FI-WARE generic enabler, please consult as well the FI-WARE Product Vision, the website on http://www.fi-ware.org and similar pages in order to understand the complete context of the FI-WARE project.

26.2 Copyright

26.3 Legal Notice

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26.4 Overview

The Business Modeler GE is a part of the Applications/Services ecosystem and provides a graphical tool to business experts for creating and evaluating high-level business models. It allows them to get an estimation of the profitability of a certain model and define value and money streams quickly and transparently.
This component will integrate tightly with the Business Calculator which allows for the calculation of costs and adds simulation capabilities.
The Business Modeler GE uses a superset of XMI and UML metadata languages to describe a business model and all its additional relevant metadata:

- Document meta-data: Model description, authors, creation date, et cetera.
- The business elements and their relations, with descriptive values

- Comments and annotations, providing additional detailed information to document design decisions and clarify intent.
- The values necessary for the graphic representation and layout of the business elements

26.5 Basic Concepts

26.5.1 Target Usage

Market place and store owners, service providers and application developers that will be active on the Future Internet will need to be able to work out new business models to calculate revenue and cost streams in a distributed, asynchronous manner. Due to the rapid progress of technology and heavily fluctuating global economies these models need to be easily adjustable and centrally accessible to all of the relevant actors of the business models. The Business Modeler GE, in conjunction with the Business Calculator, Repository and RSS GE's, will be part of FI-WARE's contribution towards presenting internet based business networks the modalities to easily and timely adapt to an ever-changing market on a strategic level.

26.5.2 Target Users

Business experts interested in creating business models to document and facilitate high-level strategical decisions.

26.5.3 Workflow

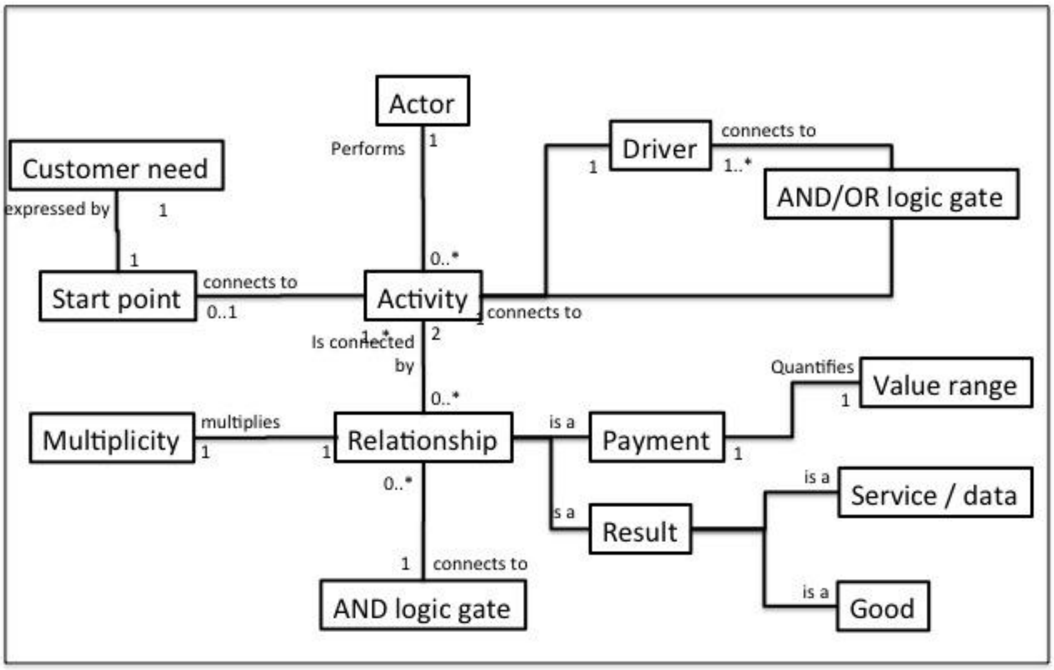
In an initial phase the different actors sit together and draw out in a lively discussion one or several variants for a business model. In this phase, building a business model will consist of determining (i) the activity(ies) played by every actor and the relationships between these activities and (ii) the related costs and revenues. Key to this is the definition of the type of flows (money, knowledge, products, etc.) that will be exchanged between those actors. The main focus in this work is aligning the view of all parties around the table to proceed to a clear delimitation of the roles and responsibilities.

All actors in the business model constructed in the first step will have to perform some tasks and invest to make the service work. In the initial business model, this work and the associated costs have not been detailed yet. In the second phase, different more technical experts can construct an estimation model for the costs of their part in the business model. This can happen in an isolated manner, in which the technical experts each work on their own model and do not have to interact directly. The result of this step is a set of cost estimation models for each of the elements in the business model.

The Business Modeler GE supports the first step in the modeling process, allowing easy and intuitive creation of high-level business models. The Business Calculator is used for creating the estimation models and calculate the simulated results.

26.5.4 Ontology

An explicit formal specification of the various business elements represented in the Business Modeler GE is described in the following ontology:



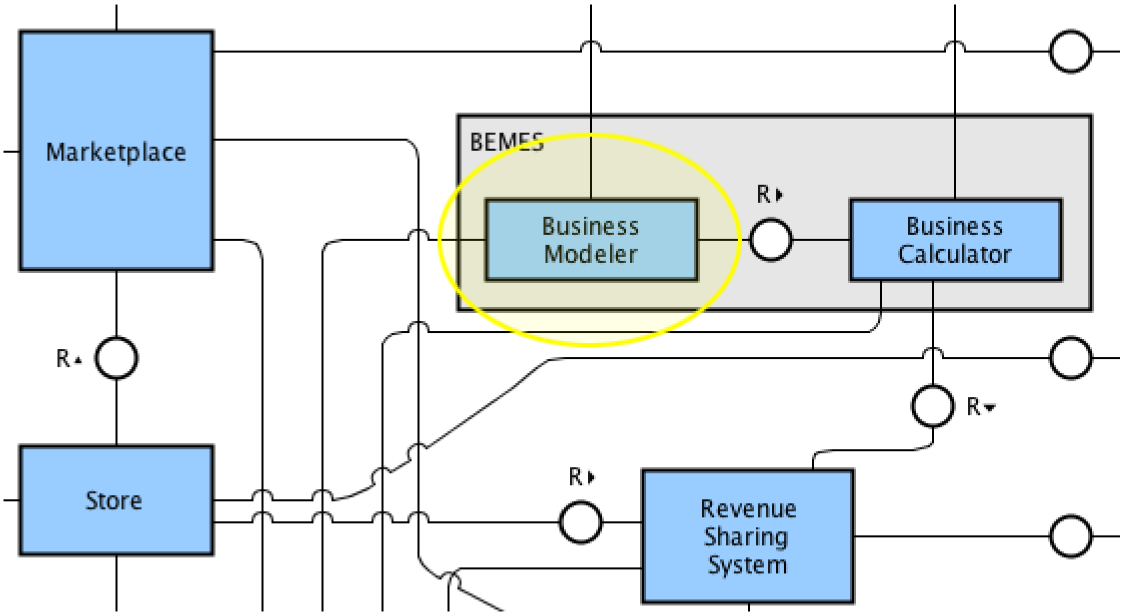
Business model value network ontology

The Business editor ontology has the following elements :

- Actor: an organisation (commercial or non-commercial) or type of individual (e.g. a consumer)
- Activity: a process that is performed by an actor in the context of the business model, e.g. share revenue.
- Customer need: the business model can address a customer need.
- Driver: a quantity that drives the outcome of the business model, e.g. number of customers.
- Relationship: indicates an interaction between two activities and therefore between two actors. We discern the following types:
- Payment: a monetary relationship.
- Results: either a service or data or a physical good that result from the payment
- Multiplicity: allows the modeller to indicate that a relationship is not executed just once, but more than once.

26.6 Business Modeler GE Architecture

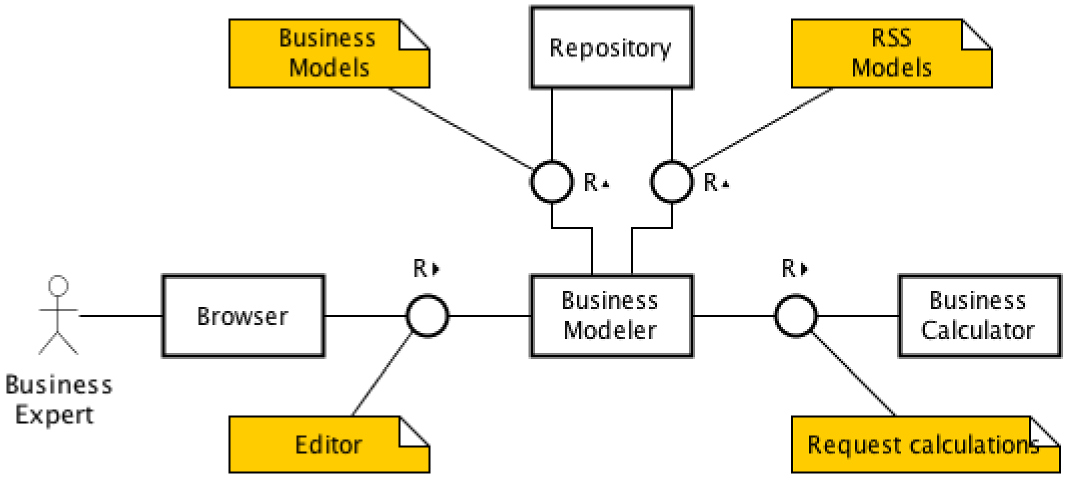
The Business Modeler GE is part of the Business Framework within the FI-WARE platform and integrates with the Business Calculator, Repository and RSS GE's



Business Modeler GE in the context of the FI-WARE platform

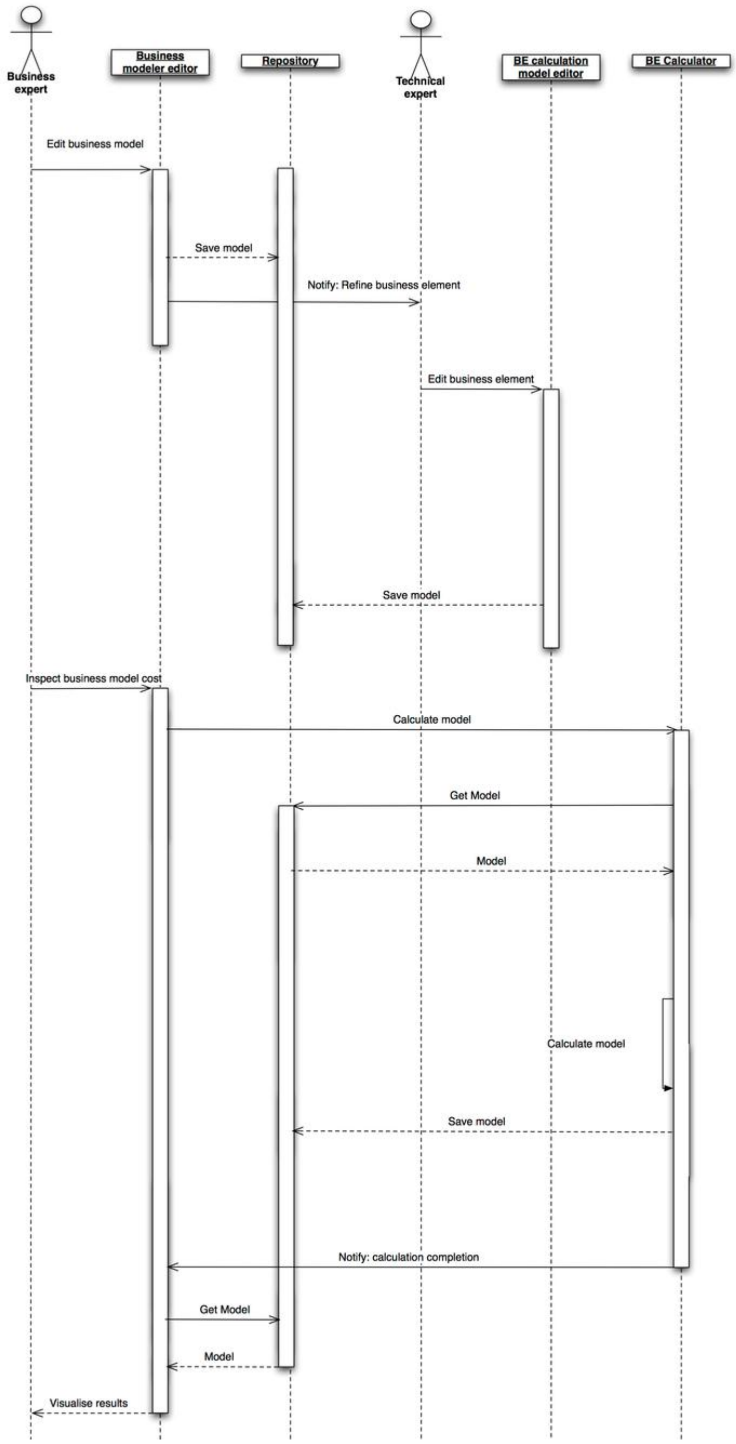
The Business Modeler GE is a responsive single-page web application created in HTML5, CSS3 and JavaScript, accessible through a common web browser. All business model creation and rendering is executed client-side. It allows users to save business model documents (XML) to their hard drives and subsequently open them for further editing. They are also presented with the possibility to load, use and upload business model (templates) from and to the Repository GE.

Revenue sharing activities are an integral part of business models; users of the Business Modeler GE can download existing RSS models from the Repository GE to use them in their business models. All cost and revenue sharing calculations are performed by the Business Calculator GE (using an adapter to connect to the RSS GE) and are requested through standard asynchronous REST API calls with XML as a messaging format.



26.7 Main Interactions

The Business Modeler GE mainly interacts with the Business Calculator and Repository GE's, through service request calls to their RESTful API's.



Business Modeler GE and Business Calculator sequence diagram

After the Business Expert finishes creating a business model and uploads it to the Repository, a Technical Expert is notified that (a) certain business element(s) require(s) more technical refinement and detailing. The Technical Expert then uses the business element calculation model editors to supply this information and provide detail on revenue or cost calculations inside the business model.

The Business Expert requests the business element calculator to calculate and simulate cost and revenue streams using the updated business model. When calculation results are avaible the business expert uses the Business Modeler GE to visualise the results.

26.7.1 Business model management

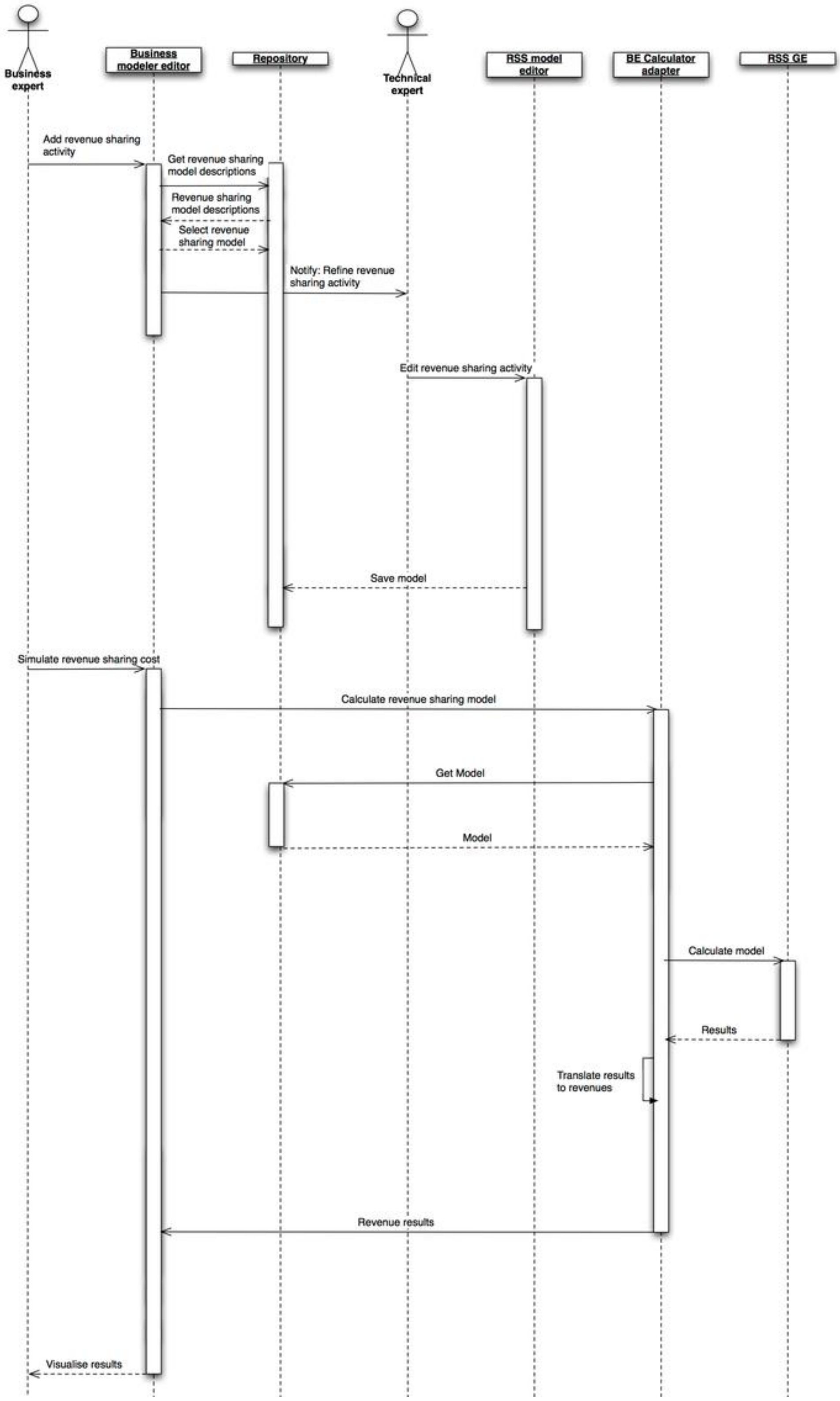
See above figure, the Business Modeler GE retrieves and stores business models from and to the Repository GE.

26.7.2 Cost calculations

See above figure, the Business Modeler GE communicates with the Business Calculator for the calculation and simulation of costs.

26.7.3 External calculator integration

The Business Modeler GE can connect to external calculators through the use of calculator adapters. An example of this is the RSS GE which is used to calculate revenue streams for a business model.



Business Modeler GE and RSS sequence diagram

The Business Expert is presented with a list of RSS models registered to the Repository, which she can use in her business model. If the RSS model needs input parameter refinement it is sent to a Technical Expert whom, using the RSS model editor (part of the RSS GE), details the RSS model and its parameters. To simulate the revenue sharing an adapter (part of the Business Calculator) connects to the RSS GE's RESTful API and feeds it with the necessary data to obtain a calculation. These results are translated to a business model compatible format and are visualised in the Business Modeler GE.

26.8 Basic Design Principles

The Business Modeler GE provides a webbased GUI with a focus on ease-of-use, possible extendability and future portability, using the latest technologies and paradigms to ensure a maximum reusability potential.
Special attention is being given to the encapsulation of 3 domains:

1. user interaction mechanisms
2. concrete model construction
3. model visualisation

For the FI-WARE reference application a concrete implementation of these 3 domains is focused on a web-based asynchronous client-side single-page application to be viewed in a web browser and with typical desktop input devices. This separated approach however facilitates easy porting of the application to other contexts. E.g. a native mobile application, a server-side static multi-page application or a desktop application.

26.9 Detailed Open Specifications

- FIWARE.OpenSpecification.Apps.BusinessModeler.Ontology (TBD)
- FIWARE.OpenSpecification.Apps.BusinessModeler.BusinessModelFormatSpecification

26.10 References

- XMI specification
- UML

26.11 Terms and definitions

This section comprises a summary of terms and definitions introduced during the previous sections. It intends to establish a vocabulary that will be help to carry out discussions internally and with third parties (e.g., Use Case projects in the EU FP7 Future Internet PPP). For a summary of terms and definitions managed at overall FI-WARE level, please refer to FIWARE Global Terms and Definitions

- **Aggregator (Role):** A Role that supports domain specialists and third-parties in aggregating services and apps for new and unforeseen opportunities and needs. It does so by providing the dedicated tooling for aggregating services at different levels: UI, service operation, business process or business object levels.
- **Application:** Applications in FI-WARE are composite services that have a IT supported interaction interface (user interface). In most cases consumers do not buy the application, instead they buy the right to use the application (user license).

- **Broker (Role):** The business network's central point of service access, being used to expose services from providers that are delivered through the Broker's service delivery functionality. The broker is the central instance for enabling monetization.
- **Business Element:** Core element of a business model, such as pricing models, revenue sharing models, promotions, SLAs, etc.
- **Business Framework:** Set of concepts and assets responsible for supporting the implementation of innovative business models in a flexible way.
- **Business Model:** Strategy and approach that defines how a particular service/application is supposed to generate revenue and profit. Therefore, a Business Model can be implemented as a set of business elements which can be combined and customized in a flexible way and in accordance to business and market requirements and other characteristics.
- **Business Process:** Set of related and structured activities producing a specific service or product, thereby achieving one or more business objectives. An operational business process clearly defines the roles and tasks of all involved parties inside an organization to achieve one specific goal.
- **Business Role:** Set of responsibilities and tasks that can be assigned to concrete business role owners, such as a human being or a software component.
- **Channel:** Resources through which services are accessed by end users. Examples for well-known channels are Web sites/portals, web-based brokers (like iTunes, eBay and Amazon), social networks (like Facebook, LinkedIn and MySpace), mobile channels (Android, iOS) and work centers. The access mode to these channels is governed by technical channels like the Web, mobile devices and voice response, where each of these channels requires its own specific workflow.
- **Channel Maker (Role):** Supports parties in creating outlets (the Channels) through which services are consumed, i.e. Web sites, social networks or mobile platforms. The Channel Maker interacts with the Broker for discovery of services during the process of creating or updating channel specifications as well as for storing channel specifications and channeled service constraints in the Broker.
- **Composite Service (composition):** Executable composition of business back-end MACs (see MAC definition later in this list). Common composite services are either orchestrated or choreographed. Orchestrated compositions are defined by a centralized control flow managed by a unique process that orchestrates all the interactions (according to the control flow) between the external services that participate in the composition. Choreographed compositions do not have a centralized process, thus the services participating in the composition autonomously coordinate each other according to some specified coordination rules. Backend compositions are executed in dedicated process execution engines. Target users of tools for creating Composites Services are technical users with algorithmic and process management skills.
- **Consumer (Role):** Actor who searches for and consumes particular business functionality exposed on the Web as a service/application that satisfies her own needs.
- **Desktop Environment:** Multi-channel client platform enabling users to access and use their applications and services.
- **Event-driven Composition:** Components concerned with the composition of

business logic, which is driven by asynchronous events. This implies run-time selection of MACs and the creation/modification of orchestration workflows based on composition logic defined at design-time and adapted to context and the state of the communication at run-time.

- **Front-end/Back-end Composition:** Front-end compositions define a front-end application as an aggregation of visual mashable application pieces (named as widgets, gadgets, portlets, etc.) and back-end services. Front-end compositions interact with end-users, in the sense that front-end compositions consume data provided by the end-users and provide data to them. Thus the front-end composition (or mashup) will have a direct influence on the application look and feel; every component will add a new user interaction feature. Back-end compositions define a back-end business service (also known as process) as an aggregation of backend services as defined for service composition term, the end-user being oblivious to the composition process. While back-end components represent atomization of business logic and information processing, front-end components represent atomization of information presentation and user interaction.
- **Gateway (Role):** The Gateway role enables linking between separate systems and services, allowing them to exchange information in a controlled way despite different technologies and authoritative realms. A Gateway provides interoperability solutions for other applications, including data mapping as well as run-time data store-forward and message translation. Gateway services are advertised through the Broker, allowing providers and aggregators to search for candidate gateway services for interface adaptation to particular message standards. The Mediation is the central generic enabler. Other important functionalities are eventing, dispatching, security, connectors and integration adaptors, configuration, and change propagation.
- **Hoster (Role):** Allows the various infrastructure services in cloud environments to be leveraged as part of provisioning an application in a business network. A service can be deployed onto a specific cloud using the Hoster's interface. This enables service providers to re-host services and applications from their on-premise environments to cloud-based, on-demand environments to attract new users at much lower cost.
- **Marketplace:** Part of the business framework providing means for service providers, to publish their service offerings, and means for service consumers, to compare and select a specific service implementation. A marketplace can offer services from different stores and thus different service providers. The actual buying of a specific service is handled by the related service store.
- **Mashup:** Executable composition of front-end MACs. There are several kinds of mashups, depending on the technique of composition (spatial rearrangement, wiring, piping, etc.) and the MACs used. They are called application mashups when applications are composed to build new applications and services/data mash-ups if services are composed to generate new services. While composite service is a common term in backend services implementing business processes, the term 'mashup' is widely adopted when referring to Web resources (data, services and applications). Front-end compositions heavily depend on the available device environment (including the chosen presentation channels). Target users of mashup platforms are typically users without technical or programming expertise.
- **Mashable Application Component (MAC):** Functional entity able to be consumed

executed or combined. Usually this applies to components that will offer not only their main behaviour but also the necessary functionality to allow further compositions with other components. It is envisioned that MACs will offer access, through applications and/or services, to any available FI-WARE resource or functionality, including gadgets, services, data sources, content, and things. Alternatively, it can be denoted as ‘service component’ or ‘application component’.

- **Mediator:** A mediator can facilitate proper communication and interaction amongst components whenever a composed service or application is utilized. There are three major mediation area: Data Mediation (adapting syntactic and/or semantic data formats), Protocol Mediation (adapting the communication protocol), and Process Mediation (adapting the process implementing the business logic of a composed service).
- **Monetization:** Process or activity to provide a product (in this context: a service) in exchange for money. The Provider publishes certain functionality and makes it available through the Broker. The service access by the Consumer is being accounted, according to the underlying business model, and the resulting revenue is shared across the involved service providers.
- **Premise (Role):** On-Premise operators provide in-house or on-site solutions, which are used within a company (such as ERP) or are offered to business partners under specific terms and conditions. These systems and services are to be regarded as external and legacy to the FI-Ware platform, because they do not conform to the architecture and API specifications of FI-WARE. They will only be accessible to FI-WARE services and applications through the Gateway.
- **Prosumer:** A user role able to produce, share and consume their own products and modify/adapt products made by others.
- **Provider (Role):** Actor who publishes and offers (provides) certain business functionality on the Web through a service/application endpoint. This role also takes care of maintaining this business functionality.
- **Registry and Repository:** Generic enablers that able to store models and configuration information along with all the necessary meta-information to enable searching, social search, recommendation and browsing, so end users as well as services are able to easily find what they need.
- **Revenue Settlement:** Process of transferring the actual charges for specific service consumption from the consumer to the service provider.
- **Revenue Sharing:** Process of splitting the charges of particular service consumption between the parties providing the specific service (composition) according to a specified revenue sharing model.
- **Service:** We use the term service in a very general sense. A service is a means of delivering value to customers by facilitating outcomes customers want to achieve without the ownership of specific costs and risks. Services could be supported by IT. In this case we say that the interaction with the service provider is through a technical interface (for instance a mobile app user interface or a Web service). Applications could be seen as such IT supported Services that often are also composite services.
- **Service Composition:** in SOA domain, a service composition is an added value service created by aggregation of existing third party services, according to some predefined work and data flow. Aggregated services provide specialized business

functionality, on which the service composition functionality has been split down.

- **Service Delivery Framework:** Service Delivery Framework (or Service Delivery Platform (SDP)) refers to a set of components that provide service delivery functionality (such as service creation, session control & protocols) for a type of service. In the context of FI-WARE, it is defined as a set of functional building blocks and tools to (1) manage the lifecycle of software services, (2) creating new services by creating service compositions and mashups, (3) providing means for publishing services through different channels on different platforms, (4) offering marketplaces and stores for monetizing available services and (5) sharing the service revenues between the involved service providers.
- **Service Level Agreement (SLA):** A service level agreement is a legally binding and formally defined service contract, between a service provider and a service consumer, specifying the contracted qualitative aspects of a specific service (e.g. performance, security, privacy, availability or redundancy). In other words, SLAs not only specify that the provider will just deliver some service, but that this service will also be delivered on time, at a given price, and with money back if the pledge is broken.
- **Service Orchestration:** in SOA domain, a service orchestration is a particular architectural choice for service composition where a central orchestrated process manages the service composition work and data flow invocations of the external third party services in the order determined by the work flow. Service orchestrations are specified by suitable orchestration languages and deployed in execution engines who interpret these specifications.
- **Store:** An external component integrated with the business framework, offering a set of services that are published to a selected set of marketplaces. The store thereby holds the service portfolio of a specific service provider. In case a specific service is purchased on a service marketplace, the service store handles the actual buying of a specific service (as a financial business transaction).
- **Unified Service Description Language (USDL):** USDL is a platform-neutral language for describing services, covering a variety of service types, such as purely human services, transactional services, informational services, software components, digital media, platform services and infrastructure services. The core set of language modules offers the specification of functional and technical service properties, legal and financial aspects, service levels, interaction information and corresponding participants. USDL is offering extension points for the derivation of domain-specific service description languages by extending or changing the available language modules.

27 FIWARE OpenSpecification Apps BusinessCalculator

You can find the content of this chapter as well in the wiki of fi-ware.

Name	FIWARE.OpenSpecification.Apps.BusinessCalculator
Chapter	Apps,
Catalogue-Link to Implementation	Business Calculator
Owner	iMinds, Koen Casier

27.1 Preface

Within this document you find a self-contained open specification of a FI-WARE generic enabler, please consult as well the FI-WARE Product Vision, the website on http://www.fi-ware.org and similar pages in order to understand the complete context of the FI-WARE project.

27.2 Copyright

27.3 Legal Notice

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27.4 Overview

The business calculator is the component which will be closely interacting with the Business modeler in order to add the simulation capabilities. The business calculator will be not a single implementation, but rather an open specification of the interface for the interaction between the business modeler and the business calculator. In the implementation phase several approaches to modeling and simulating costs are investigated and extended in open specifications, and are developed up to a plugin to the generic enabler.
The core functionality of each of these plugins is to provide the user with a means to estimate the evolution of costs in one consisting element of the business model according to a structured calculation model.

Typically users will make use of this business calculator GE and the different possible implementations it has within the FiWare project, through the Business Modeler GE. This allows the users to add a simulation layer to a business model, making it more predictive of economic background. In order to allow the user to draw and integrate their models in the business calculator GE, an additional limited web-based editor front-end will be provided in case this is needed. Finally the models generated in the editor, as well as any models created in another editor can be saved in a repository for later binding in the business modeler GE (by means of their identification-name). Integrating the business calculator GE in a larger tool-chain is of course possible and the business calculator GE will provide one REST interface (with asynchronous call-back) to accomplish this. This same interface will also be used in the limited editor in order to test-run a new detailed model, as well as in the business modeler in order to link all detailed models to the different elements and integrate all simulation results.

27.5 Basic Concepts

27.5.1 Target usage

When the different business actors come together to work out a new business model in the Future Internet, their first hub will be the Business Modeler. This highly interactive editor allows them to quickly draw out a business model, instigate the discussions and add descriptions and documentation in order to make it a more solid proposal. Of course as a final outcome of this process, the actors would like to go a step beyond this documentation and try to simulate the impact this new model could have in terms of revenues, costs, profitability. In order to achieve this, the technical experts of the different actors should be able to quickly and accurately sketch out their cost and revenue structure. This will be the case for all actors, whether they are providing equipment (e.g. routers, software instances, linecards, servers, sensors, etc.) , operational tasks (maintenance, installation, etc.), write software or have a more complex business propositions. The Business Calculators complement flexible modeling languages with an accurate and tunable calculation approach. To make the modeling languages and approaches extensible and scalable, we use a plugin architecture in which the REST interface will be the same for each plugin calculator and only the model selector will be differing. The results of the calculation will of course in the follow-up steps be fed into the business modeler and visualized in there. The structure of the business model in combination with the simulation results will give the business experts of the different actors an intuitive view on both the interactivity in the model as its validation.

27.5.2 Plug-in architecture

As mentioned before the business calculator is constructed with a plugin extensibility in mind. Even more, we consider the use of one expert model encompassing all possible costs and revenues as infeasible and will lead to an overly complex and no longer intuitive modeling approach. From our background research we found that extensible models should be kept small and dedicated to one task. In this sense they will also perfectly map with the smallest consisting element of a business model. We make an initial distinction between equipment coupling (tree or graph structure linking equipment to each other by dependencies), operational processes, software development and network structure. We will work out an open specification modeling approach for all these models, and provide a calculator GE which is capable of estimating the costs of a given model when given the required inputs (e.g. estimated number of customers). As such each of the aforementioned modeling approaches will have a dedicated open specification (when this is not yet existing) and a calculator. These will be added gradually as research, open specs and implementation for these evolves. When a new GE implementation for a new modeling approach is available, this GE will be linked into the overall business calculator GE.

27.5.3 Equipment Coupling Modeling Notation (ECMN)

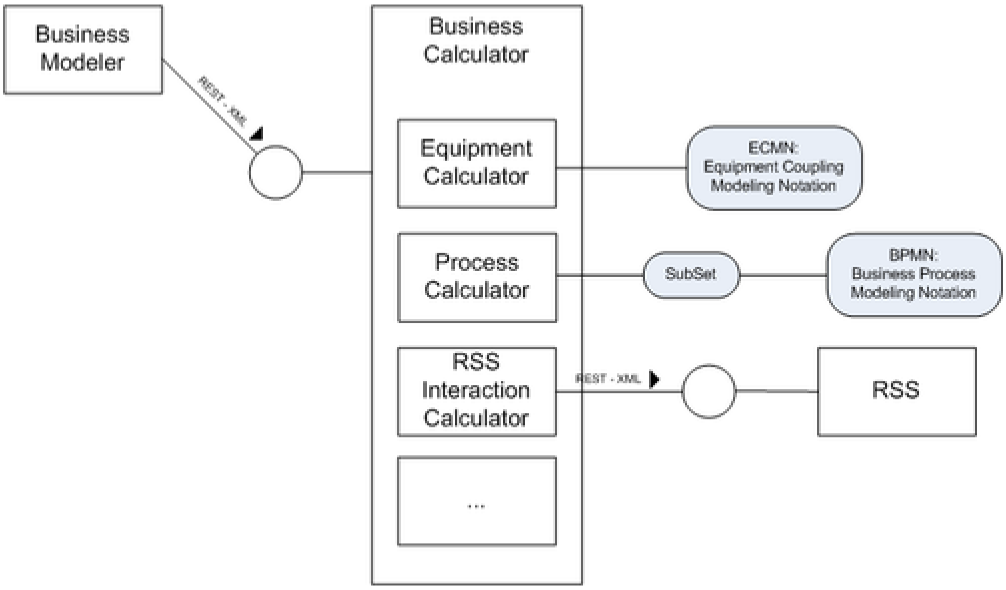
The Equipment Coupling Modeling Notation is a novel approach to drawing out the essential structure of equipment and its coupling constraints to each other and to the context of a business model (by means of so called drivers). The ECMN consists of a hierarchical structure documenting how equipment is linked to each other and what the constraints on later calculations will be. The hierarchical model will be represented in a graph structure. The inputs for these models will come from context specific parameters from the business model such as number of customers, number of sites,etc., from default parameters detailed in the model itself or from already calculated parameters from other models within the business model. The calculator is able to calculate for each type of equipment in the model, the amount to be installed at each point in time, when given the required input for the drivers. As such the ECMN allows to model the equipment to be installed in order to fulfill an activity in a business model, for instance installation of racks, storage, servers, communication equipment, etc. for providing a data-center capability. As such the ECMN also allows a model to be reused in different business models or different contexts of the same business model, and at the same time allows to quickly insert an alternative technology stack for the same business model. The details of the ECMN will be added in the open specifications and pushed towards standardization. A GE implementation will enable the user to estimate the amounts and costs for installing equipment given the context of the business model in which it is to be used.

27.5.4 Business Process Modeling Notation (BPMN)

Business Process Modeling Notation will be used as the backing model for all estimations of process related costs. It is important to make the distinction between operational expenditures and process related costs here, as even capital expenditures could well caused and modeled in a process based approach. For details on the BPMN we refer to the existing standard [1] and we will be using a very limited subset of this for the calculator. The reason for this subset lies in the balance between modeling effort and estimation detail. In the case of a new business model the details the BPMN offers are too expensive in terms of modeling effort and especially considering the fact that there are many unknown (or variable) parameters, the modeling should be fast and as such cut in the details. Details on this subset will be added to the open specification document

27.6 Business Calculator Architecture

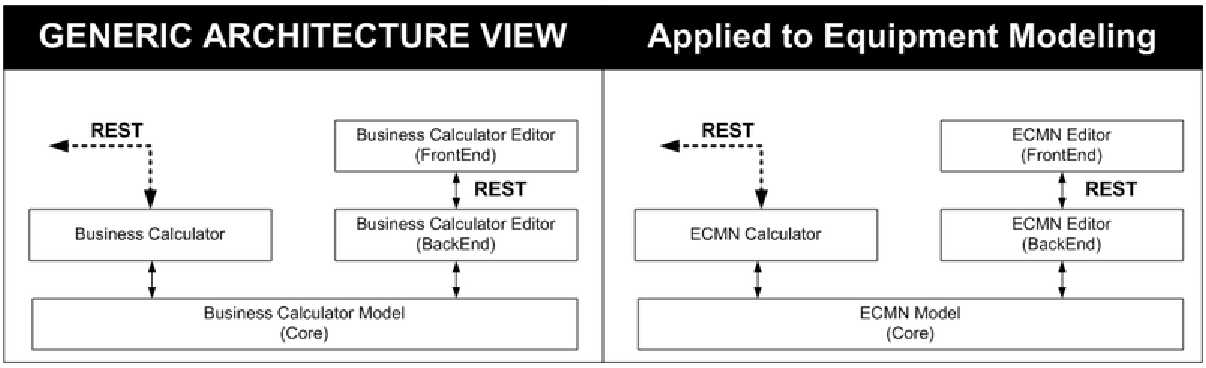
The Business Calculator is a plugin architecture which will be providing one identical interface for all different calculator approaches which are plugged in at runtime. All these calculators will be provided as separate GE implementation and might be directly called from the business modeler, or dispatched by detection of the modeling language by one overarching Business Calculator GE (TBD). The main building blocks and its interactions of the Business Calculator Architecture are shown in the figure underneath.



Business calculator architecture

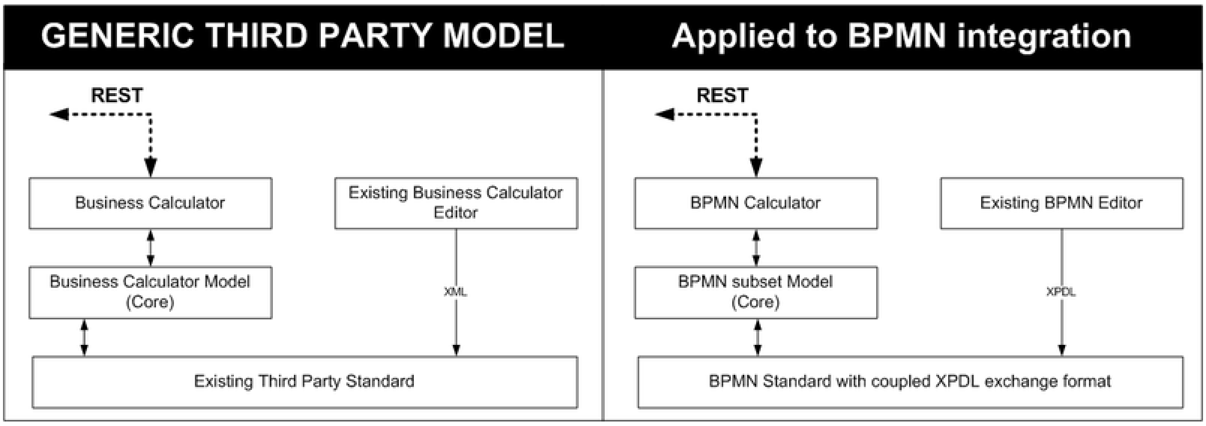
27.6.1 Typical Implementation Architecture

For any implementation within the Business Calculator we make an explicit split between the model, editor and calculator components. Both the calculator as the editor have a REST interface by which the communication is handled. The editor also has a front-end communicating with the back-end and storing the models, properties and calculations data remotely in normal operation. We make the front-end also available in a stand-alone version in which no connection to the server is required. In this case new models will have to be uploaded to the repository prior to calculations in the business modeler. A view on this architecture is shown in the figure below.



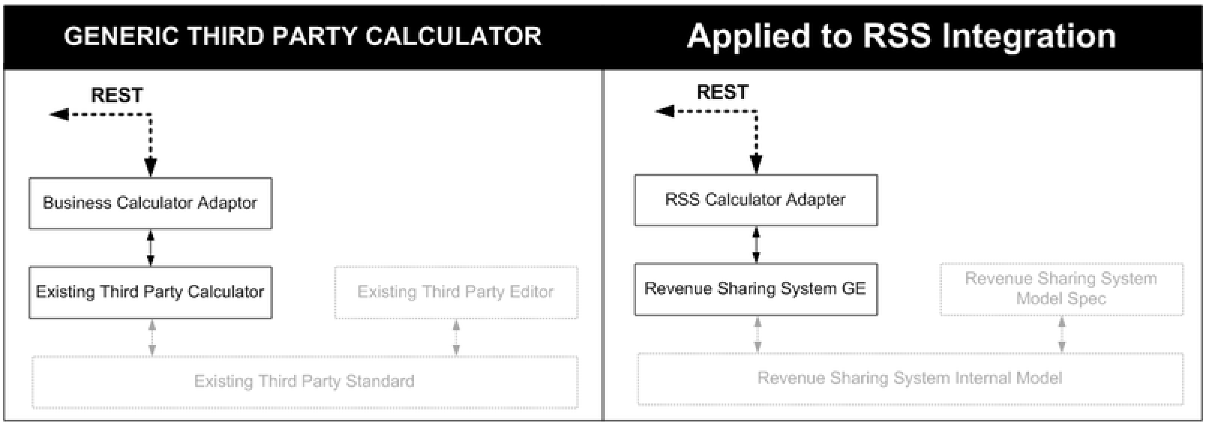
Business Calculator Typical Implementation

With this architecture it is fairly straightforward to implement an additional editor working on the same core and with additional functionality, or implement a new calculator providing an alternative means of estimating the costs for a given model. This will be for instance the case for the business process modeling notation for which plenty of editors are available all equipped with an export to XPDL (XML process description language) functionality. This standardized model can then be used in the BPMN calculator. This is shown in the figure underneath.



Business Calculator Implementation with existing model

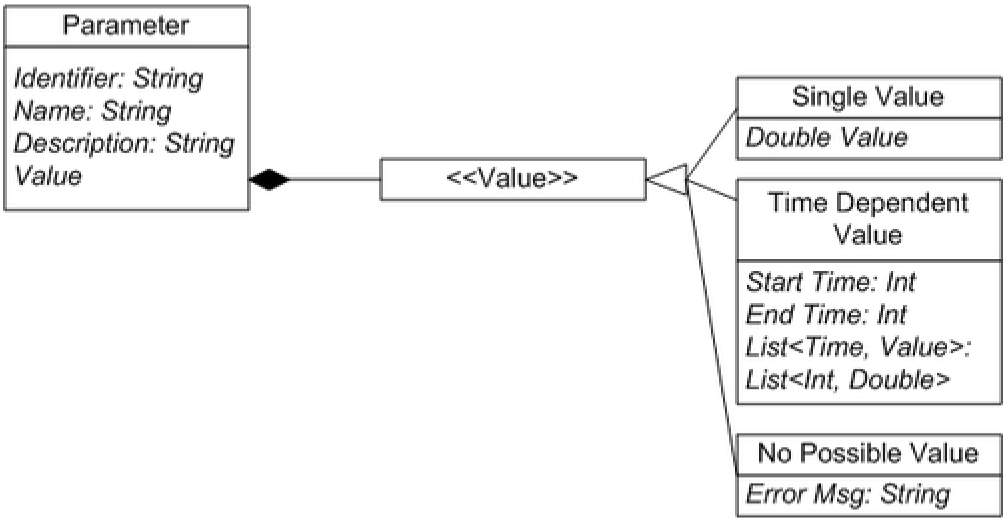
Finally as mentioned before we will make a link of the business modeler with the revenue sharing system and in order to accomplish this, we make an adapter which will call the RSS calculator and load in there the model as selected by the user and execute this with the necessary input and translate the calculated output. In this scheme both the calculator as the editor are proprietary and the adapter will translate to an internal mapping model. This is shown in the figure underneath.



Business Calculator Implementation with existing calculator

27.6.2 Business Calculator Input/Output Ontology

The business modeler will shift all simulation to the business calculators. In order to accomplish this, the business modeler and business calculator agree to the interface between them. The ontology of the data for the input as well as for the output of the business calculator, we are working towards the following:

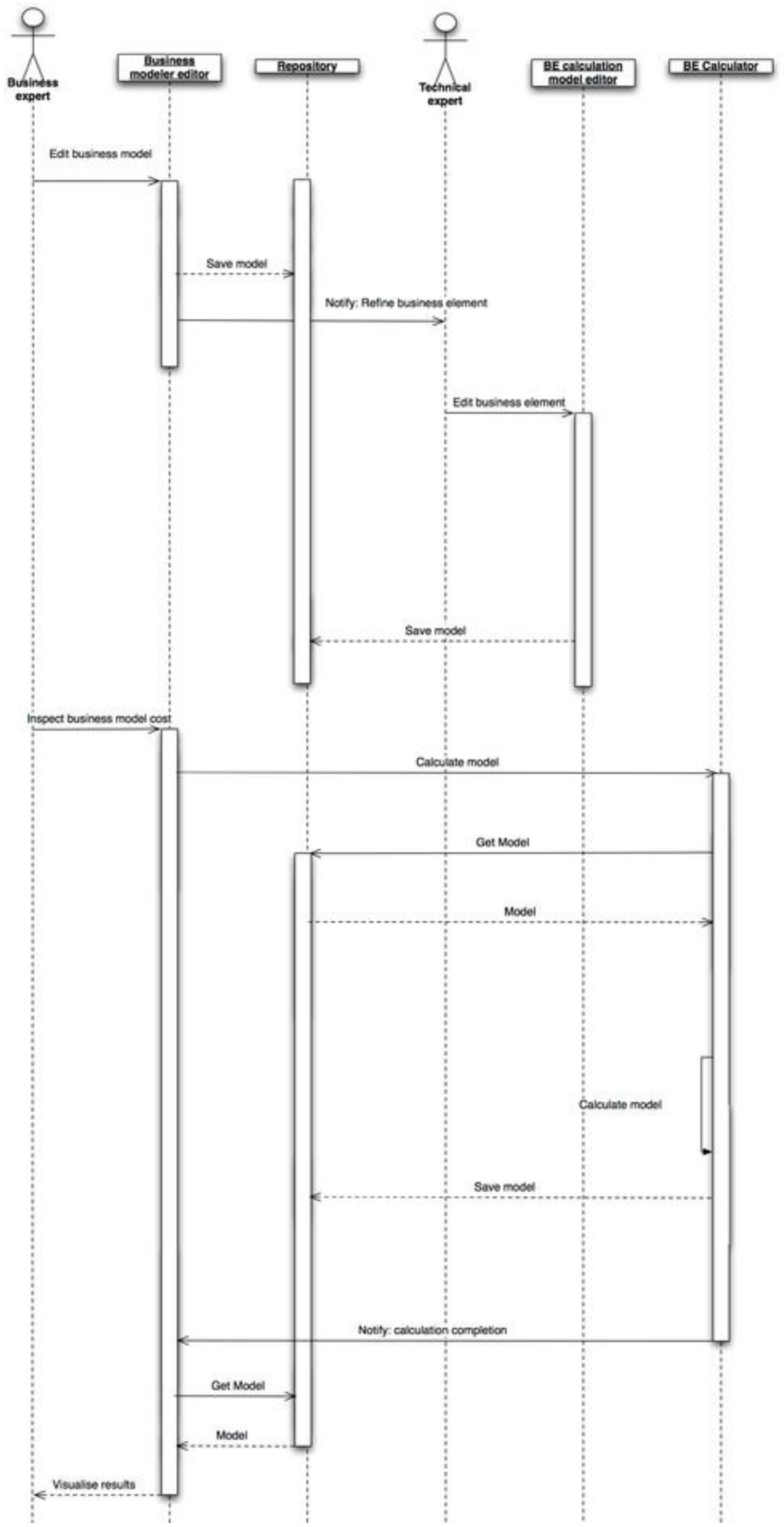


Business calculator Input Output Ontology

As the integration of the business modeler and the business calculator is scheduled to take place after the first release of both business modeler GE and business calculator GE, this interface is still a subject of discussion and there might be changes in this format during implementation phase.

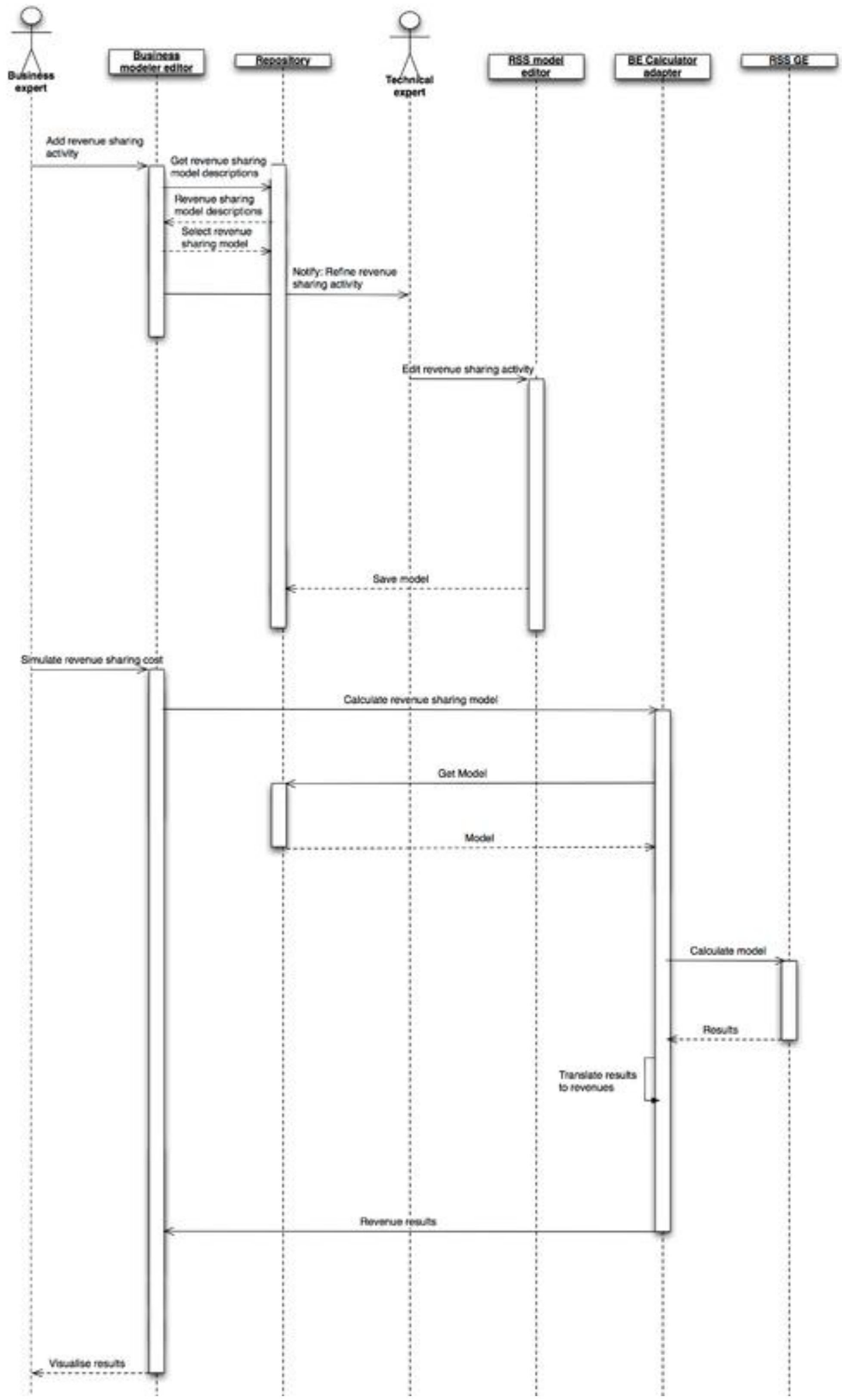
27.7 Main Interactions

The Business Calculators will be used in close cooperation with the business modeler. The sequence diagram shown below depicts the most typical interaction of the business modeler with the business calculator. When the business modeler is fully defined, in which case each business element has a more detailed technical model associated, it can be simulated. To accomplish this, the business modeler will call for each element the business calculator corresponding to the model internally associated and give the overall context as input to work with. For instance when the task of providing (installing) network, IaaS, PaaS equipment or software packages is concerned, the detailed model could be an ECMN model in which the equipment to be installed is modeled in terms of customers, area, etc. When such model is combined with information on the predictions for amount of customers, coverage, etc, this leads to an estimation of the amount of equipment of the different types to be installed. This will directly lead to a prediction of future costs for fulfilling this task in the business model. All information from this role will be added to the context of the business model and handed as input in the follow-up steps in the calculation where iteratively all elements in the business model are calculated. In this way the profitability of the full business model and for each separate role and actor in it can be estimated prior to the real implementation.



Business Modeler and Business Calculator sequence diagram

Any tool chain incorporating the whole or parts of these calculators will work in the same way. All interaction between the business modeler and the different business calculators will happen through the same REST-interface. In this way several business calculators can be linked to other tools in a transparent manner. Extending the Business Calculator with additional implementations is as such also only a question of implementing the common REST interface and linking it in the tool chain or in the overall Business Calculator GE. When a calculator is already existing using another way of interaction, the best way to integrate this into the tool chain of the Business Calculator is by adding an adapter translating the input and output from the proprietary calculator to the input and output of the Business Calculator. This is also the workflow that will be used for integrating the Revenue Sharing System into the Business Modeler tool chain as shown in the sequence diagram below. In this way the user of the Business Modeler can integrate revenue sharing models into the business modeler to add specific estimations to the overall business modeling tool chain.



Business Modeler and RSS sequence diagram

27.8 Basic Design Principles

As has been mentioned above, the business calculator GE is actually a plug-in aggregation of several dedicated modeling and calculation approaches. We have chosen to work with one web-based REST interface which allows to present a calculator with a model and input and return the outcome. We extend this interface with an identification approach for checking whether the presented model can be calculated with the business calculator send to. This in order to provide the following properties:

- easily extend the business calculator GE with additional calculator plug-ins
- instantiation and linking could be done at run-time
- easy to obtain parallelism by plugging in redundant calculators of the same kind
- easy linking within Fi-Ware by means of adapters translating input and output to/from the business modeler GE
- easy linking within Fi-Ware and outside of the business modeler GE

27.9 Detailed Open Specifications

27.9.1 Open Model Specifications and existing model specification adjustments

As mentioned, the business calculator is a plugin approach which will be providing a calculator for multiple modeling approaches. Some of the modeling approaches might already have a standardized format (e.g. BPMN) and will be adjusted or reduced to fit the cost estimation purposes, other modeling approaches might already have an implementation within the FiWare consortium (RSS) and a simple adapter will be added to interact with this component. For all cases the specification, novel or with adjustments and possible reductions, will be described in detail and conforming to the calculator. It is important to note that failing to apply these specs with their adjustments and reductions might lead in non-functioning of the calculator.

The open specifications for the following modeling languages have been included in this architecture:

- Equipment Coupling Modeling Notation
- Business Process Modeling Notation (of which we use a subset)
- Revenue Modeling Wizard
- Hierarchical Network Modeling Wizard

The full open specs for each of those languages can be found in a separate section for each language.

27.9.2 Business Calculator Open API Specifications

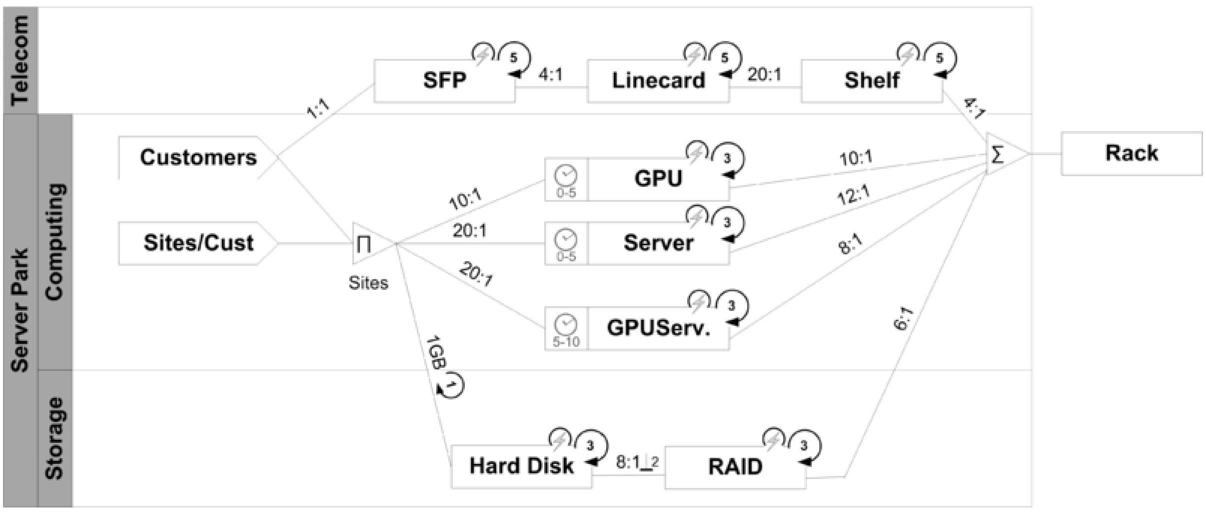
- XML storage format
  all XML data formats are described in detail in the [Programmer Guide]
- REST interfaces
  all REST interfaces are described in detail in the [Programmer Guide]

27.10 Open Specification for Equipment Coupling Modeling Notation

When tackling the problem of how to dimension a central office, a street cabinet, a server room, etc., one is repetitively having the same discussions and making very comparable calculations. For instance a street cabinet of a telecom operator contains one small rack and one or two power blocks in there. It contains at max 3 (sometimes 4) shelves and each of those shelves can be equipped with a predefined amount of line cards. Finally this amount of line cards will be directly correlated to the amount of customers to serve via this street cabinet. Calculations of the dimensioning are as such clearly hierarchical in nature. For instance the amount of shelves will depend on the amount of line cards which is in turn dependent on the amount of customers to connect. Definitely the modeling and calculation are two separate steps in the process of dimensioning the equipment. The first subsection will detail the visual equipment coupling modeling notation. In the section following, this visual language is coupled to an XML format for which an XSD description will be added to make this more rigid and standardized. The third subsection is detailing how the calculation of the dimensioning (amount of needed equipment for each type) can be performed based on this visual ECMN. Finally, the last subsection will add examples to make things more concrete and at the same time provide cases that can be used both in testing as in the construction of templates.

27.10.1 Visual Notation

As mentioned, the equipment model consists of a hierarchical structure documenting how equipment is linked to each other and what the constraints on later calculations will be. The hierarchical model will be represented in a graph structure for which an example, on which we will extend, is shown below:



Equipment Modeling Notation Example

The basic building blocks of the equipment model are:

Driver

A driver with the name indicated in the arrow. The direction of the arrow is inside the equipment model and can be placed at any side of the model. Typically the drivers are placed at the left hand side or at the bottom (at the 'leaves' of the tree). Additional information is to be coupled to this driver and some modeling specific information, e.g. recurrence, can be added directly attached to the driver block in the model.

The following information can be coupled to the driver:

- Name: Unique (model) String value
- ID: String – for identification in a broader context

The driver is an input block and as such no other block can connect before this block. The driver can connect to multiple other equipment, aggregator and/or separator blocks.

Intermediate Driver

An intermediate driver is the same as a driver with the difference that it is used for making the link between two points in the model. It can connect at the one side to one incoming child and on the other side it can connect to multiple equipment, aggregator and/or separator blocks.

It is to be used in the following two cases:

1. Clarity of the model: In this case the intermediate driver will make the link from one point in the model to another point to allow having less connectors crossing other connectors or blocks.
2. Sub model: In the case of the sub model it is used in the expanded view to indicate clearly the end of the sub model and where it connects to the higher level model.

The following information can be coupled to the intermediate driver:

- Name: String value which can be used twice in the same model
- ID: String – for identification in a broader context

In the editor, clicking on the one intermediate driver should also indicate the other intermediate driver (when existing) it is linking to.

Equipment

Identifies a type of equipment based on its name.

Additional information is to be coupled to this equipment and some modeling specific characteristics, e.g. reinstallation period, power usage, etc., can be added directly attached to the equipment block in the model.

The following information can be coupled to the equipment:

- Name: Unique (model) String value
- ID: For identification

- Cost: Double or time dependent
- Capacity: Double
- Size: Double + possibility to give its unit (e.g. gigabyte)
- Maintenance: Fixed percentage (Double) or time dependent
- Energy Consumption: Double (possibly later time dependent)
- Installation: Fixed percentage (double) or fixed cost per unit (double) or time depenent
- Floor space: Double
- Reinstallation time: Integer value

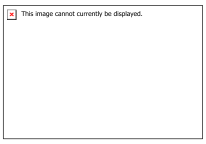
Equipment can be coupled directly after one other equipment, one driver, one aggregator or one separator by means of a connector (shown below). An equipment block itself can couple to multiple other equipment, aggregators and/or separators.

Sub-model

Equipment models are inherently hierarchical and can be stacked in a hierarchical manner with more intuitive visualization and modeling by means of a sub model.

The editor should intuitively allow seeing the expanded view of this sub-model (e.g. through double click). The content of the sub-model is similar to a regular ECMN using all blocks mentioned here. To start with we fix the constraints so that a sub-model should connect to one input (child) indicated in the expanded view as a driver and one output (parent) indicated by an intermediate driver in the expanded view. In the future we might relax this constraint and open up the possibility to have multiple input drivers and multiple intermediate drivers. At that point we will have to make the link between the higher level model and its sub-models clear (e.g. by ID or name).

Aggregator

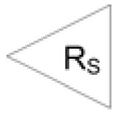


An aggregator will combine constraints into one new constraint to link to blocks further in the calculations (called down flow parent), thereby linking multiple children to one parent. Additionally, aggregators can define how the combination of constraints should be performed by means of a flexible rule set (RA) indicated directly into the symbol. By default, the summating aggregator is assumed: then, the aggregator can be removed from the figure in this case. An aggregator can be linked from multiple drivers, equipment, aggregators and/or separators (called children) up to several other equipment, aggregators and/or separators. The following information can be coupled to the aggregator:

- Name: String value
- ID: String – for identification in a broader context

The example below should be read as the amount of servers is depending on the total number of sites which is the multiplication of the number of customers and average sites/customer.

Separator



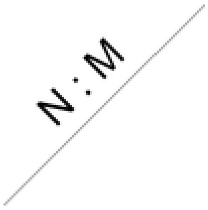
Name Separator

A separator will separate constraints into multiple - not necessarily different - constraints to link to equipment further in the calculations, thereby linking one child to multiple parents. Additionally separators can define how the split of constraints should be performed by means of a flexible rule set (RS) indicated directly into the symbol. By default the parallel separator is assumed in which case the separator can be removed from the figure. If wished or required, a separator can have an identification or name. The separator can be linked from one driver, equipment, aggregator or separator up to several other equipment, aggregators and/or separator.

The following information can be coupled to the separator:

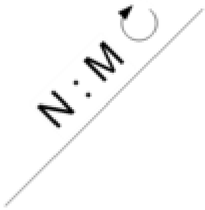
- Name: String value
- ID: String – for identification in a broader context

Connector



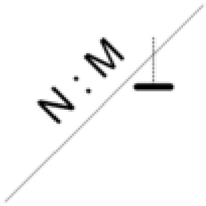
The connector is represented by a simple line and connects drivers, equipment, aggregators or separators to each other. The granularity factor links the different levels of equipment types, by indicating the maximum number of equipment of the lower type (children - N) that is needed before a new equipment of the higher type (down flow parent - M) is to be installed. By default, a connector without any granularity indicated refers to a 1:1 connector. The following example should read as follows: For every 1000 customers a new hard disk should be installed. It is not required that the parent side of the connector be equal to one or be smaller than the child side. The following example requires hard disks to be installed per 2 for every 1000 customers, for instance for the sake of redundancy. When a size is set for the parent of this connector link, a simple granularity relation to this size can be used as well. For instance the following example indicates that 1GB per user is reserved on the disk. When the size of the disk is set to 1000GB or 1TB, this means that a new hard disk has to be installed per 1000 new customers.

Recurrent Driver



In case equipment needs to be installed on a yearly base (or with a predefined recurrence) in correspondence to its input (e.g. driver), this is indicated with the repetitive symbol on top of the connector. An example can include the yearly increase of the available disk space for each user. Extending the previous example, the example shown below reads as "every year an extra 1GB hard disk space must be installed per existing customer". As mentioned before the 1 in the recurrence symbol can be omitted.

Batched Installation



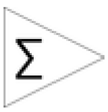
Certain types of equipment can only be installed in batches. The basis for the batch can be either the parent or the child. In case the child side has been selected, this refers to a minimal installation batch per installation of the parent (taking into account the granularity). This has been used in the example below and means: A RAID controller can contain 8 hard disks and for every new RAID controller at least 2 new hard disks should be installed.

In case the parent side has been selected, this refers to a minimal installation batch first time – so only for the first installation of the parent. This has been used in the example below and means: for every 1000 customers, a new hard disk should be installed, but the first time installation requires two hard disks to be installed.

A batch can also be the default way of installation, or a requirement for a every new installation. This is made clear by means of an averaging indicator. The example below uses this, which means: every addition of hard disks to the RAID should always happen in batches of 2.

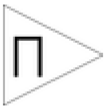
As mentioned before, the links between drivers and equipment and from equipment to other equipment higher in the hierarchy can be tuned with calculation rules. The following calculation rules are defined in the equipment modeling language:

Summation Aggregator



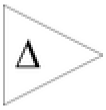
Calculates the amount of all down flow parent types based on the sum of the amount of all children.

Multiplication Aggregator



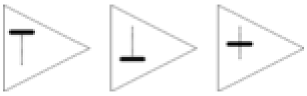
Calculates the amount of all down flow parent types based on the multiplication of the amount of all children.

Difference Aggregator



Difference aggregator: Calculates the amount of all down flow parent types based on the difference between two children (limited to two children).

Maximum, Minimum and Average Aggregator



Max, min and average aggregator: Calculates the amount of parent type equipment based on the highest, lowest or average amount of children type equipment

As mentioned before, additional annotations can be added to both the drivers and equipment to indicate additional aspects to take into account in discussions and in the calculations. The following annotations are defined in the equipment modeling language:

Recurrent Installation

Any equipment annotated with this symbol will have to be reinstalled with a reinstallation period as indicated (t) in the loop.

Time Dependent Installation

This equipment has to be included for a certain period in time. Applying this to different types of equipment allows substituting equipment for newer equipment at a later point in time.

Maintenance

The maintenance of this type of equipment entails an extra cost, which is recurring periodically.

Upfront Maintenance

The maintenance of this type of equipment entails an extra cost, which needs to be paid to the supplier upfront (fixed maintenance contract).

Floor space

The equipment consumes a reasonable amount of floor space inside the central office, cabinet, server room. A leasing cost for this floor space should be taken into account.

Active Equipment

This symbol indicates that the equipment under study contains active components, and will therefore consume electricity.

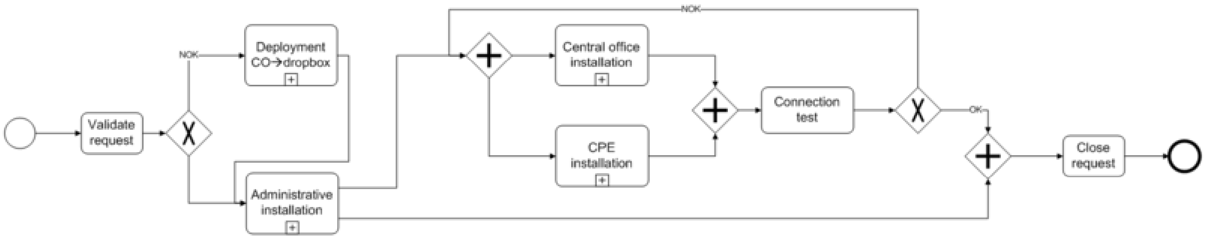
Finally the different building blocks of an ECMN can be grouped in swim lanes and pools as an indication of the responsibilities for the different equipment. Swim lanes are indicated by large bars indicating the grouping in which the different equipment blocks are assigned. This can be based on different types of groupings, such as which business unit is going to pay or maintain them, etc. More in general all blocks in the model should be assignable to different groups and it should be possible to make this grouping visible by means of swim lanes or coloring.

27.11 Open Specification of the subset from BPMN to be used for process based cost modelling

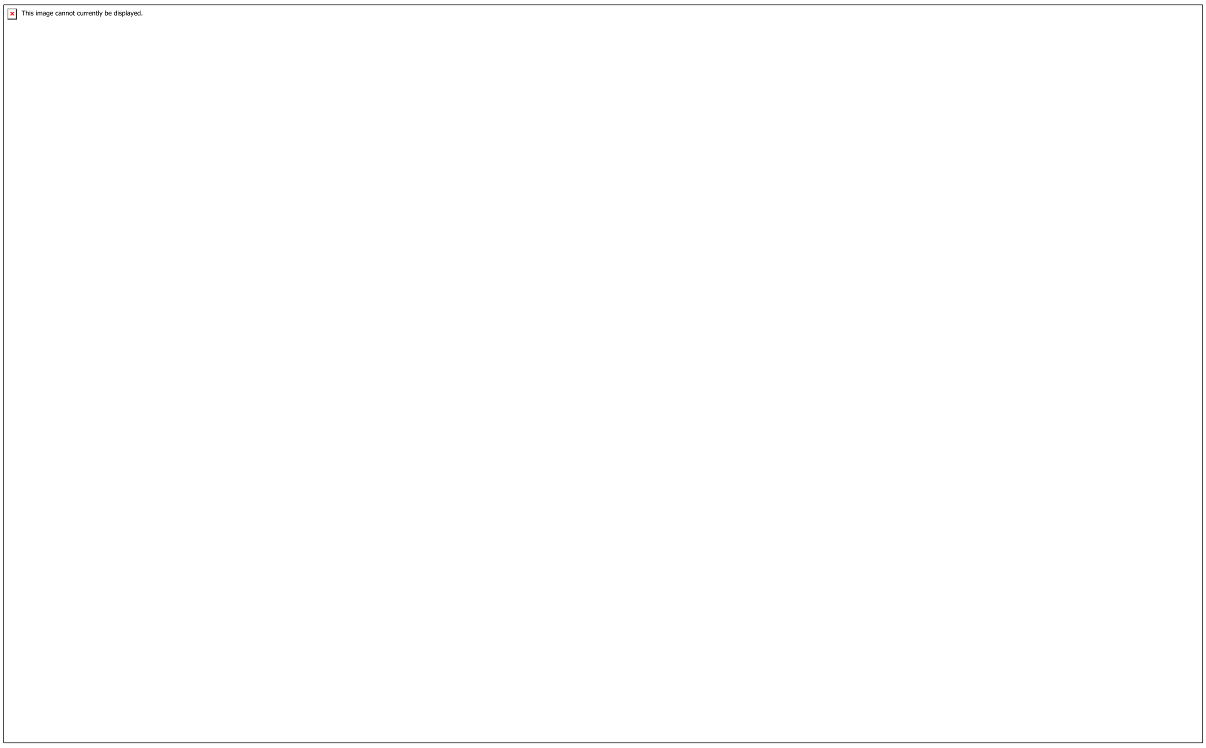
When tackling the problem of how to dimension and estimate of the costs of executing operational processes for instance physical repair tasks, installation, etc. One is repetitively performing the same tasks. Although many approaches exist for visualizing the flow of a process, typically by means of some flowchart based modeling language, the link of this flowchart towards estimation of future new costs is not straightforward. There are several tools which allow the user to perform such operational modeling for their current organization with the focus on allocation of the costs to the different departments and predict the effect of small changes in these models. The business process modeling notation (BPMN) is an existing modeling language which is mature and has an XML based storage and exchange format (XPDL). For the sake of modeling the costs of future installations and with a focus on the estimation and not on the hyper realistic mapping of costs, we will adapt this format, but leave out several of the more detailed aspects. In what follows we describe in short the visual notation, the interpretation of this format in the case of business modeling and future cost estimations. The second subsection will detail how the XPDL format is accustomed to contain new information required for the calculation and/or resulting from the calculations. The third subsection details how the operational process calculation can be performed in two possible ways when given the operational process and the necessary information in this model. Finally the last subsection will add examples to make things more concrete and at the same time provide cases that can be used both in testing as in the construction of templates.

27.11.1 Visual Notation

As mentioned before, the business process modeling notation is a standardized visual modeling language which can be used for drawing out operational processes and link cost calculation to this. The visual format is based on a flowchart structure and two examples are shown below:



Business Process Modeling Notation



Business Process Modeling Notation

A process model in BPMN is built around three basic building blocks: events, activities and gateways, indicated by circles, rectangles and diamonds respectively. Additional graphical notations give intuitive information on the type, occurrences, causes, etc. of the elements. A complete detailed description of all elements can be found in the full reference.

Events

From the start event, an incoming request for execution of the process is fired. When reaching the end event, all activities (if any) still running in the process are stopped, the request is consumed and control is handed back to the encompassing process.

Intermediate events indicate situations in which a given part of the process is triggered during the running of the process. The following more specific events will be used in the calculation models. (all other events will be handled in the following manner: Start events will be considered message start events, Intermediate events will be removed from the model (or calculation), and end events will be considered end or cancelling events)

Message start event

Contains some information within the event that can be used in the running of the process (e.g. cause of the execution). For the estimation purposes of the costs of running an operational process, the message start event will contain information on the amount of events for each year are expected and possibly also of the spread of these events.

The following information can be coupled to the message start event:

- Name: Unique (model) String value
- ID: String – for identification in a broader context
- Interval or events per year Double: The interval between two events of this type or the amount of events encountered per year of this type
- Variation on the interval or events per year: The standard deviation expected in the interval or events per year of this type of event

Timer intermediate event

Will trigger an intermediate event once a predetermined time has elapsed. The timer starts counting from the moment this intermediate event is reached in the process. In the description of an operational process with the aim of estimating the costs, this will contain data on the timing over which the events are running. This can contain data on the time when the first events will start, the time they will end or both start and end indicating the interval over which the events are triggered. This is an interesting tool for splitting the process in time-dependent execution paths.

The following information can be coupled to the link timer intermediate event:

- Name: Unique (model) String value
- ID: String – for identification in a broader context
- Interval or events per year Double: The interval between two events of this type or the amount of events encountered per year of this type
- Variation on the interval or events per year: The standard deviation expected in the interval or events per year of this type of event

Link intermediate and end event

Will trigger the execution of the corresponding link end event. All link intermediate events with the same name will link to the same (unique) link end event in the process. It is often used to link two situations to the same execution path and for graphically structuring the process.

The following information can be coupled to the link intermediate events:

- Name: Unique (model) String value
- ID: String – for identification in a broader context

End or cancelling event

An ending event which will cancel all process steps up to this point and leave the overall process.

The following information can be coupled to the end event:

- Name: Unique (model) String value
- ID: String – for identification in a broader context

Activities

Activities indicate the actions taking place in the execution of the process. They will contain a descriptive name and can contain parameters for the calculation of the costs.

Simple activity

This can have additional indications for repetitive execution and multiple parallelized instances indicated at the bottom border. For the case of estimating future costs, the following information should be available in the activity: (1) an average time required for the execution and the amount and type of people executing this. (2) the number of parallelized instances possible (3) the amount of repetitions to be executed (4) any information on variations of this data.

In the calculations currently the following information of the activity is used:

- Name: Unique (model) String value
- ID: String – for identification in a broader context
- extendedAttributes: Mapping of name to double value. The name indicates the type of personnel, and the double value indicates the amount of time required for this personnel on average to perform this activity.

For the future the following information should be coupled to the activity:

- Name: Unique (model) String value
- ID: String – for identification in a broader context
- Average working time: the average working time for a team of people to accomplish the task
- Size of team: team size
- Personnel-type: ID based name for the personnel type
- Amount of parallel instances
- Amount of repetitions

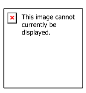
Collapsed sub process

An activity linking to a sub process which is indicated by its (unique) name and will have a start and end event linking to entrance and exit of this activity. The link from the main process to the sub process will happen in the case of the cost estimation calculator by means of the events – start: input, end: output.

Gateways

Gateways indicate splits or joins in the process. Those splits can either be conditional or unconditional and can have multiple incoming and outgoing execution paths of which more than one can be chosen at the same time. The incoming and outgoing paths are distinguished by their names.

Exclusive gateway



Only one of the outgoing paths is taken. The default path can be indicated by a small strike through. Additional information can be added on the probabilities of the different outgoing paths. An exclusive join is typically not used in the model. Paths are just aggregated, often at the next mutual activity, without the use of this symbol.

The following information can be coupled to the exclusive gateway:

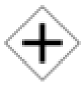
- Name: Unique (model) String value
- ID: String – for identification in a broader context

Additional calculation information is typically linked to the paths coming out of the exclusive gateway.

The following information can be coupled to the path (transition) coming out of the gateway:

- Name: Unique (model) String value
- ID: String – for identification in a broader context
- probability: value between 0 and 1. In an exclusive gateway the summation of all probabilities will be one. If probabilities are not defined for one or more paths coming out of the gateway, the remaining probability is evenly distributed over these paths.

Fork or Join gateway



A fork will trigger execution along all outgoing paths in parallel. A join will wait for all incoming paths to end and trigger execution on the outgoing path in this case. Sometimes a fork is not explicated and paths are split at the last mutual activity, without the use of this symbol.

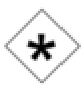
The following information can be coupled to the fork or join gateway:

- Name: Unique (model) String value
- ID: String – for identification in a broader context

The following information can be coupled to the path (transition) coming out of the gateway:

- Name: Unique (model) String value
- ID: String – for identification in a broader context
- probability: value between 0 and 1. In a fork gateway the summation of all probabilities is not required to be limited to one. A probability of 1 is used for each path for which this probability is not delicately set.

Complex gateway



Where the calculation and selection of the follow-up steps is calculated according to an additional rule.

The following information can be coupled to the fork or join gateway:

- Name: Unique (model) String value
- ID: String – for identification in a broader context

The following information can be coupled to the path (transition) coming out of the gateway:

- Name: Unique (model) String value
- ID: String – for identification in a broader context
- probability: value between 0 and 1. Missing probability information leads to an error in the calculation.

Finally all kinds of data objects can be used to hold crucial information on one of those elements, or give more verbose explanation in some parts of the model. Very important in this are all types of aggregation through different structural groups (e.g. administration, technical personnel, etc.). Such aggregation is most often indicated by means of horizontal bars called pools and swim lanes.

27.12 Open Specification of the flexible and modular approach for estimating revenues

In a business model, the interaction between two actors (by means of activities) will often be based on an exchange of value, product or service in return for money. The figure below shows this interaction in an example business model in the most simplified form. In more general business models, such value-to-money exchange will be present in many more instances. In what follows we use the terminology (customer and provider) as indicated in the figure.

Making a profit on top of the costs is of course the main aim of the provider. Getting the right amount of products, services, or other value is the main aim of the customer. As such generic value exchange is essential to the business model and to its quantification; Within the business calculator, there is a dedicated and novel modeling approach defined to cover this.

27.12.1 Structure

The revenue modeling details the relation between the provider and the customer and will link information from both sides to each other. For instance in order to know which price to ask for a product in order to have a margin of 10% each year, the calculation will need the costs of the provider and the amount of customers. Additional information will be taken into account in this calculation as well.

The revenue modeling has no dedicated visual language and will be fully specified in an XML format and/or by means of a wizard. It consists of two different levels of detail at which a processing step can be added:

1. The pricing scheme itself which will calculate a price for a given amount of customers, the different costs, intended profit margin, etc. The pricing schemes here allow to define the calculation and parameters to use in the price calculation.
2. A hierarchical selection model that decides which pricing scheme to use for a given situation, depending on the amount of customers reached, timing, coverage, etc. The selection model allows differentiating the price for instance allowing a lower or higher price in the initial years or for the first customers and a different price at a later stage.

Finally, the processing step allows discussing the impact of discounting in the context of the pricing schemes and hierarchical selection models.

27.12.1.1 *Pricing Schemes*

(1)Fixed Price

In a fixed pricing scheme the user directly indicates the price for the customers to pay. There are no additional parameters and calculations. Clearly the fixed pricing scheme can also make use of a timed predefined price.

(2)Cost Based Pricing (=Cost Plus Pricing)

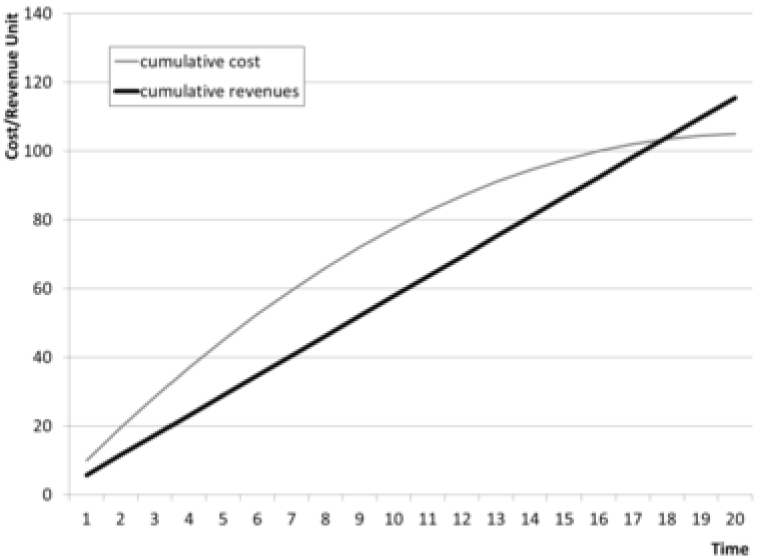
In cost based pricing the price the provider will charge will be based on an intended profit margin over the time horizon. This profit margin can be fixed or changing over the time horizon.

1. For a fixed profit margin

   As a consequence the price will be fixed over the time horizon as well.

   - The parameters in this pricing scheme are
   - Profit margin (%) a value in 0-1
   - The inputs of this pricing scheme are
   - The costs per year
   - The customers per year

   The figure underneath gives an overview of this pricing scheme for a given decreasing cost for a profit of 10%.

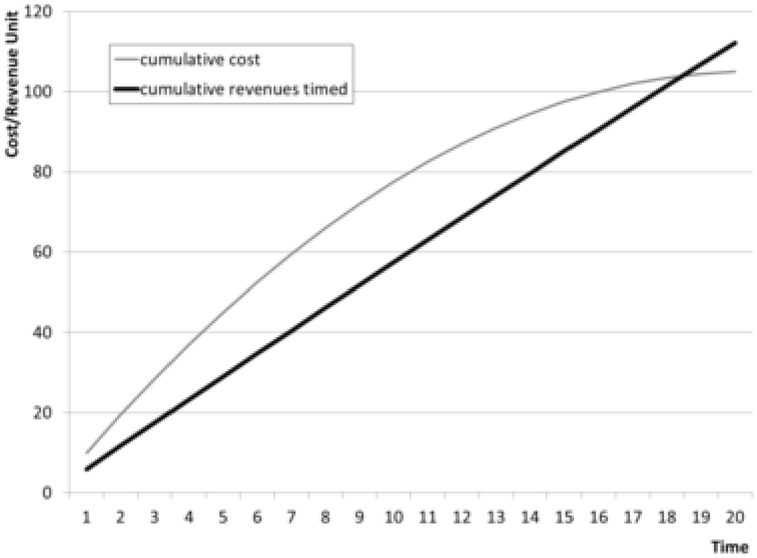


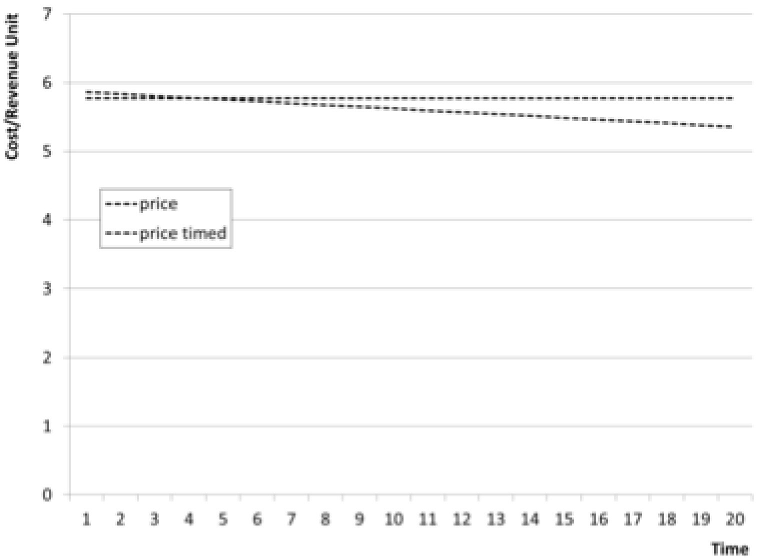
1. For a changing profit margin

As a consequence the price will no longer be fixed over the time horizon

- The parameters in this pricing scheme are
- Profit margin (%) a time dependent function with values in each year in 0-1
- The inputs of this pricing scheme are
- The costs per year
- The customers per year

The figure underneath gives an overview of this pricing scheme for a given decreasing cost for a profit of 10% over the first year, decreasing till 0% on the last year. The figure underneath gives the comparison of the pricing in this timed scheme to the untimed scheme:



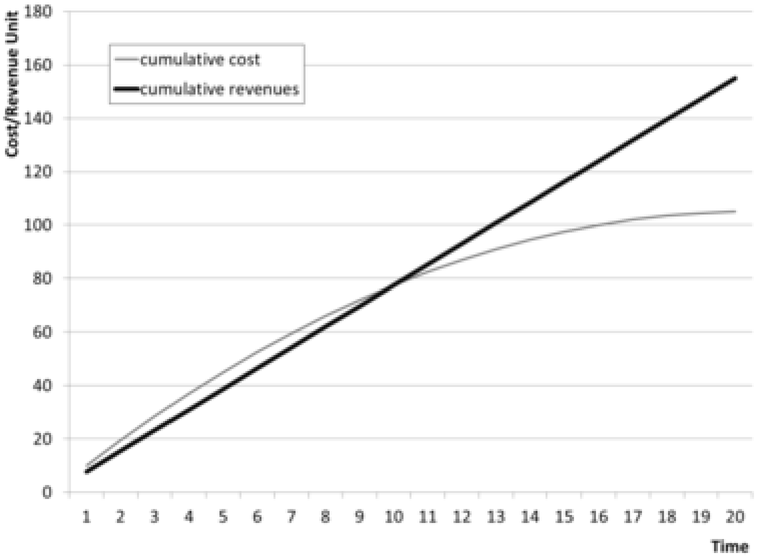


(3)Limit Pricing

In limit pricing the price the provider will charge will be aimed at breaking even on an intended time span (which can be shorter than the total time horizon). Again in our specification we consider the price to be fixed over the total time horizon.

- The parameters in this pricing scheme are
- Time Span for Break-even is set shorter than the time horizon for the analysis
- The inputs of this pricing scheme are
- The costs per year
- The customers per year

The figure underneath gives an overview of this pricing scheme for a given decreasing cost for a time span for break-even of 10 years:



(4)Integrated Cost Based Pricing

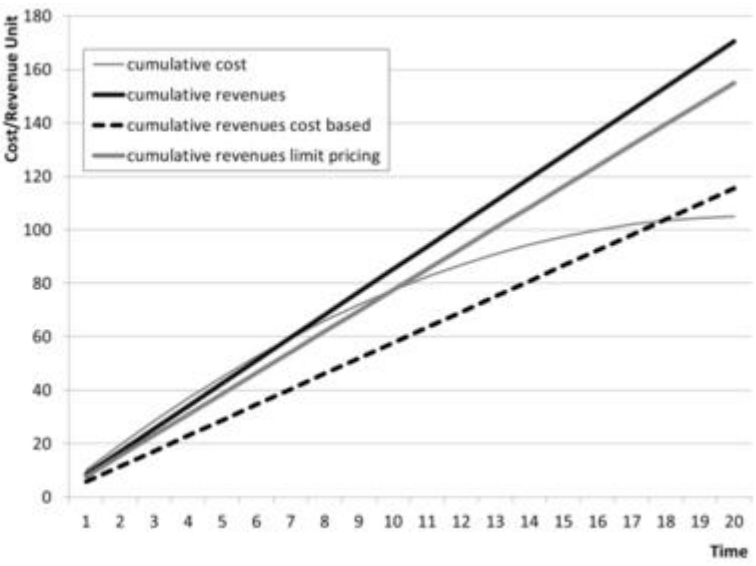
The integrated cost based pricing is actually an integration of both aforementioned pricing schemes. It is clear that a limit pricing scheme with a time span equal to the total time horizon can be mimicked by a cost based pricing with no intended profit margin. Taking together the two parameters – (1) intended profit margin and (2) intended time span – both cost based pricing and limit pricing can be covered by this new integrated cost based pricing. Again the integrated cost based pricing can be calculated using a fixed or a changing profit margin.

1. For a fixed profit margin

   As a consequence the price will be fixed over the time horizon as well.

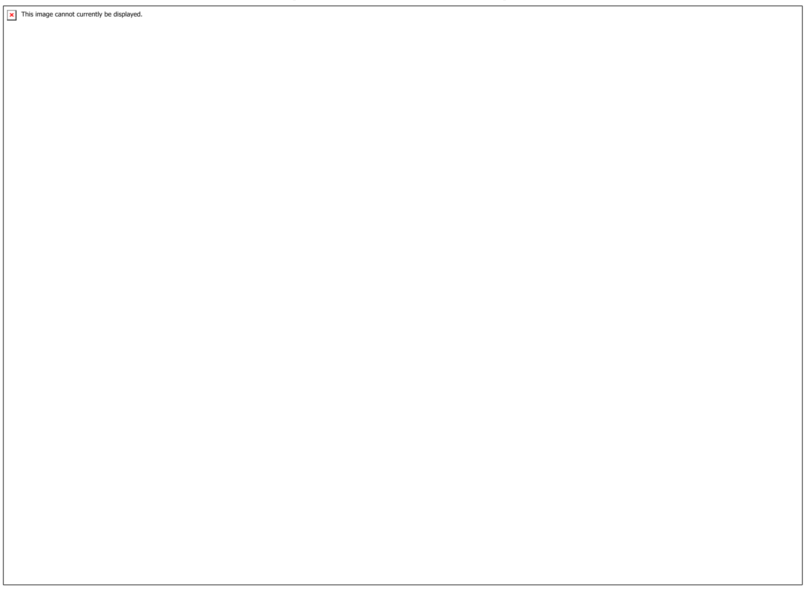
   - The parameters in this pricing scheme are
   - Profit margin (%) a value in 0-1
   - Time Span for Break-even is set shorter than the time horizon for the analysis
   - The inputs of this pricing scheme are
   - The costs per year
   - The customers per year

   The figure underneath gives an overview of this pricing scheme for a given decreasing cost for a time span for profit point of 10 years with a profit of 10% compared to both a limit pricing and a cost based pricing scheme with the same parameters:



1. For a changing profit margin
   As a consequence the price will no longer be fixed over the time horizon
   - The parameters in this pricing scheme are
   - Profit margin (%) a time dependent function with values in each year in 0-1
   - Time Span for Break-even is set shorter than the time horizon for the analysis
   - The inputs of this pricing scheme are
   - The costs per year
   - The customers per year

   The figure underneath gives an overview of this pricing scheme for a given decreasing cost for a time span for profit point of 10 years and a profit decreasing from 20% to 10% compared to a fixed profit of 10%:

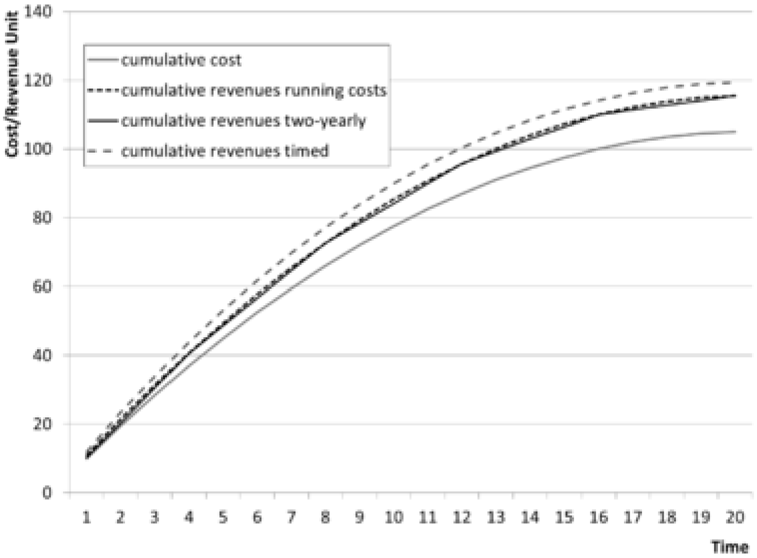


(5)Running Cost Plus Pricing

In running cost plus pricing the price will be based on a short term part of the total costs. It can be mimicked by a repetitive cost based pricing over the short term and with the repetition ending at the total time horizon. Typically the provider would want to have its costs of this year repaid by the customers of the same year taking into account an intended profit margin. This means that in the running cost plus pricing

- The parameters in this pricing scheme are
- Profit margin (%) a time dependent function with values in each year in 0-1
- Running Time Span: on which time basis the running cost should aim to get the desired profit
- The inputs of this pricing scheme are
- The costs per year
- The customers per year

The figure underneath gives an overview of this pricing scheme for a given decreasing cost and for a yearly and a 4 yearly running profit of 10%, and a yearly running with a profit of 20% decreasing to 0%.



27.12.1.2 ***Hierarchical Selection Model***

It is clear that pricing is not required to be the same for the full horizon of a business case. The revenue modeling provides an additional hierarchical selection model on which basis the pricing will vary. This selection model allows specifying on which basis the pricing scheme will be calculated in a different manner. This enables the user for instance to detail that first 5 years pricing will be aiming at running break even and afterwards profits are expected to grow to 10%.

(1)Threshold Selection Model

The selection model will in essence be a check for a predefined parameter against threshold values. Currently the following parameters have been defined to be used in the revenue modeling:

1. Time: The pricing scheme can be different for different periods in time
2. Customers: The pricing scheme can change when reaching a predefined amount of customers
3. Coverage: The pricing scheme can change when deployment, or customer count reaches a predefined coverage.

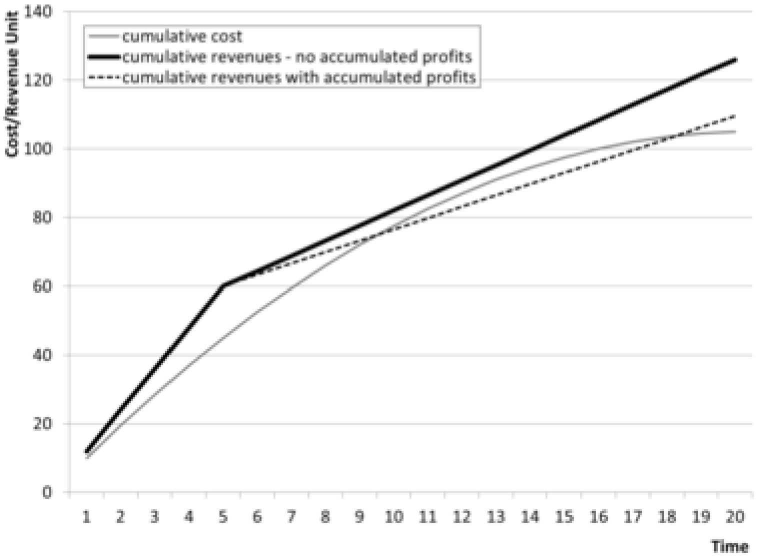
The selection model can be used in a hierarchical manner, where different selections are applied one after the other. For instance the following hierarchical structure (figure) indicates that the first 5 years and for a customer count smaller than 5000 customers a cost based pricing is used with 20% profit, whereas in these same years but for a larger customer base only 15% is used and after the first 5 years, the profits are even decreased to 10%.

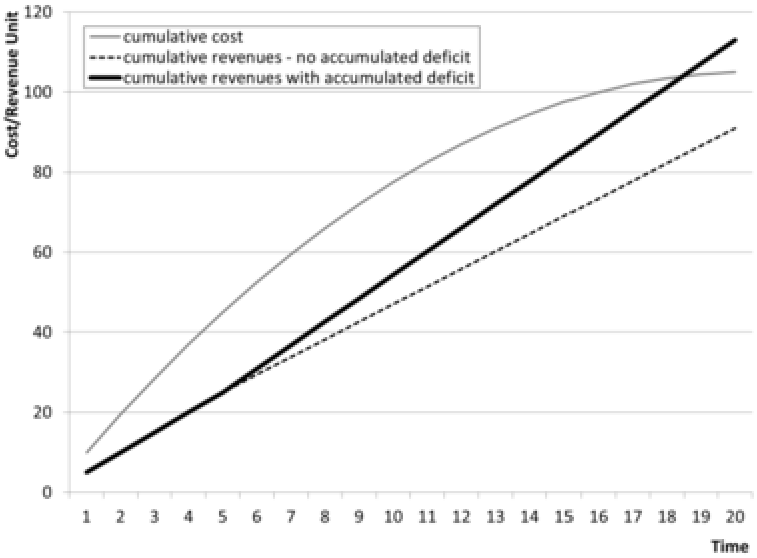
```
Selection Model:
      Time    y0 - y5
              Customer      <5000  cost based pricing   20% profit
                            >5000  cost based pricing   15% profit
      Time    y6 - …               cost based pricing   10% profit
```

The calculation of the hierarchical selection model will be using the originally defined pricing schemes over the considered periods, coverage and/or customer ranges. For the integrated cost based pricing and in general all pricing schemes which take into account a predefined calculation horizon, the calculation will have to take into account in how far the accumulated revenues cover the accumulated costs. Two approaches have been taken into account during the development of the revenue model:

1. Disregard all accumulated costs and revenues. A limit pricing in this scheme will try to break even over all costs over the considered time frame (or range) and will not take into account all deficit or profit over the previous period.
2. Take fully into account all accumulated costs and revenues. A limit pricing in this scheme will aim to break even over all costs over the considered time frame (or range) increased or decreased with all potentially remaining accumulated costs respectively revenues over the previous periods.

In the calculations we chose to make a distinction between the cases of accumulated profit and deficit. In the case of accumulated profit, the first approach is preferred in order not to have the pricing compensate for these gains by underpricing. In the case of accumulated deficit, the second approach is preferred in order to finally end up with price leading at some point to a viable business case – or reflecting what price should be set in order to have a positive business case. In the following two figures we show the resulting accumulated revenues for a hierarchical model which has a fixed pricing for the first 5 years and a cost based pricing (10% profit) for the remaining 15 years. Both figures give a view on both approaches, with the preferred approach indicated with a fatter line. The top figure shows the case for an accumulated profit, while the bottom figure shows the case for an accumulated deficit.





(2)Anchoring to the cost structure

The main aim in the pricing and the structure of the pricing should not always be the same for all elements of the cost. A clear example of this is the often made distinction between CapEx and OpEx, more or less in line with infrastructure costs respectively running operational costs. A valid pricing scheme could well take this distinction into account and demand a 20% profit with a time-span for break-even of 5 years for all infrastructure, and on top of that a yearly running 10% profit over all remaining costs. In the revenue model this is achieved by anchoring a cost element to a pricing scheme, in which this cost element is typically identified by means of a name. Additionally it is allowed to have multiple simultaneous time frames or customer/coverage ranges in the selection model. The calculations will then be triggered with the right cost input (by name linking) and sum all simultaneous revenues to the final revenue.

Following example shows a revenue model in which the first 5 years infrastructure is taken into account cost based (and depending on customer count) and operations are taken into account in a yearly running cost (with 10% profit) and afterwards all costs are taken into account:

```
Selection Model:
       Time    y0 - y5
               Anchored to infrastructure
               Customer      <5000   cost based pricing   20% profit
                             >5000   cost based pricing   15% profit
       Time    y0 - y5
       Anchored to operations running yearly cost        10% profit
       Time    y6 - …        cost based pricing   10% profit
```

27.12.1.3 *The Impact of Discounting*

Discounting, or the fact that money spent at different points in time has not the same value, will be important in the revenue modeling and especially in the pricing schemes as well. Any revenue model can be retrofitted with this information and this can be added to the final outcome.

It should be noted that the price calculated in this way is not discounted yet (as would be expected) and the revenues calculated by multiplying the price to the customers is also not discounted. The discounted revenues can be calculated by multiplying the price to the discounted customers or by discounting the revenues after calculation. FIWARE.OpenSpecification.Apps.BusinessCalculator.PNMN

27.13 References

[1] http://www.omg.org/spec/BPMN/2.0/

27.14 Terms and definitions

This section comprises a summary of terms and definitions introduced during the previous sections. It intends to establish a vocabulary that will be help to carry out discussions internally and with third parties (e.g., Use Case projects in the EU FP7 Future Internet PPP). For a summary of terms and definitions managed at overall FI-WARE level, please refer to FIWARE Global Terms and Definitions

- **Aggregator (Role):** A Role that supports domain specialists and third-parties in aggregating services and apps for new and unforeseen opportunities and needs. It does so by providing the dedicated tooling for aggregating services at different levels: UI, service operation, business process or business object levels.
- **Application:** Applications in FI-WARE are composite services that have a IT supported interaction interface (user interface). In most cases consumers do not buy the application, instead they buy the right to use the application (user license).
- **Broker (Role):** The business network's central point of service access, being used to expose services from providers that are delivered through the Broker's service delivery functionality. The broker is the central instance for enabling monetization.

- **Business Element:** Core element of a business model, such as pricing models, revenue sharing models, promotions, SLAs, etc.
- **Business Framework:** Set of concepts and assets responsible for supporting the implementation of innovative business models in a flexible way.
- **Business Model:** Strategy and approach that defines how a particular service/application is supposed to generate revenue and profit. Therefore, a Business Model can be implemented as a set of business elements which can be combined and customized in a flexible way and in accordance to business and market requirements and other characteristics.
- **Business Process:** Set of related and structured activities producing a specific service or product, thereby achieving one or more business objectives. An operational business process clearly defines the roles and tasks of all involved parties inside an organization to achieve one specific goal.
- **Business Role:** Set of responsibilities and tasks that can be assigned to concrete business role owners, such as a human being or a software component.
- **Channel:** Resources through which services are accessed by end users. Examples for well-known channels are Web sites/portals, web-based brokers (like iTunes, eBay and Amazon), social networks (like Facebook, LinkedIn and MySpace), mobile channels (Android, iOS) and work centers. The access mode to these channels is governed by technical channels like the Web, mobile devices and voice response, where each of these channels requires its own specific workflow.
- **Channel Maker (Role):** Supports parties in creating outlets (the Channels) through which services are consumed, i.e. Web sites, social networks or mobile platforms. The Channel Maker interacts with the Broker for discovery of services during the process of creating or updating channel specifications as well as for storing channel specifications and channeled service constraints in the Broker.
- **Composite Service (composition):** Executable composition of business back-end MACs (see MAC definition later in this list). Common composite services are either orchestrated or choreographed. Orchestrated compositions are defined by a centralized control flow managed by a unique process that orchestrates all the interactions (according to the control flow) between the external services that participate in the composition. Choreographed compositions do not have a centralized process, thus the services participating in the composition autonomously coordinate each other according to some specified coordination rules. Backend compositions are executed in dedicated process execution engines. Target users of tools for creating Composites Services are technical users with algorithmic and process management skills.
- **Consumer (Role):** Actor who searches for and consumes particular business functionality exposed on the Web as a service/application that satisfies her own needs.
- **Desktop Environment:** Multi-channel client platform enabling users to access and use their applications and services.
- **Event-driven Composition:** Components concerned with the composition of business logic, which is driven by asynchronous events. This implies run-time selection of MACs and the creation/modification of orchestration workflows based on composition logic defined at design-time and adapted to context and the state of the

communication at run-time.

- **Front-end/Back-end Composition:** Front-end compositions define a front-end application as an aggregation of visual mashable application pieces (named as widgets, gadgets, portlets, etc.) and back-end services. Front-end compositions interact with end-users, in the sense that front-end compositions consume data provided by the end-users and provide data to them. Thus the front-end composition (or mashup) will have a direct influence on the application look and feel; every component will add a new user interaction feature. Back-end compositions define a back-end business service (also known as process) as an aggregation of backend services as defined for service composition term, the end-user being oblivious to the composition process. While back-end components represent atomization of business logic and information processing, front-end components represent atomization of information presentation and user interaction.
- **Gateway (Role):** The Gateway role enables linking between separate systems and services, allowing them to exchange information in a controlled way despite different technologies and authoritative realms. A Gateway provides interoperability solutions for other applications, including data mapping as well as run-time data store-forward and message translation. Gateway services are advertised through the Broker, allowing providers and aggregators to search for candidate gateway services for interface adaptation to particular message standards. The Mediation is the central generic enabler. Other important functionalities are eventing, dispatching, security, connectors and integration adaptors, configuration, and change propagation.
- **Hoster (Role):** Allows the various infrastructure services in cloud environments to be leveraged as part of provisioning an application in a business network. A service can be deployed onto a specific cloud using the Hoster's interface. This enables service providers to re-host services and applications from their on-premise environments to cloud-based, on-demand environments to attract new users at much lower cost.
- **Marketplace:** Part of the business framework providing means for service providers, to publish their service offerings, and means for service consumers, to compare and select a specific service implementation. A marketplace can offer services from different stores and thus different service providers. The actual buying of a specific service is handled by the related service store.
- **Mashup:** Executable composition of front-end MACs. There are several kinds of mashups, depending on the technique of composition (spatial rearrangement, wiring, piping, etc.) and the MACs used. They are called application mashups when applications are composed to build new applications and services/data mash-ups if services are composed to generate new services. While composite service is a common term in backend services implementing business processes, the term 'mashup' is widely adopted when referring to Web resources (data, services and applications). Front-end compositions heavily depend on the available device environment (including the chosen presentation channels). Target users of mashup platforms are typically users without technical or programming expertise.
- **Mashable Application Component (MAC):** Functional entity able to be consumed executed or combined. Usually this applies to components that will offer not only their main behaviour but also the necessary functionality to allow further compositions with other components. It is envisioned that MACs will offer access, through applications

and/or services, to any available FI-WARE resource or functionality, including gadgets, services, data sources, content, and things. Alternatively, it can be denoted as 'service component' or 'application component'.

- **Mediator:** A mediator can facilitate proper communication and interaction amongst components whenever a composed service or application is utilized. There are three major mediation area: Data Mediation (adapting syntactic and/or semantic data formats), Protocol Mediation (adapting the communication protocol), and Process Mediation (adapting the process implementing the business logic of a composed service).
- **Monetization:** Process or activity to provide a product (in this context: a service) in exchange for money. The Provider publishes certain functionality and makes it available through the Broker. The service access by the Consumer is being accounted, according to the underlying business model, and the resulting revenue is shared across the involved service providers.
- **Premise (Role):** On-Premise operators provide in-house or on-site solutions, which are used within a company (such as ERP) or are offered to business partners under specific terms and conditions. These systems and services are to be regarded as external and legacy to the FI-Ware platform, because they do not conform to the architecture and API specifications of FI-WARE. They will only be accessible to FI-WARE services and applications through the Gateway.
- **Prosumer:** A user role able to produce, share and consume their own products and modify/adapt products made by others.
- **Provider (Role):** Actor who publishes and offers (provides) certain business functionality on the Web through a service/application endpoint. This role also takes care of maintaining this business functionality.
- **Registry and Repository:** Generic enablers that able to store models and configuration information along with all the necessary meta-information to enable searching, social search, recommendation and browsing, so end users as well as services are able to easily find what they need.
- **Revenue Settlement:** Process of transferring the actual charges for specific service consumption from the consumer to the service provider.
- **Revenue Sharing:** Process of splitting the charges of particular service consumption between the parties providing the specific service (composition) according to a specified revenue sharing model.
- **Service:** We use the term service in a very general sense. A service is a means of delivering value to customers by facilitating outcomes customers want to achieve without the ownership of specific costs and risks. Services could be supported by IT. In this case we say that the interaction with the service provider is through a technical interface (for instance a mobile app user interface or a Web service). Applications could be seen as such IT supported Services that often are also composite services.
- **Service Composition:** in SOA domain, a service composition is an added value service created by aggregation of existing third party services, according to some predefined work and data flow. Aggregated services provide specialized business functionality, on which the service composition functionality has been split down.
- **Service Delivery Framework:** Service Delivery Framework (or Service Delivery Platform (SDP)) refers to a set of components that provide service delivery

functionality (such as service creation, session control & protocols) for a type of service. In the context of FI-WARE, it is defined as a set of functional building blocks and tools to (1) manage the lifecycle of software services, (2) creating new services by creating service compositions and mashups, (3) providing means for publishing services through different channels on different platforms, (4) offering marketplaces and stores for monetizing available services and (5) sharing the service revenues between the involved service providers.

- **Service Level Agreement (SLA):** A service level agreement is a legally binding and formally defined service contract, between a service provider and a service consumer, specifying the contracted qualitative aspects of a specific service (e.g. performance, security, privacy, availability or redundancy). In other words, SLAs not only specify that the provider will just deliver some service, but that this service will also be delivered on time, at a given price, and with money back if the pledge is broken.
- **Service Orchestration:** in SOA domain, a service orchestration is a particular architectural choice for service composition where a central orchestrated process manages the service composition work and data flow invocations of the external third party services in the order determined by the work flow. Service orchestrations are specified by suitable orchestration languages and deployed in execution engines who interpret these specifications.
- **Store:** An external component integrated with the business framework, offering a set of services that are published to a selected set of marketplaces. The store thereby holds the service portfolio of a specific service provider. In case a specific service is purchased on a service marketplace, the service store handles the actual buying of a specific service (as a financial business transaction).
- **Unified Service Description Language (USDL):** USDL is a platform-neutral language for describing services, covering a variety of service types, such as purely human services, transactional services, informational services, software components, digital media, platform services and infrastructure services. The core set of language modules offers the specification of functional and technical service properties, legal and financial aspects, service levels, interaction information and corresponding participants. USDL is offering extension points for the derivation of domain-specific service description languages by extending or changing the available language modules.

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