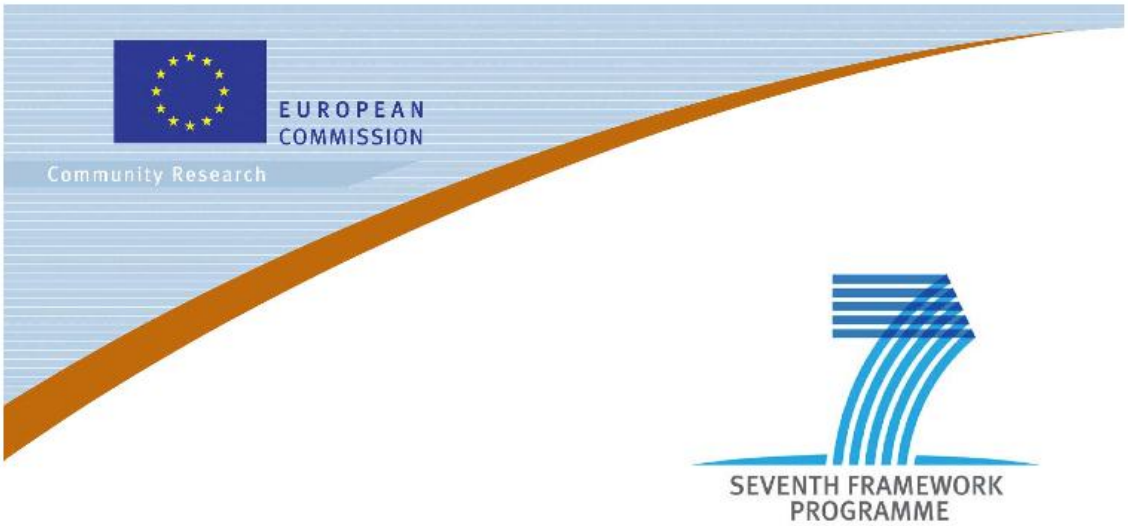

Private Public Partnership Project (PPP)
Large-scale Integrated Project (IP)

D.3.1.2: FI-WARE GE Open Specification

Project acronym: FI-WARE
Project full title: Future Internet Core Platform
Contract No.: 285248
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Author: FI-WARE Consortium
Contributors: FI-WARE Consortium

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.

iMinds will provide the required modules for drawing out a business model and the detailed cost and revenue models, in order to answer relevant economic questions on the profitability for all actors involved in this business model. iMinds is committed to integrate the related information within the Architecture and the Open Specification document. This information couldn't be submitted with this current set of documents and will be submitted to the public wiki as soon as possible. There will be a separate input on this during the next review.

Comment: This deliverable is submitted on request of the WP3 partners prior to finalize an open discussion on rephrasing the legal notice, which govern the open specifications. The partners are committed to finalize the discussion around the Open Specification Legal Notice in time and prior to the review. They will be put in place publicly in the wiki ASAP. For the content review of this submission, this early submission can and should be considered.

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. For example the Mediator GE has 2 different implementations. 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.

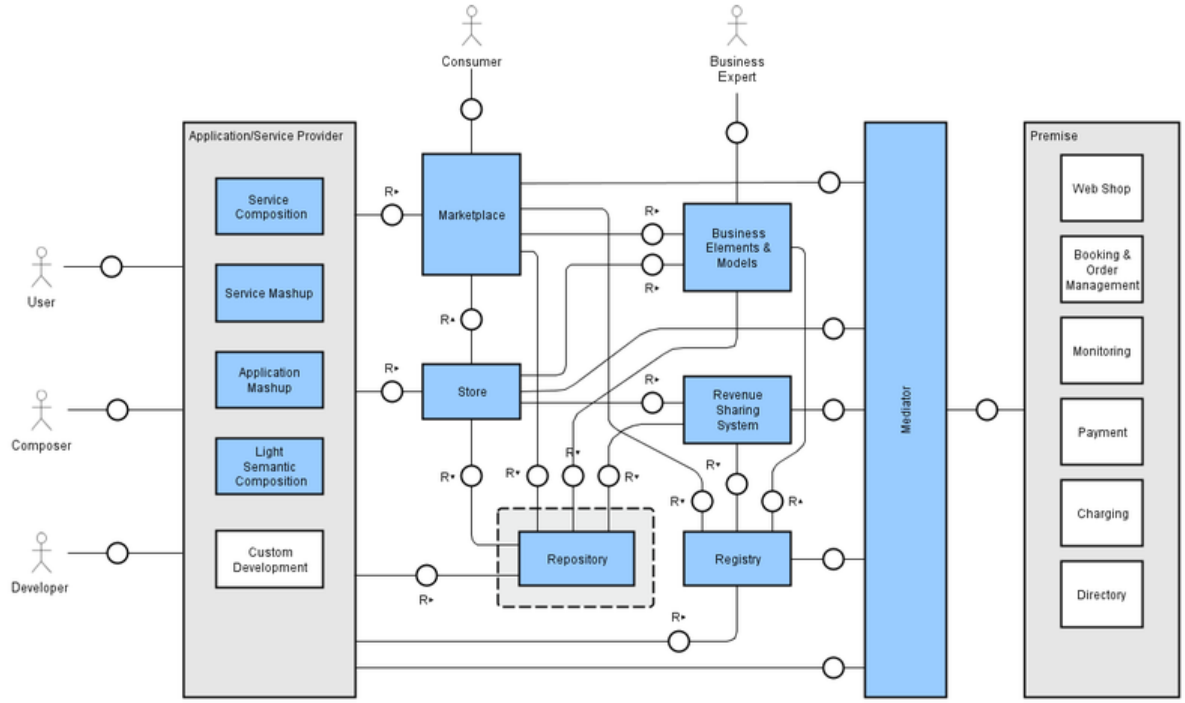
- **Store** - allows to offer services for consumers as well as developers of future internet applications.
- **Marketplace** - defines a standard way to access market places in order to find and compare offerings from different stores and provides further functionality to foster the market for future 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.
- **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.3.1.2 FI-WARE GE Open Specifications front page
FIWARE.OpenSpecification.Apps.Repository
FIWARE.OpenSpecification.Apps.RepositoryREST
FIWARE.OpenSpecification.Apps.Marketplace
FIWARE.OpenSpecification.Apps.MarketplaceSearchREST
FIWARE.OpenSpecification.Apps.MarketplaceOfferingsREST
FIWARE.OpenSpecification.Apps.MarketplaceRegistrationREST
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
Store_Open_API_RESTful_Specification
FIWARE.OpenSpecification.Apps.RSS
FIWARE.OpenSpecification.Apps.RSSRest
FIWARE.OpenSpecification.Apps.RSS.RSS-Models

FI-WARE Open Specifications Legal Notice
Open Specifications Interim Legal Notice

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 not all pages that are part of this document can be linked document-local within the final document. For example, if an open specification references and "links" an API specification within the page text, you will find this link firstly pointing to the wiki, although the same content is usually integrated within the same submission as well.

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, EAB, TI, DT, ATOS.

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	2013-04-22	SAP
v2	Second Version of deliverable submission	2013-04-26	SAP
v3	preparation of submission	2013-05-16	SAP

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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.eu and similar pages in order to understand the complete context of the FI-WARE project.

2.2 Copyright

2.3 Legal Notice

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 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 https://forge.fi-ware.eu/plugins/mediawiki/wiki/fiware/index.php/Main_Page . 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 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 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 BasicConcepts

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 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.

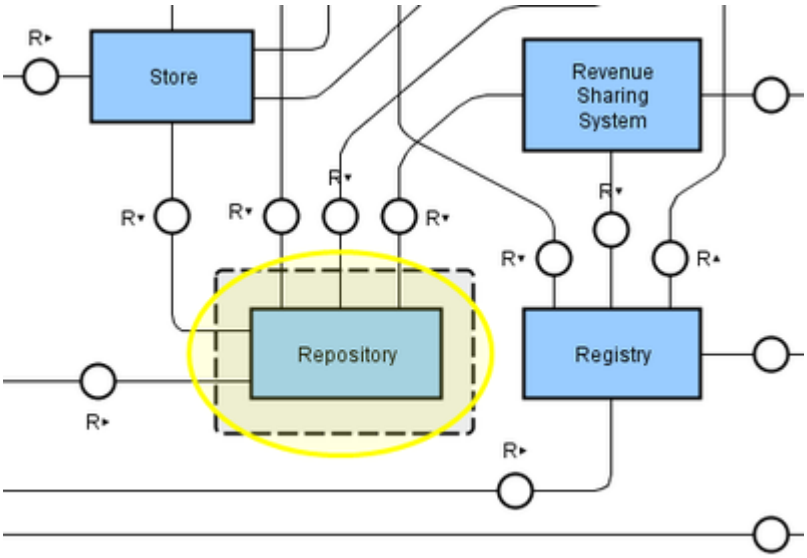
2.5.4 Content Negotiation

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.

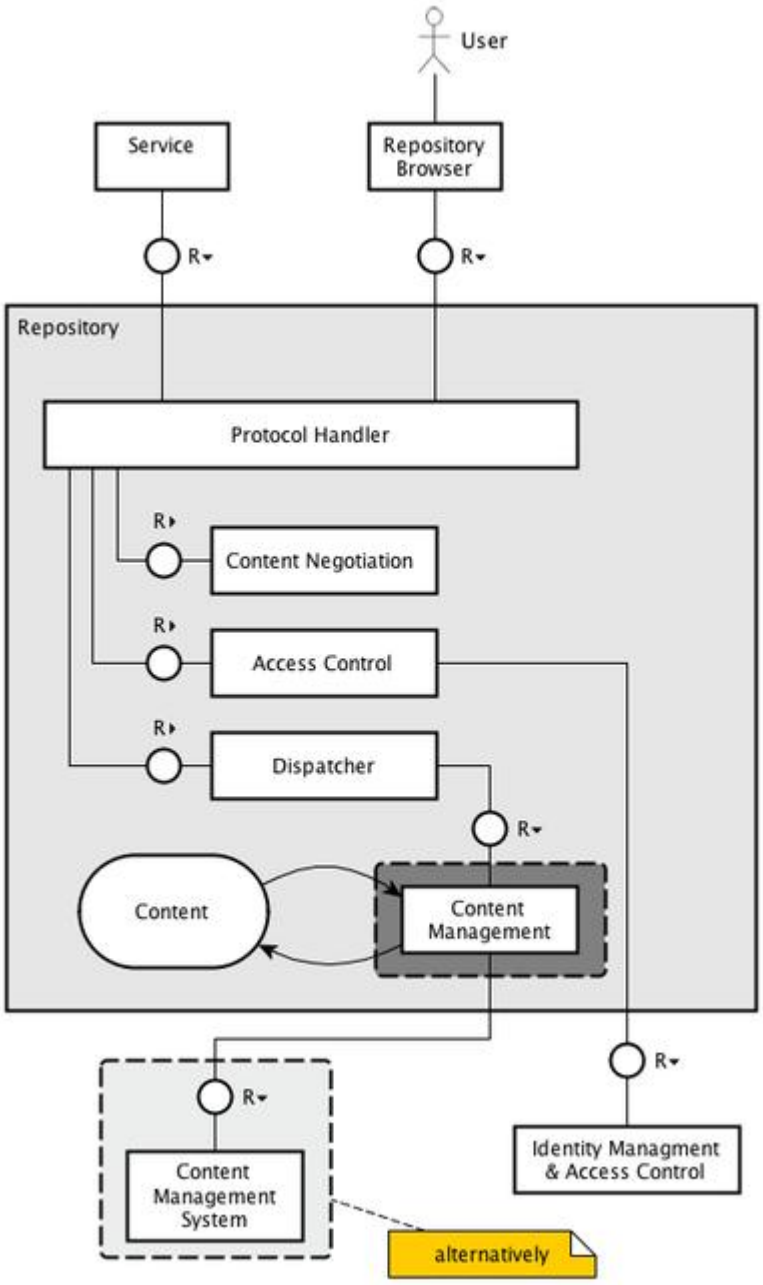
2.6 Repository Architecture

The Repository GE is used by various other GE 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 also Future Internet applications or composite services on top of the FI-Ware platform can 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

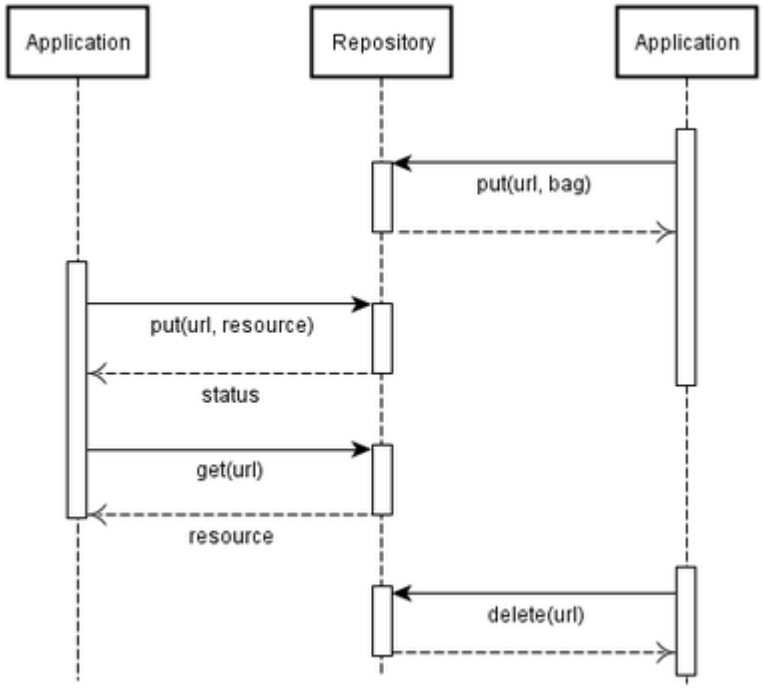
- FIWARE.Interface.Apps.USDLRepositoryRest - A very simple REST based protocol based on plain HTTP.

2.7 Main Operations

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 Specifications

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 RepositoryREST

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

3.1 Introduction to the *Repository* API

The FI-WARE Generic Enabler Specification are owned by different partners. Therefore, different Legal Notices might apply. Please check for each FI-WARE Generic Enabler Specification the Legal Notice attached. For this FI-WARE Generic Enabler Specification, this Legal Notice applies.
SAP 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, 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

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

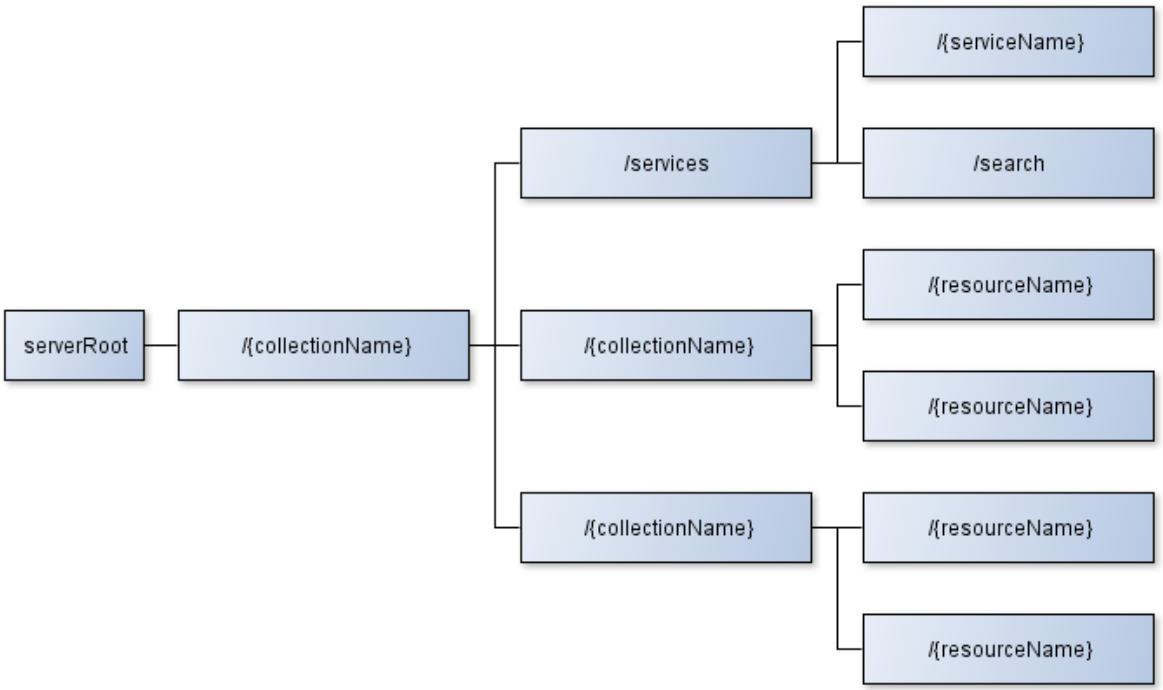
The repository is structured into core objects, which are *resources*, and *collections*. These objects constitute also the granularity of access control. Collections are containers for storing resources. Any object can provide services such as search, query, transform, maintain, depending on the type 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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The request cannot be fulfilled due to bad syntax.

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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.

3.3.3 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.eu and similar pages in order to understand the complete context of the FI-WARE project.

4.2 Copyright

4.3 Legal Notice

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.

4.4.1 Target usage

Internet based business networks require at least one marketplace and stores, where people can offer and deal with services like goods and finally combine them to value added services. On the marketplace one can quickly find and compare services, which enable you to attend an industry-ecosystem better than before. Services become tradable goods, which can be offered and acquired on internet based marketplaces. Beside 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.
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.
- 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.

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 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 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

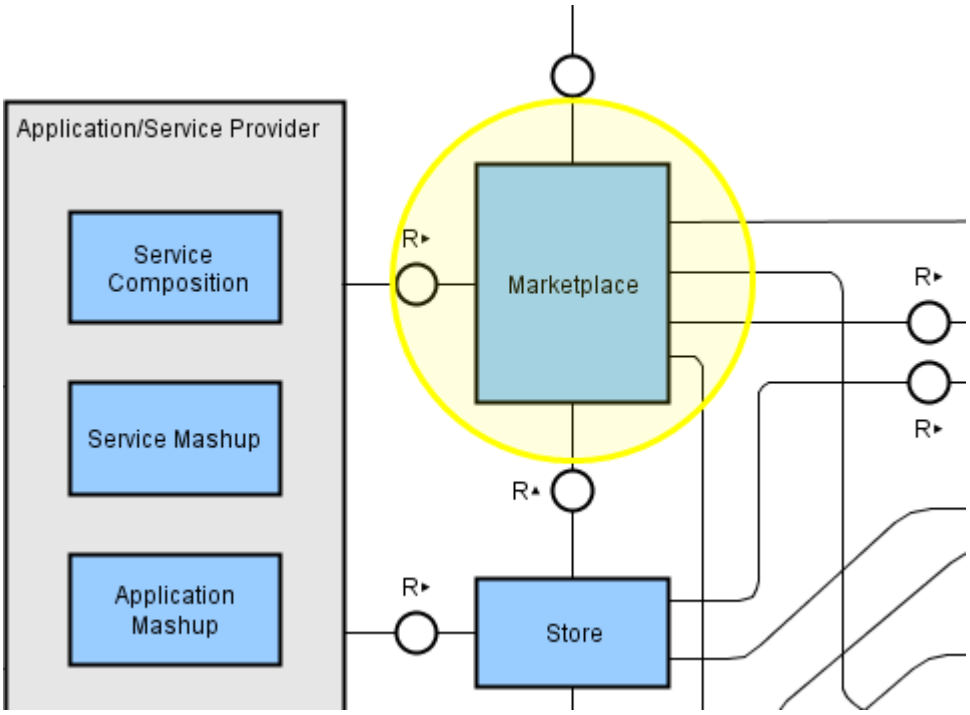
This component provides the user service recommendations based on the users' profile and context in comparison to explicit semantics of available offerings as well as previous activities and experiences of the marketplace participants (Wisdom of the crowd and social networks).

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.

4.6 Marketplace Architecture

The Marketplace GE is used by other GE 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.



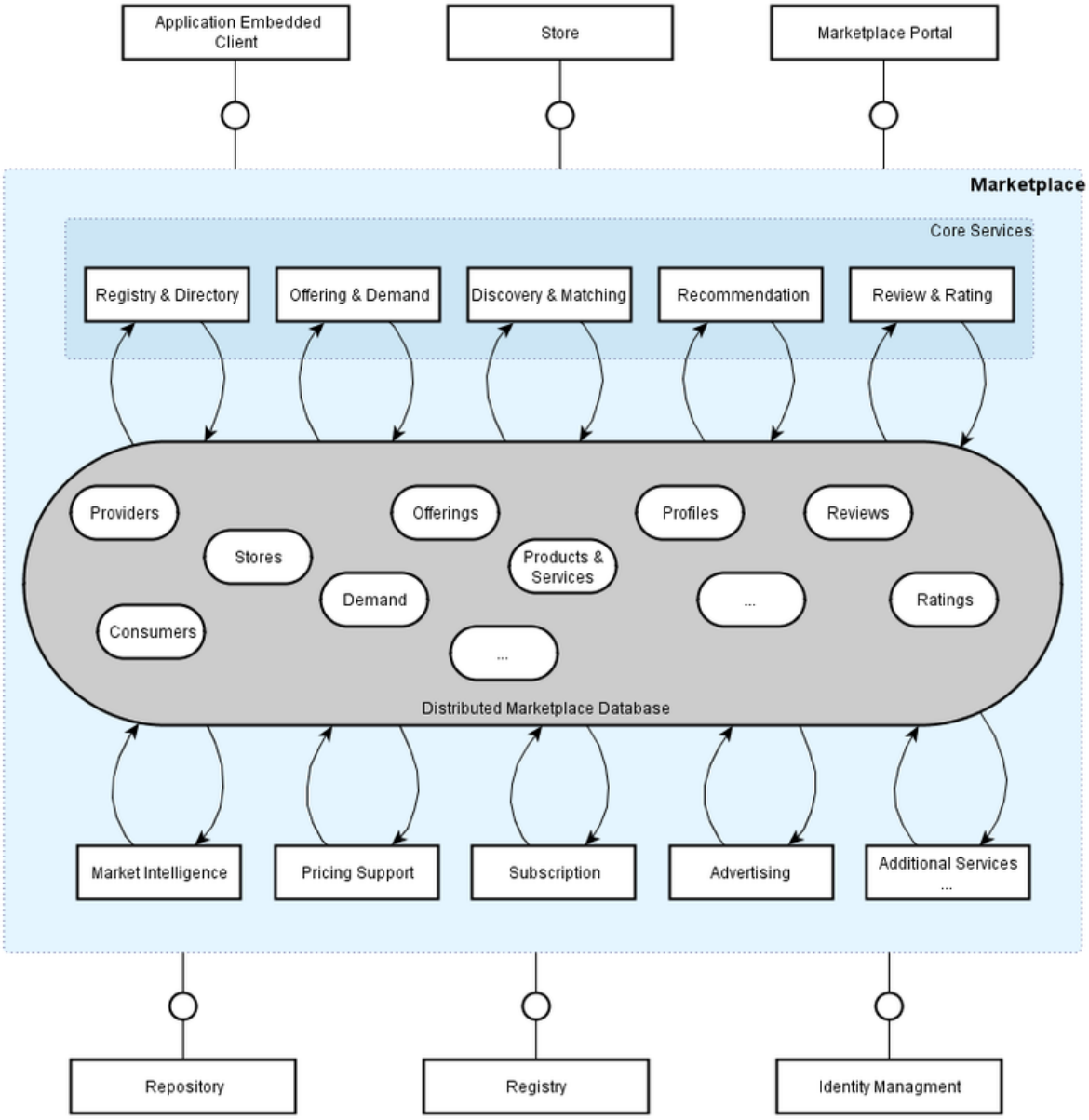
Marketplace in the context of the Business Framework

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 to embed 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.



Architecture of a Marketplace implementation

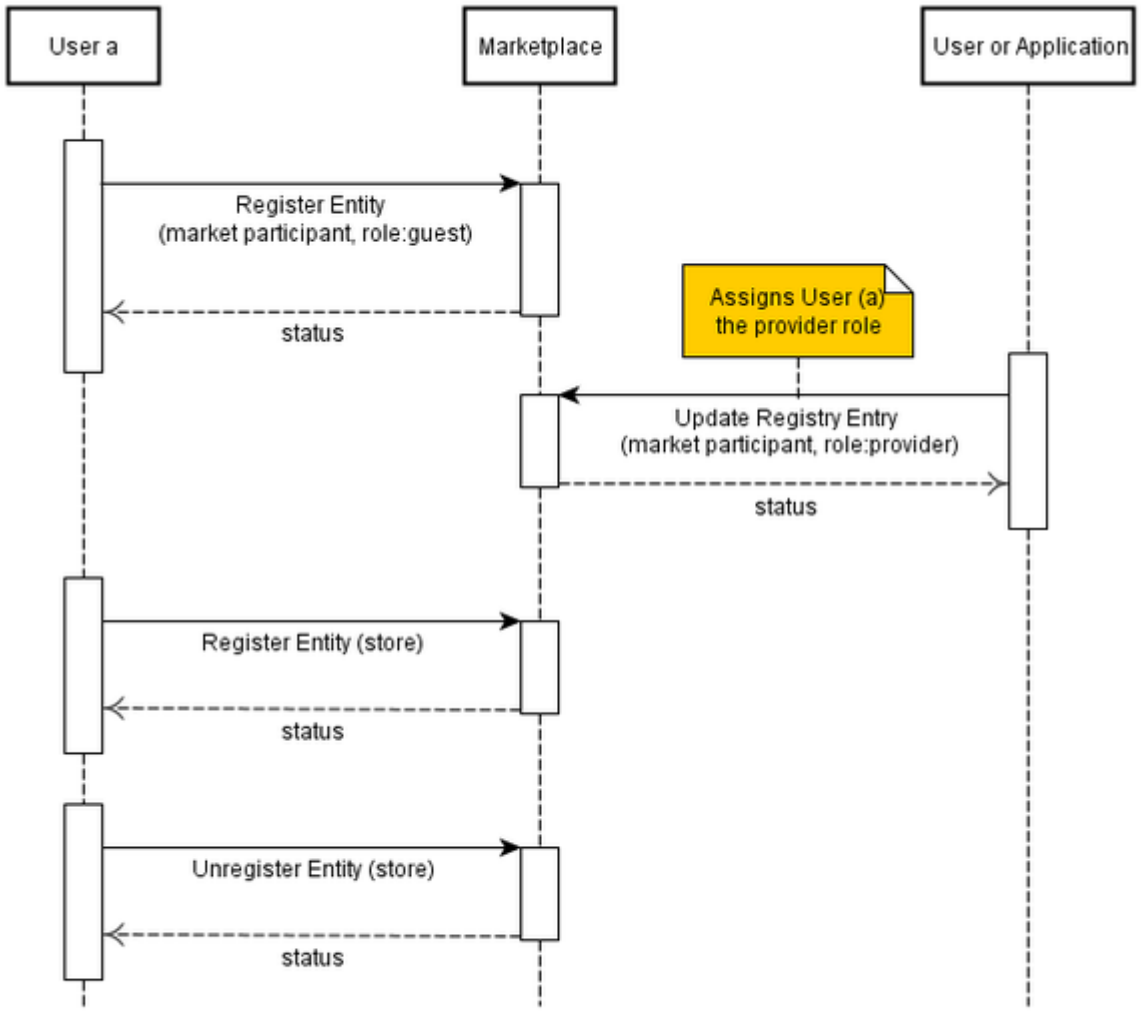
4.7 Main Operations

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:

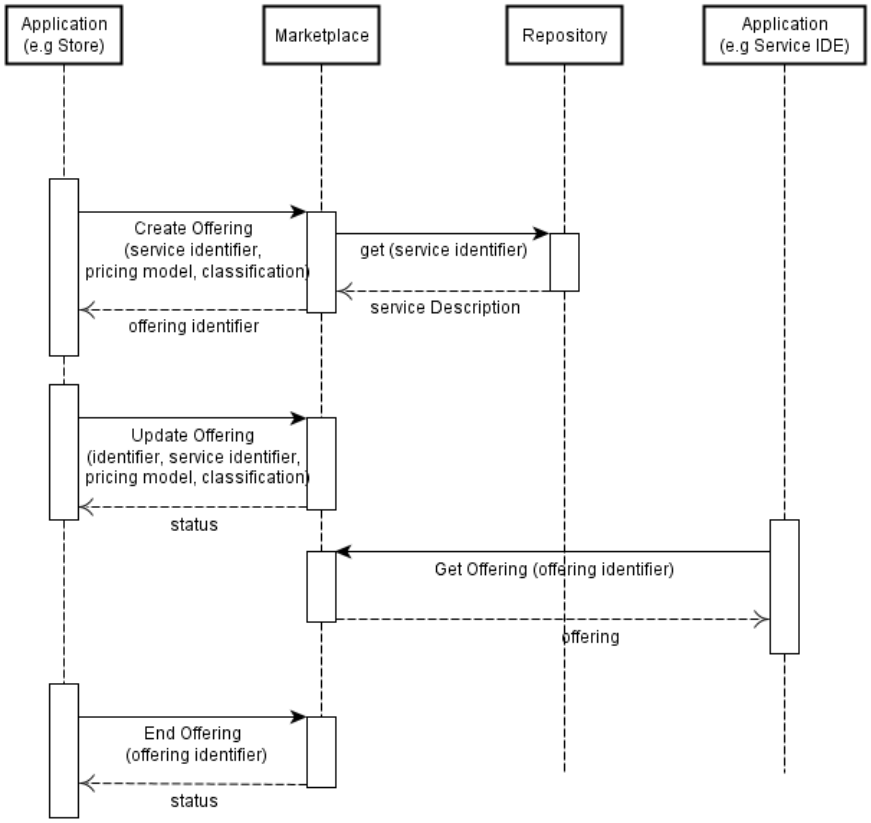
- *entity* - Description of the entity to be updated including the entity identifier.

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 the operation is rather 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:

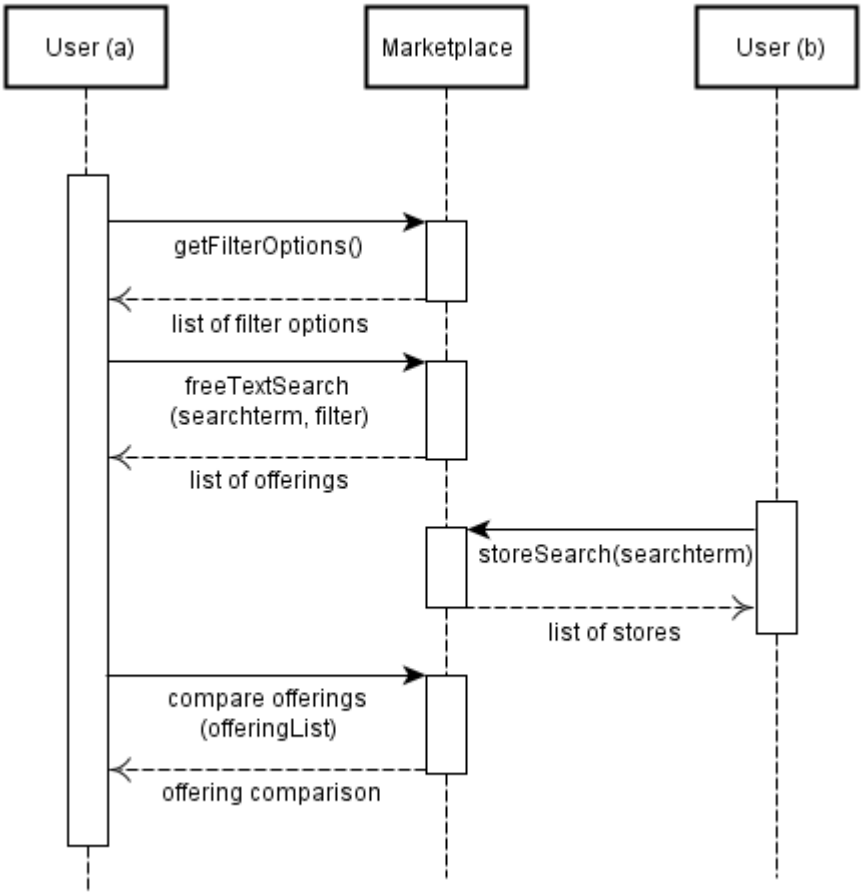
- *offering identifier* - Identifier of the offering.

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 sortoptions, 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*** 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*** operation is used. An optional filter expression can be used to reduce the number of delivered results. The parameters for this operation are:

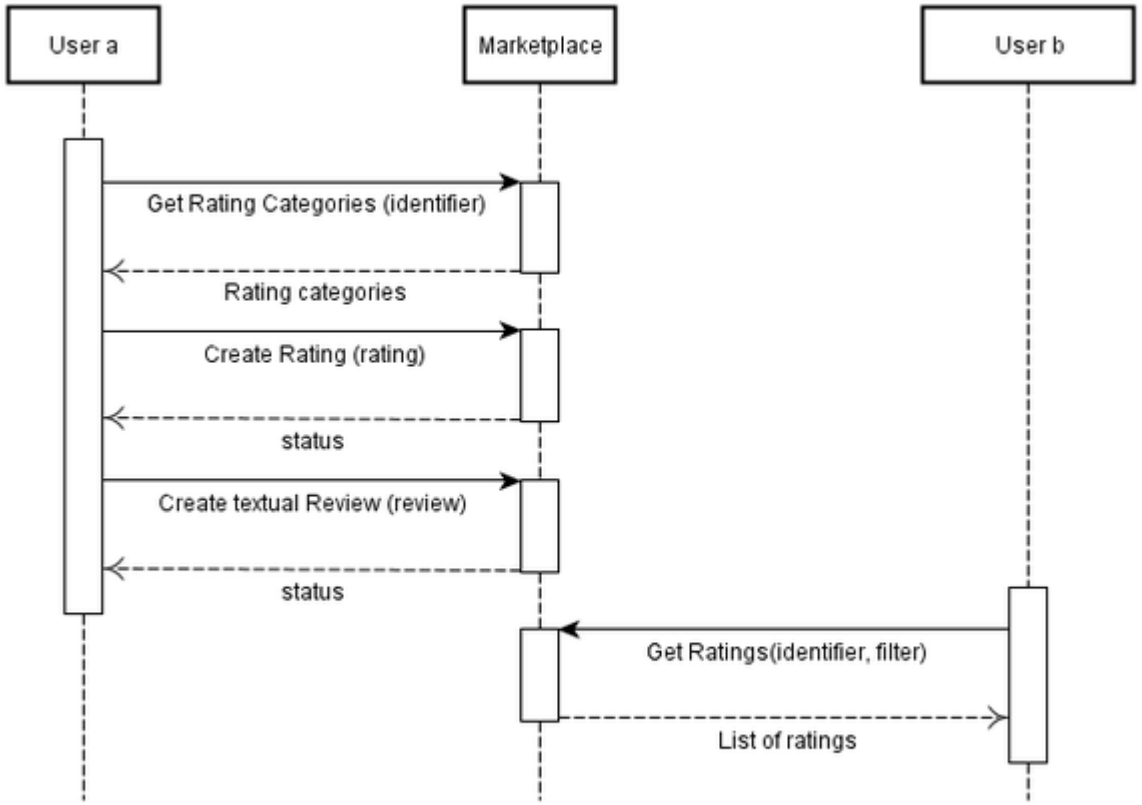
- *offering list* - List of offerings
- *filter* - Optional - Filter expression to reduce the number of delivered results.
- *index* - Optional - Index of the first offering to be returned.
- *limit* - Optional - number of results to be returned.

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:

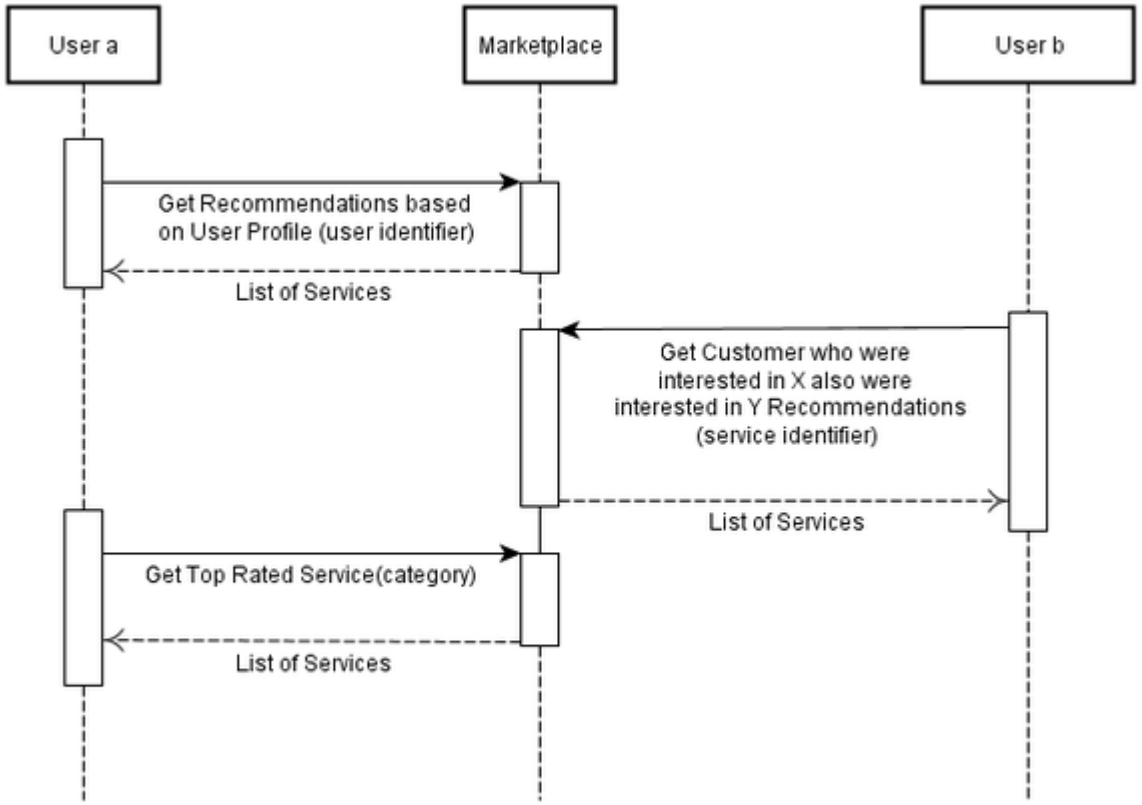
- *identifier* - Identifier of a rate-able entity instance.

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.

4.8 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 Specifications

4.9.1 Open API Specifications

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

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 MarketplaceSearchREST

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

5.1 Introduction to the *Marketplace Search* API

The FI-WARE Generic Enabler Specification are owned by different partners. Therefore, different Legal Notices might apply. Please check for each FI-WARE Generic Enabler Specification the Legal Notice attached. For this FI-WARE Generic Enabler Specification, this Legal Notice applies.
SAP 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, 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 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.

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 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

5.1.3 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

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

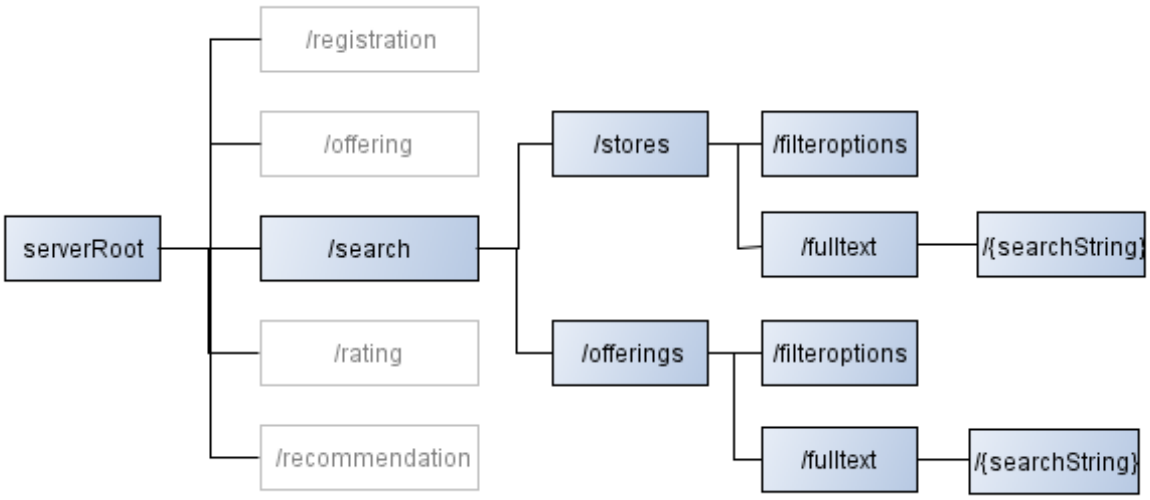
You can download the most current version of this document from the FI-WARE API specification website at **Marketplace Search API** . For more details about the Marketplace GE that this API is based upon, please refer to High Level Description. Related documents, including an Architectural Description,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

5.2 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.

5.2.1 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.



5.2.2 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).

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 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.

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 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

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 authorizing 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 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.

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 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

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 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
```

5.3.2 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,	search for stores where the

		sortBy, order, minScore	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
```

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 MarketplaceOfferingsREST

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

6.1 Introduction to the *Marketplace Offering* API

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SAP 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, 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.

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

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.

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- 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

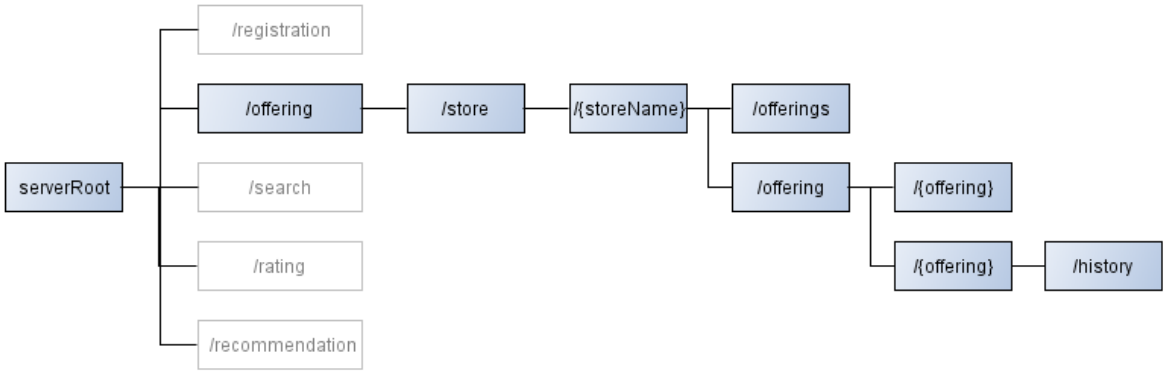
You can download the most current version of this document from the FI-WARE API specification website at **Marketplace Offerings API** . For more details about the Marketplace GE that this API is based upon, please refer to High Level Description. Related documents, including an Architectural Description, 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	-	Get the history of a specific offering
PUT	/offering/store/{storeName}/offering/{offering}	-	Create a new offering

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 MarketplaceRegistrationREST

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

7.1 Introduction to the *Marketplace Registration* API

The FI-WARE Generic Enabler Specification are owned by different partners. Therefore, different Legal Notices might apply. Please check for each FI-WARE Generic Enabler Specification the Legal Notice attached. For this FI-WARE Generic Enabler Specification, this Legal Notice applies.
SAP 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, 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.

7.1.1 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.

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 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

7.1.3 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

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

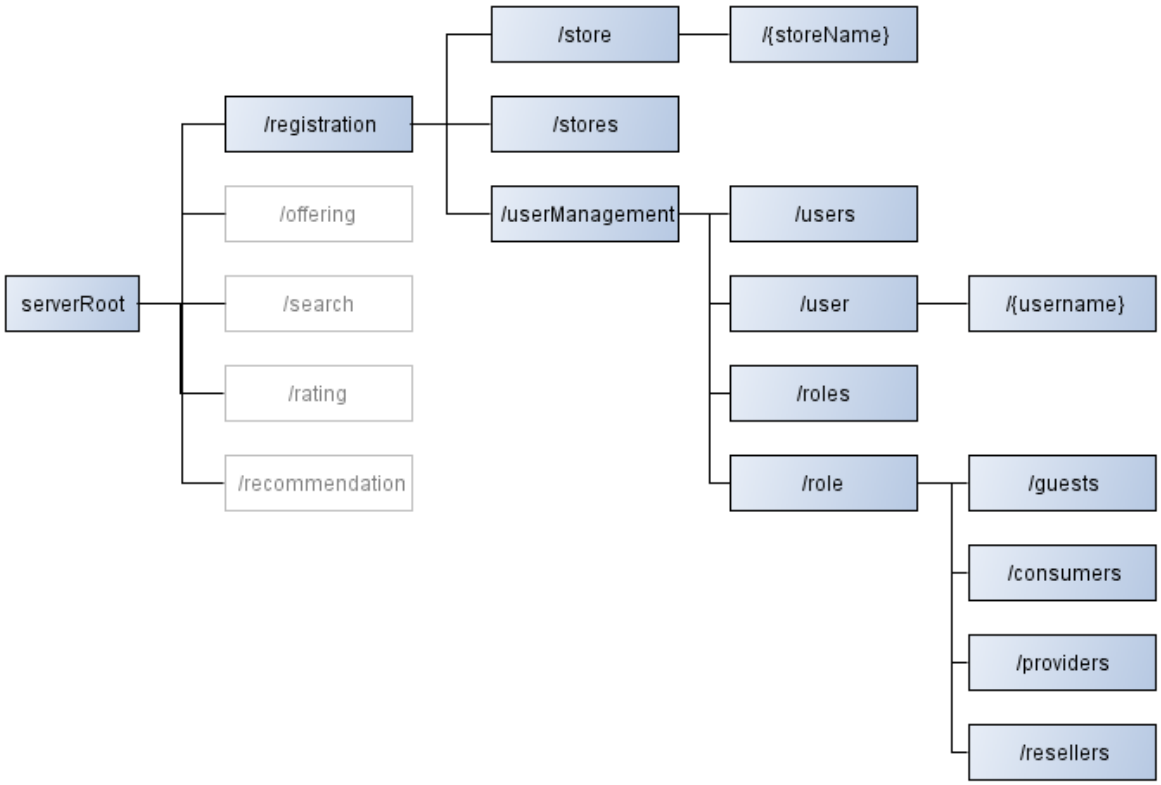
You can download the most current version of this document from the FI-WARE API specification website at **Marketplace Registration API** . For more details about the Marketplace GE that this API is based upon, please refer to High Level Description. Related documents, including an Architectural Description,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

7.2 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.

7.2.1 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.



7.2.2 Authentication

Each HTTP request against the *Marketplace Registration 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).

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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.
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- *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.

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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 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)
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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 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.

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 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 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
```

7.3.2 Managing Marketplace Participants

7.3.2.1 *Marketplace Participant*

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

7.3.2.2 *Marketplace Participants by Role*

Verb	URI	Additional Path Parameters	Description
GET	/registration/roles/	filter, index, limit	Get a list of all marketplace participant roles

GET	/registration/roles?role=guest	filter, index, limit	Get all marketplace participants with the role guest
GET	/registration/roles?role=consumer	filter, index, limit	Get all marketplace participants with the role consumer
GET	/registration/roles?role=provider	filter, index, limit	Get all marketplace participants with the role provider
GET	/registration/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
```

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 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

8.1 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.eu and similar pages in order to understand the complete context of the FI-WARE project.

8.2 Copyright

- Copyright © 2012 by SAP

8.3 Legal Notice

Please check the following Legal Notice to understand the rights to use these specifications.
SAP 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, 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.

8.4 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.

8.4.1 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.

8.4.2 Rationale

The Registry has specific requirements according to scalability and performance. Highly volatile information abut 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.

8.4.3 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].

8.5 Basic Concepts

8.5.1 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.

8.5.2 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

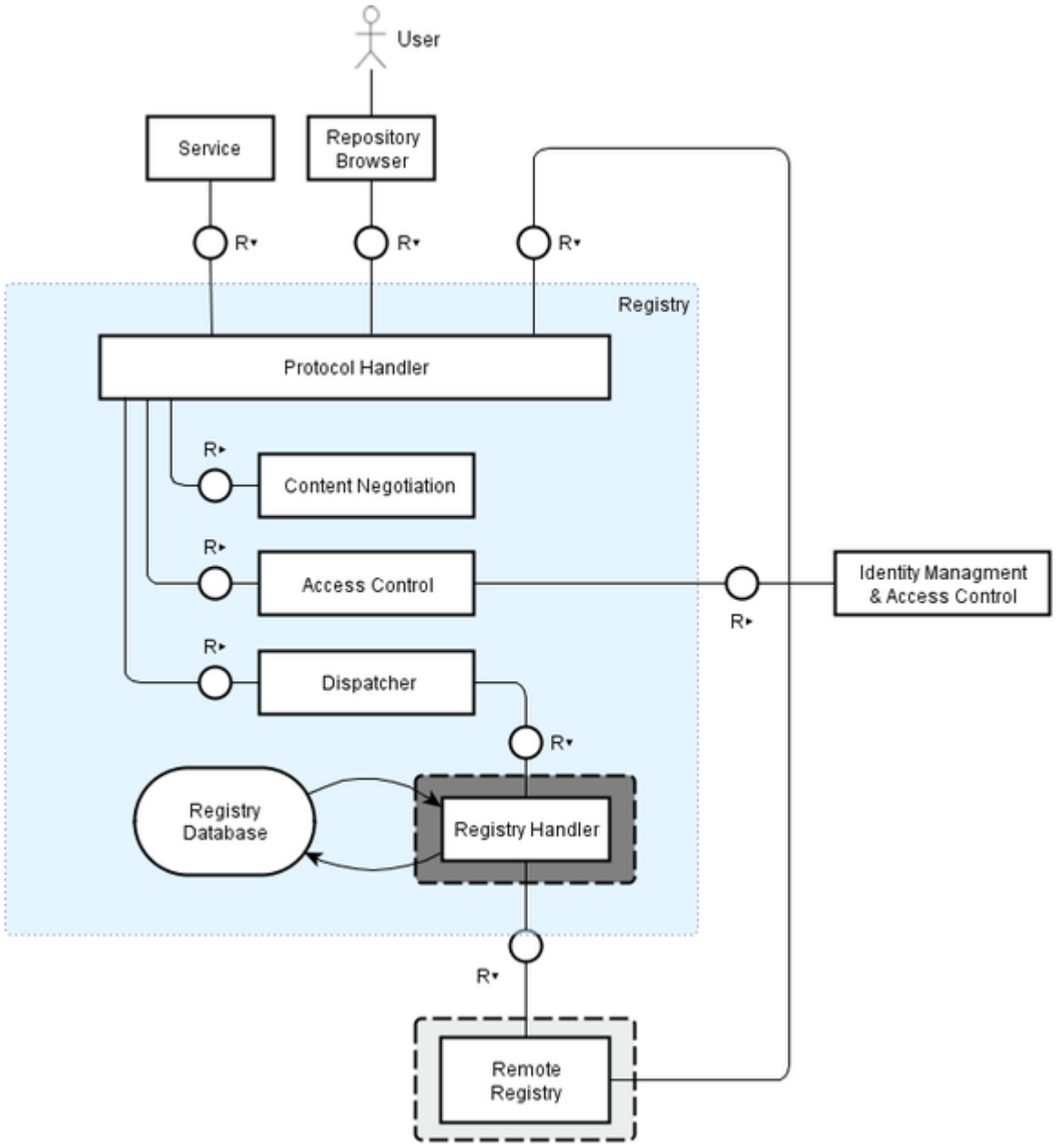
retrieval is based on a filter expression, which is referring to concrete entry values. In this case a list of matching entries is returned. Using a selector expression, the user can limit the number of property values to be returned.

8.5.3 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.

8.6 Architecture

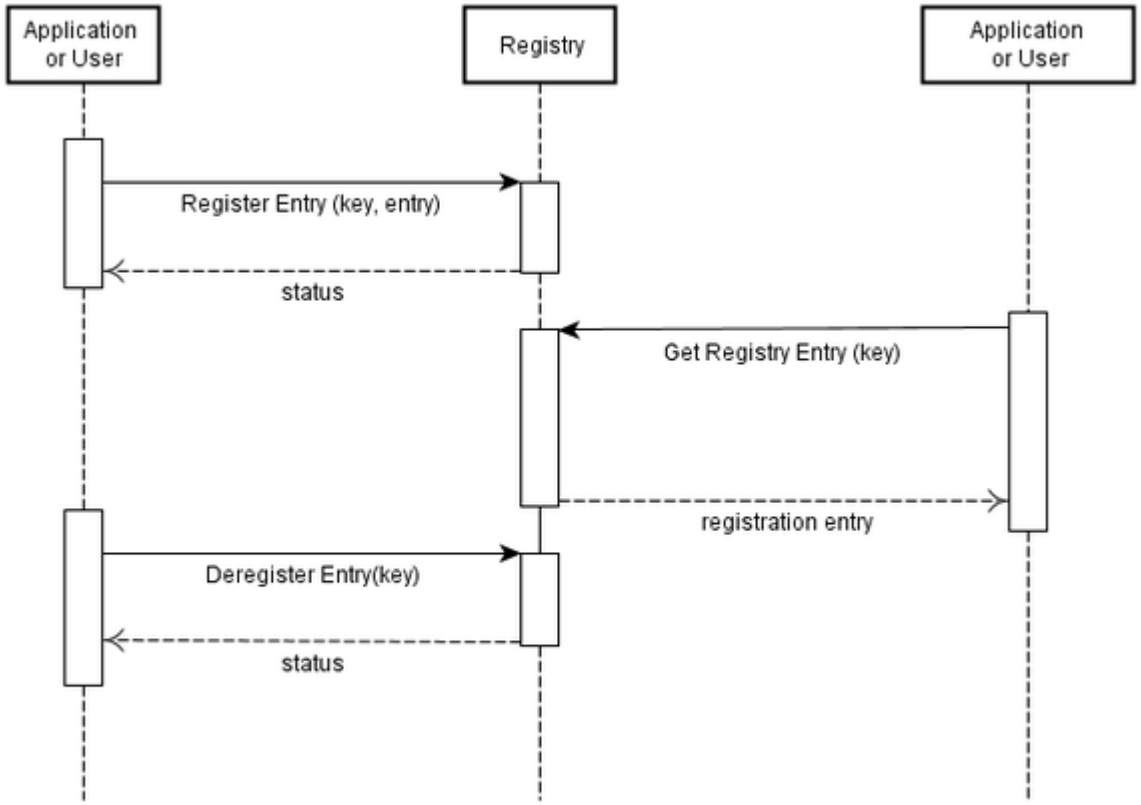
The Registry is a searchable index of the Repository GE. The following picture shows the schematic architecture of the Repository GE. A protocol handler is responsible for the realization of the RESTfull HTTP protocol. Content negotiation is used to deliver the results of the operations in different 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)

8.7 Main Operations

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

8.7.1 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

8.7.2 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.

8.7.3 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].

8.8 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)

8.9 Detailed Specifications

8.9.1 Open API Specifications

- Repository Open RESTful API Specification (PRELIMINARY)

8.9.2 Other Relevant Specifications

none

8.10 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).

8.11 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.
• **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.

9 FIWARE OpenSpecification Apps RegistryREST

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

9.1 Introduction to the *Registry* API

The FI-WARE Generic Enabler Specification are owned by different partners. Therefore, different Legal Notices might apply. Please check for each FI-WARE Generic Enabler Specification the Legal Notice attached. For this FI-WARE Generic Enabler Specification, this Legal Notice applies.
SAP 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, 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 Registry API Core

The Registry API is a RESTful, resource-oriented API accessed via HTTP that uses various representations for information interchange. The Registry Enabler is used to store information on service instances necessary for run-time execution.

9.1.2 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 Repository 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 Registry Enabler. You should also be familiar with:

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

9.1.3 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

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 Registry Enabler.

9.1.5 Additional Resources

You can download the most current version of this document from the FI-WARE API specification website at Registry API . For more details about the Registry 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.

9.2 General *Registry* API Information

9.2.1 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*.

9.2.2 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. Some authentication schemes may require that the API operate using SSL over HTTP (HTTPS).

9.2.3 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 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.

9.2.4 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 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/rdf+xml* - A RDF description of the input and output.

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

9.2.5 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.

9.2.6 Resource Identification

The Distinguished Entry Name (DEN) is used to unambiguously identify registry entries. In analogy to the LDAP protocol (RFC 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

9.2.7 Links and References

9.2.7.1 *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

9.2.8 Paginated Collections

In order to reduce the load on the service, the number of elements to return when it is too big can be limited. 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).

9.2.9 Limits

There might be limits according to the number of results or created entries in order to save resources and prevent the abuse of the system. These limitations will be configured by the operator and may differ from one implementation to other of the GE implementation.

9.2.9.1 *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.

9.2.10 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 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	/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
Limit Fault	413	YES
Internal Server error	50X	YES

9.3 API Operations

9.3.1 Retrieving Registry Information

9.3.1.1 *Read registry entry*

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

Verb	URI	Description
GET	/{DistinguishedEntryName}? {FilterParameters}&attributes={AttributeList}	Get registry entry information:

Parameters
FilterParameters - Expression for filtering registered entries according to its property values. A filter expression is given as URL query parameters.
AttributeList - Comma-separated list of attribute names which should be returned.

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".

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"
  },
```

```
  ...
]
```

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.

9.3.2 Modifying Entries

9.3.2.1 *Creating and Updating*

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

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.

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.

Adding Information

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

Request Body

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

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

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.

9.3.3 Deleting Registry Information

9.3.3.1 *Deleting Entries*

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

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.

9.3.3.2 *Delete Attributes of an Entry*

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

Parameters

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

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.

10 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

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.eu and similar pages in order to understand the complete context of the FI-WARE project.

10.2 Copyright

10.3 Legal Notice

10.4 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 FIWARE. Acknowledging the necessity to deal with these heterogeneities, mediation solutions are required 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 that play the role of Mediation Service Creators to compose different kinds of target service, and enable clients that play the role of Mediation Service Clients to invoke the mediated services (see figure 1.1).
The Composition Engine GEs plays both roles of Mediation Service Creator and Mediation Service Client.

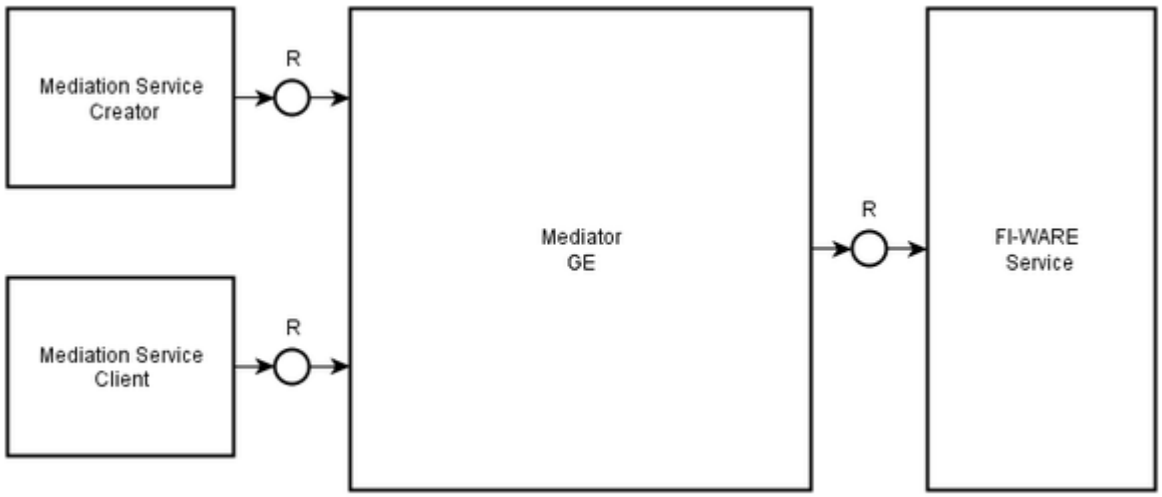


Figure 1.1: Mediator Role in FI-WARE

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

10.5 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

10.5.1 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.

10.5.1.1 *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	Send a message out
Log	Logs a message
Property	Set or remove properties associated with the message
Sequence	Refer a sequence
Event	Send event notifications to an event source
Drop	Drops a message
Enrich	Enriches a message
Enqueue	Create an enqueue mediator
Filter	Filter 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	Filter a message using Xpath (switch logic)
Router	Route messages based on XPath filtering
Conditional Router	Route messages based on 'Condition'

Validate	Schema validation for messages
XSLT	XSLT Transformations
XQuery	XQuery Transformations
Header	Set or remove SOAP Headers
Fault	Create or remove SOAP Faults
Rewrite	Create a rewrite 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>
```

10.5.1.2 *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 (from "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.

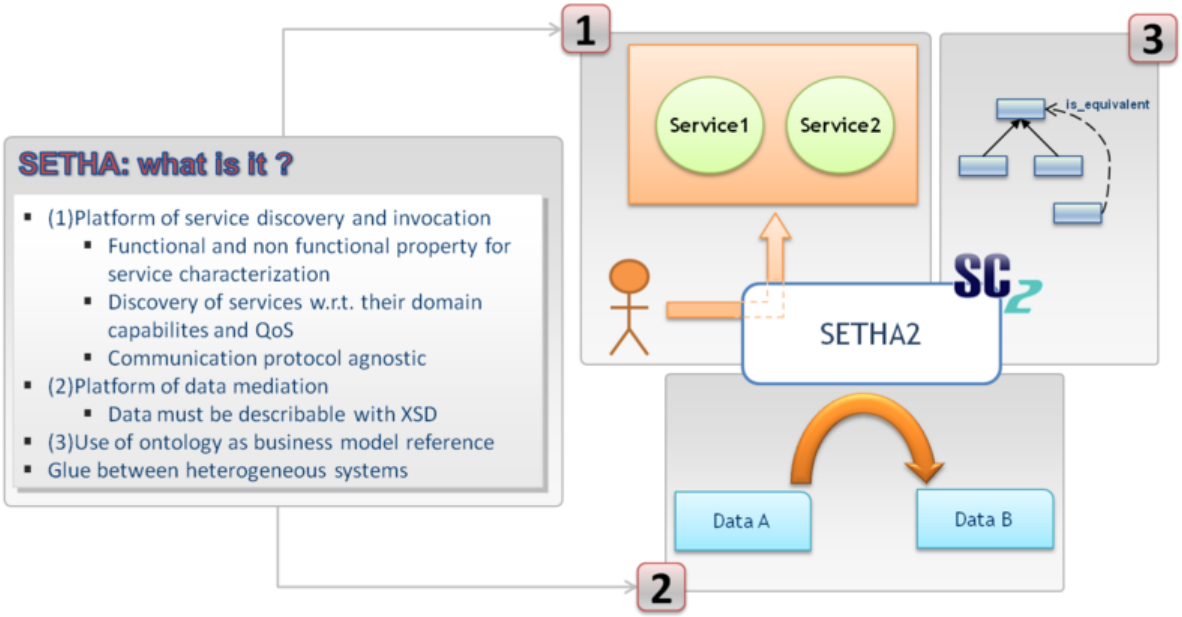


Figure 4.1: SETHA2 dynamic mediation engine

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.

10.5.1.3 *Mediation Service*

The mediation service represents 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 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.

10.6 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.

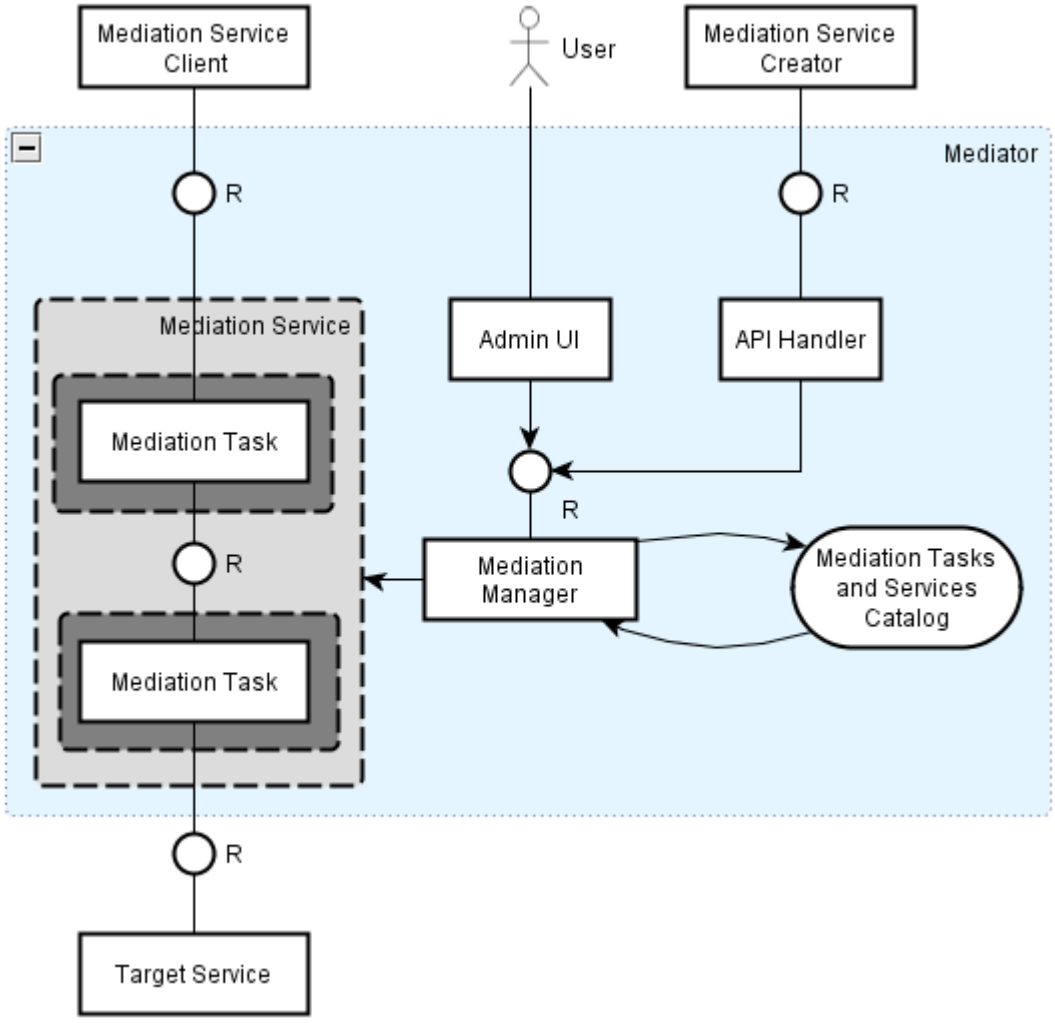


Figure 4.2: Mediator Architecture

10.7 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)

10.7.1 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.

10.7.2 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

10.8 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.

10.9 Concrete Implementation Documentation

10.9.1 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

10.9.2 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*

10.10 Detailed Specifications

10.10.1 Open API Specifications

- FIWARE.OpenSpecification.Apps.MediatorREST

10.10.2 Other Relevant Specifications

None

10.11 Re-utilised Technologies/Specifications

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

10.12 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.

- **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.

11 FIWARE OpenSpecification Apps MediatorREST

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

11.1 Introduction to the *Mediator* API

Please check the FI-WARE Open Specifications Legal Notice to understand the rights to use FI-WARE Open Specifications.

11.1.1 Mediator API Core

The Mediator API is a RESTful, resource-oriented API accessed via HTTP that uses XML representation for information interchange.
Mediator APIs allow to create and handle mediationServices i.e. services that can be invoked to call a target service adding specific mediation logics to the existing target service basic interface and behaviour. For more details about the Mediator GE, please refer to Mediator GE Open Specification.

The mediator APIs are meant to expose a common interface for different mediator implementations. These APIs provide resources and operations that allow to create mediation services that are able to use the specific mediation tasks provided by the mediator implementations. These APIs don't fully specify the mediator tasks themselves to avoid any constraint into possible mediator implementation capabilities.
Mediator APIs are not provided in the current version of the Mediator GE. A reference implementation of these APIs , will be provided in the final release of the Mediator GE.

11.1.2 Intended Audience

This specification is intended for both software developers and reimplementers of the Mediator GE. For the former, this document provides a full specification of how to interoperate with products that implement the Mediator APIs. 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 Mediator Generic Enabler. You should also be familiar with:

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

11.1.3 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	Users
Apr 30, 2012	• Initial version	TI
Jul 05 05, 2012	• Dynamic mediation tasks	THALES

Sept 05, 2012	• Update Template	TI
Oct 29, 2012	• Updated Data Model Specification	TI THALES

11.1.4 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 and in italic font, e.g.

{id}

The reader can replace the *{id}* with an appropriate value.
For a description of some terms used within this document, refer to the Mediator GE Open Specification.

11.1.5 Additional Resources

For more details about the Mediator GE that this API is based upon, please refer to Mediator GE Open Specification.

11.2 General *Mediator* API Information

11.2.1 Resources Summary

The mediator is structured into mediationServices and mediationTasks (mediationTasks type can also be *dynamic mediation tasks*).

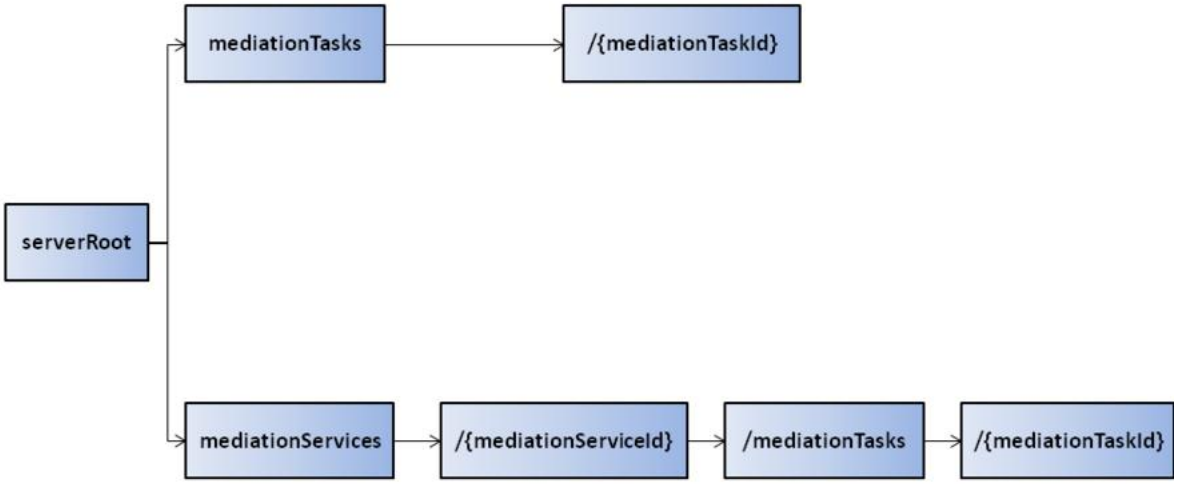


Figure 2.1 Resources

11.2.2 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 them 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 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.

11.2.4 Representation Transport

Resource representation is transmitted between client and server by using the 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.

11.2.5 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.

11.2.6 Links and References

11.2.6.1 *Web citizen*

The mediator is relying on Web principles:

- URI to identify resources
- consistent URI structure based on REST style protocol

11.2.7 Paginated Collections

Mediator API will not limit the number of elements to return, because mediation service creation and handling doesn't require the exchange of very big data.

11.3 API Operations

11.3.1 Managing MediationServices

11.3.1.1 *MediationServices Operations*

Operations on the MediationServices resource:

Verb	URI	Name	Description
GET	/MediationServices	getMediationServices	Get the list of available mediationServices
GET	/MediationServices/{mediationServiceID}	getMediationService	Get the mediationService by ID
PUT	/MediationServices/{mediationServiceID}	createOrUpdateMediationService	Create or update a mediationService
DELETE	/MediationServices/{mediationServiceID}	deleteMediationService	Delete the mediationService

11.3.1.2 *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.

11.3.2 Managing MediationTasks and DynamicMediationTasks

11.3.2.1 *MediationTasks and DynamicMediationTasks Operations*

Verb	URI	Name	Des
GET	/MediationTasks/	getMediationTasks	Get the li mediation
GET	/DynamicMediationTasks/	getDynamicMediationTasks	Get the li DynamicM
GET	/MediationTasks/{mediationTaskID}	getMediationTask	Get the m by ID
GET	/DynamicMediationTasks/{dynamicMediationTaskID}	getDynamicMediationTask	Get the DynamicM
GET	/MediationServices/{mediationServiceID}/MediationTasks	getMediationTasksForMediationService	Get the li mediation DynamicM set on the mediation

11.3.2.2 *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.

11.3.3 Resources and Operations Details

11.3.3.1 *Resources*

The mediator GE offers a set of available mediation tasks: the set of mediation capabilities provided by the specific implementations.
The mediator GE 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 between the caller and the target service. The mediation task must be choosen from the set of available mediation tasks.

Mediation Task
Every available mediation task is identified by a Mediation task id. This identifier is used to specify this mediation task in every usage; it will be used in the creation of a mediation service to configure this mediation task in the mediation task chain that will be executed by the mediation service.
Every mediation task may have task-specific properties.
Mediation task capabilities will be added to the Mediator GE on the basis of FI-WARE needs.

Mediation Service
A mediation service is identified by a Mediation service name.
Every mediation service is configured with a chain of Mediation tasks: it is the mediation task chain 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 of the mediation task configured to be executed by the mediation service.
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.
Mediation service additional settings can be configured too (e.g. Timeout).

11.3.3.2 *Operations*

createOrUpdateMediationService

This interaction allows to create a new mediation service (virtual proxy) to a web service or to update an existing mediation service, configuring the chain of mediation tasks that will be executed when the mediation service is invoked. The chain of mediation tasks will be executed between the caller and the target service.
Returns the URL that allows the invocation of the target service with the specified mediation, i.e. the mediation service URL.

The APIs allow to obtain the list of the available mediation tasks, in order to choose the mediation tasks that will be executed by the mediation service (see the ***getMediationTasks*** operation). An example of mediation task is the SOAP_TO_REST task that converts SOAP invocations into REST invocation.

Input Parameters

- *Mediation service name* - Identification name for the mediation service. If no mediation service with the specified name exists, creates a new mediation service, identified by this name. If the specified name identify an existing mediation service then the invocation updates that mediation service according to the input data.
- *Target service endpoint* - Target service URL i.e. URL of the service that will be invoked via the mediation service.
- *Mediation service additional parameters* - mediation service additional settings (e.g. Timeout).
- *Mediation task list* - The mediation task list that the mediation service will execute between the caller and the service. For every mediation task the following parameters must be specified:
    -
    - *Mediation task id* - The task identifier (e.g. SOAP_TO_REST is the id of the mediation task that converts SOAP invocations into REST invocation). The list of available tasks, and the id of each of them, can be retrieved via the ***getMediationTasks*** operation.
    - *Task-specific parameters* - The parameter list of the specific task. For every parameter must be specified the identification name of the task parameter and the value of the parameter in the mediation service configuration.

Output Parameters

- *Mediation service URL* - The URL that will be returned: it is the URL that allows service invocation with the specified mediation, i.e. the mediation service URL.

deleteMediationService

This interaction allows to delete a mediation service.

Input Parameters

- *Mediation service name* - Identification name of the mediation service to delete.

getMediationService

This interaction allows to obtain the configuration of an existing mediation service.

Input Parameters

- *Mediation service name* - Identification name of the mediation service whose configuration we are asking for.

Output Parameters

- *Target service endpoint* - Target service URL i.e. URL of the service that will be invoked via the mediation service.

- *Mediation service additional parameters* - mediation service additional settings (e.g. Timeout).
- *Mediation task list* - The mediation task list that the mediation service will execute between the caller and the service. For every mediation task the following parameters are specified:
  -
  - *Mediation task id* - The task identifier (e.g. SOAP_TO_REST is the id of the mediation task that converts SOAP invocations into REST invocation). The list of available tasks, and the id of each of them, can be retrieved via the ***getMediationTasks*** operation.
  - *Mediation task description* - The description of the Mediation task.
  - *Task-specific parameters* - The parameter list of the specific task. For every parameter is specified the identification name of the task parameter and the value of the parameter in the mediation service configuration.
- *Mediation service URL* - the URL that allows service invocation with the specified mediation, i.e. the mediation service URL.

getMediationServices
This interaction allows to obtain the configured mediation services, as a list of their identification names.

Input Parameters
None

Output Parameters
- *Mediation service list* - The list of mediation services configured on the Mediator. For every configured mediation service is returned its *Mediation service name*: the identification name of the mediation service, and the URL of the resource: the URL of the ***getMediationService*** operation for the specific mediation service

getMediationTasks
Returns the list of available mediation tasks that can be used to configure a mediation service. The mediation task is a basic mediation capability. When the mediation service is invoked, a list of mediation task will be executed (by the mediation service) between the caller and the target service.
Input Parameters
None

Output Parameters
- *Mediation task list* - The list of available mediation task that is returned. For every available mediation task is returned its *Mediation task id*, a *Mediation task description* and the URL of the resource: the URL of the ***getMediationTask*** operation for the specific mediation task. The *Mediation task id* is the identifier that will be used to specify this mediation task in every usage (e.g. it will be used in the ***createOrUpdateMediationService*** operation to configure this mediation task as the one that will be executed by the mediation service)

getMediationTasksForMediationService
Returns the list of mediationTasks and DynamicMediationTasks set on the specified mediationService
Input Parameters
The *Mediation service name*, the identification name of the mediation service whose tasks we want to obtain.

Output Parameters

- *Mediation task list* - The list of mediationTasks and DynamicMediationTasks set on the specified mediationService. For every mediation task is returned its *Mediation task id*, a *Mediation task description* and the URL of the resource: the URL of the ***getMediationTask*** operation for the specific mediation task..

getMediationTask
Get the configuration of the mediationTask identified by the specified *Mediation task id*
Input Parameters

- *Mediation task id* - The id of the mediation task whose configuration we want to obtain.

The *Mediation task id* is the identifier that will be used to specify this mediation task in every usage (e.g. it will be used in the ***createOrUpdateMediationService*** operation to configure this mediation task as the one that will be executed by the mediation service)

Output Parameters

- *Mediation task id* - The task identifier.
- *Mediation task description* - The description of the Mediation task.
- *Task-specific parameters* - The parameter list of the specific task. For every parameter is specified the identification name of the parameter and the default value of the task parameter, if the parameter has a default value

11.3.4 Dynamic mediation tasks details

The **getDynamicMediationTasks** and getDynamicMediationTask provide the same information as getMediationTasks and **getMediationTask**. Here we define more specifically the RESTfull API for these dynamic operations.
User who wants to use these operations must send http request towards their url resources :
Example of HTTP request
GET /DynamicMediationTasks HTTP/1.1
Host: example.org
OR
GET /DynamicMediationTasks/{dynamicMediationTaskID} HTTP/1.1
Host: example.org

11.3.4.1 *getDynamicMediationTasks*

The mediator HTTP response for this operation follows the XSD file reproduced here:

```
<?xml version="1.0" encoding="UTF-8"?><br \>
<schema xmlns="http://www.w3.org/2001/XMLSchema"
targetNamespace="http://www.fiware.thalesgroup.com/DynamicMediationT
asks"
xmlns:tns="http://www.fiware.thalesgroup.com/DynamicMediationTasks"
elementFormDefault="unqualified"><br \>
    <element name="DynamicMediationTasks">
        <complexType>
            <sequence>
                <element name="linkrel" type="string" minOccurs="1"
maxOccurs="1">
                    <annotation>
                        <documentation>Relative location of the
operation url that retrieve dynamic mediation tasks.</documentation>
                    </annotation>
                </element>
                <element name="linkhref" type="string" minOccurs="1"
maxOccurs="1">
                    <annotation>
                        <documentation>Location in full http form of
the operation url that retrieve dynamic mediation
tasks.</documentation>
                    </annotation>
                </element>
                <element name="listDynamicMediationTasks"
minOccurs="1" maxOccurs="1">
                    <annotation>
                        <documentation>Listing of all dynamic
mediation tasks.</documentation>
                    </annotation>
                    <complexType>
                        <sequence>
                            <element name="DynamicMediationTask"
minOccurs="0" maxOccurs="unbounded">
                                <complexType>
                                    <sequence>
                                        <element name="id"
type="string" minOccurs="1" maxOccurs="1">
```

```
                                                <annotation>
                                                    <documentation>Id of
the dynamic mediation tasks :
{dynamicMediationTaskID}</documentation>
                                                </annotation>
                                            </element>
                                            <element name="linkrel"
type="string" minOccurs="1" maxOccurs="1">
                                                <annotation>

<documentation>relative location of this dynamic mediation task
resource</documentation>
                                                </annotation>
                                            </element>
                                            <element name="linkhref"
type="string" minOccurs="1" maxOccurs="1">
                                                <annotation>

<documentation>Location in full http form of this dynamic mediation
task</documentation>
                                                </annotation>
                                            </element>
                                            <element name="description"
type="string" minOccurs="1" maxOccurs="1">
                                                <annotation>

<documentation>Description of the dynamic mediation
task.</documentation>
                                                </annotation>
                                            </element>
                                        </sequence>
                                    </complexType>
                                </element>
                            </sequence>
                        </complexType>
                    </element>
                </sequence>
            </complexType>
        </element>
</schema>
```

Example of HTTP response
HTTP/1.1 200 OK
Date: ...
Content-Type: application/xml; charset=utf-8
Content-Length: nnn
Last-Modified: Sat, 12 Aug 2006 13:40:03 GMT

```
<?xml version="1.0" encoding="UTF-8"?><br \>
<tns:DynamicMediationTasks

xmlns:tns="http://www.fiware.thalesgroup.com/DynamicMediationTasks"
    xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"

xsi:schemaLocation="http://www.fiware.thalesgroup.com/DynamicMediati
onTasks DynamicMediationTasks.xsd "><br \>
    <linkrel>/DynamicMediationTasks</linkrel>
    <linkhref>http://example.org/DynamicMediationTasks</linkhref>
    <listDynamicMediationTasks>
        <DynamicMediationTask>
            <id>{dynamicMediationTaskID}</id>

<linkrel>/DynamicMediationTasks/{dynamicMediationTaskID}</linkrel>

<linkhref>"http://example.org/DynamicMediationTasks/{dynamicMediatio
nTaskID}</linkhref>
            <description>description</description>
        </DynamicMediationTask>
    </listDynamicMediationTasks>
</tns:DynamicMediationTasks>
```

11.3.4.2 *getDynamicMediationTask*

The mediator HTTP response for this operation follows the XSD file reproduced here:

```
<?xml version="1.0" encoding="UTF-8"?><br \>
<schema xmlns="http://www.w3.org/2001/XMLSchema"
targetNamespace="http://www.fiware.thalesgroup.com/DynamicMediationT
asks"
xmlns:tns="http://www.fiware.thalesgroup.com/DynamicMediationTasks"
elementFormDefault="unqualified"><br \>
```

```
    <element name="DynamicMediationTask">
        <complexType>
            <sequence>
                <element name="id" type="string" minOccurs="1"
maxOccurs="1">
                    <annotation>
                        <documentation>Id of the dynamic mediation
tasks : {dynamicMediationTaskID}</documentation>
                    </annotation>
                </element>
                <element name="linkrel" type="string" minOccurs="1"
maxOccurs="1">
                    <annotation>
                        <documentation>relative location of this
dynamic mediation task resource</documentation>
                    </annotation>
                </element>
                <element name="linkhref" type="string" minOccurs="1"
maxOccurs="1">
                    <annotation>
                        <documentation>Location in full http form of
this dynamic mediation task</documentation>
                    </annotation>
                </element>
                <element name="description" type="string"
minOccurs="1" maxOccurs="1">
                    <annotation>
                        <documentation>Description of the dynamic
mediation task.</documentation>
                    </annotation>
                </element>
                <element name="specficParameters" minOccurs="1"
maxOccurs="1">
                    <annotation>
                        <documentation>The parameter list of the
specific task. For every parameter is specified the identification
name<br \> of the parameter and the default value of the task
parameter, if the parameter has a default value.</documentation>
                    </annotation>
                    <complexType>
                        <sequence>
```

```
                                <element name="parameter" minOccurs="0"
maxOccurs="unbounded">
                                    <complexType>
                                        <sequence>
                                            <element name="name"
type="string">
                                                <annotation>
                                                    <documentation>Name
of the parameter.</documentation>
                                                </annotation>
                                            </element>
                                            <element name="description"
type="string">
                                                <annotation>

<documentation>Desciprtion of the parameter.</documentation>
                                                </annotation>
                                            </element>
                                            <element name="defaultValue"
type="string" minOccurs="0" maxOccurs="1">
                                                <annotation>
                                                    <documentation>The
parameter can have a default value.</documentation>
                                                </annotation>
                                            </element>
                                            <element name="cardinality"
minOccurs="0" maxOccurs="1">
                                                <annotation>

<documentation>Cardinality specifies the number of repetitions of
this parameter (defines array).<br \>OPTIONAL signifies the
parameter can be omittedl. UNBOUNDED signifies that this parameter
can be repeated infinitely.</documentation>
                                                </annotation>
                                                <simpleType>
                                                    <restriction
base="string">
                                                        <enumeration
value="UNBOUNDED">
                                                        </enumeration>
                                                        <enumeration
value="OPTIONAL">
```

```
                                                    </enumeration>
                                                </restriction>
                                            </simpleType>
                                        </element>
                                    </sequence>
                                </complexType>
                            </element>
                        </sequence>
                    </complexType>
                </element>
            </sequence>
        </complexType>
    </element>
</schema>
```

Example of HTTP response
HTTP/1.1 200 OK
Date: ...
Content-Type: application/xml; charset=utf-8
Content-Length: nnn
Last-Modified: Sat, 12 Aug 2006 13:40:03 GMT

```
<?xml version="1.0" encoding="UTF-8"?><br \>
<tns:DynamicMediationTask

xmlns:tns="http://www.fiware.thalesgroup.com/DynamicMediationTasks"
    xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"

xsi:schemaLocation="http://www.fiware.thalesgroup.com/DynamicMediati
onTasks DynamicMediationTasks.xsd "><br \>
    <id>{dynamicMediationTaskID}</id>

<linkrel>/DynamicMediationTasks/{dynamicMediationTaskID}</linkrel>

<linkhref>http://example.org/DynamicMediationTasks/{dynamicMediation
TaskID}</linkhref>
    <description>description</description>
    <specficParameters>
        <parameter>
            <name>name</name>
```

```
            <description>description</description>
            <defaultValue>defaultValue</defaultValue>
            <cardinality>UNBOUNDED</cardinality>
        </parameter>
    </specficParameters>
</tns:DynamicMediationTask>
```

11.3.4.3 *Listing of all dynamic mediation tasks*

Verb	URI
GET	/DynamicMediationTasks/BUILD_PAYLOAD_NOOP_WITH_PARAMS
GET	/DynamicMediationTasks/BUILD_PAYLOAD_NOOP_WITH_SAXSD
GET	/DynamicMediationTasks/DATA_MEDIATION_AND_INVOCATION_NOOP_WITH_PARAMS
GET	/DynamicMediationTasks/DATA_MEDIATION_AND_INVOCATION_NOOP_WITH_SAXSD

ID:BUILD_PAYLOAD_NOOP_WITH_PARAMS

```
<?xml version="1.0" encoding="UTF-8"?><br \>
<tns:DynamicMediationTask
xmlns:tns="http://www.fiware.thalesgroup.com/DynamicMediationTasks"
xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
xsi:schemaLocation="http://www.fiware.thalesgroup.com/DynamicMediationTasks DynamicMediationTasks.xsd "><br \>
    <id>BUILD_PAYLOAD_NOOP_WITH_PARAMS</id>

<linkrel>/DynamicMediationTasks/BUILD_PAYLOAD_NOOP_WITH_PARAMS</linkrel>

<linkhref>http://example.org/DynamicMediationTasks/BUILD_PAYLOAD_NOOP_WITH_PARAMS</linkhref>
    <description>This method allows to build dynamically the payload to send to an identified service. taken as input a list a value and<br \> the semantic operation that the client provide. The data given will be transformed into the service payload.</description>
    <specficParameters>
        <parameter>
            <name>usdUri</name>
```

```
            <description>The target service URL of the file
descriptor in USDL format with references towards a sawsdl
semantic<br \> definition</description>
            <cardinality>UNBOUNDED</cardinality>
        </parameter>
        <parameter>
            <name>usdUri</name>
            <description>The service id inside the USDL file. Need
this id if the USDL reference more than one service.</description>
        </parameter>
        <parameter>
            <name>operationConcept</name>
            <description>The client need to access a certain
operation of the service. In the case the client does not know the
service<br \> operation syntactic name, he provides the semantic
version of this operation.</description>
        </parameter>
        <parameter>
            <name>semanticInput</name>
            <description>The client has to give the list of
parameter he wants to send to the service. The payload will be
created <br \>based on these information.The parameter value must be
given with the semantic description of the parameter.</description>
            <cardinality>UNBOUNDED</cardinality>
        </parameter>
    </specficParameters>
</tns:DynamicMediationTask>
```

ID:BUILD_PAYLOAD_NOOP_WITH_SAXSD

```
<?xml version="1.0" encoding="UTF-8"?><br \>
<tns:DynamicMediationTask
xmlns:tns="http://www.fiware.thalesgroup.com/DynamicMediationTasks"
xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
xsi:schemaLocation="http://www.fiware.thalesgroup.com/DynamicMediati
onTasks DynamicMediationTasks.xsd "><br \>
    <id>BUILD_PAYLOAD_NOOP_WITH_SAXSD</id>

<linkrel>/DynamicMediationTasks/BUILD_PAYLOAD_NOOP_WITH_SAXSD</linkr
el>

<linkhref>http://example.org/DynamicMediationTasks/BUILD_PAYLOAD_NOO
P_WITH_SAXSD</linkhref>
```

```
    <description>This method allows to build dynamically the payload
to send to an identified service. taken as input the client
payload<br \> to transform with itssemantic
description.</description>
    <specficParameters>
        <parameter>
            <name>usdUri</name>
            <description>The target service URL of the file
descriptor in USDL format with references towards a sawsdl
semantic<br \> definition</description>
            <cardinality>UNBOUNDED</cardinality>
        </parameter>
        <parameter>
            <name>usdUri</name>
            <description>The service id inside the USDL file. Need
this id if the USDL reference more than one service.</description>
        </parameter>
        <parameter>
            <name>operationConcept</name>
            <description>The client need to access a certain
operation of the service. In the case the client does not know the
service<br \> operation syntactic name,he provides the semantic
version of this operation.</description>
        </parameter>
        <parameter>
            <name>saxsd_content</name>
            <description>The client must give the SAXSD description
of the data (payload) he wants to transforms (content or url). <br
\>He gives here the value of the SAXSD.</description>
        </parameter>
        <parameter>
            <name>saxsd_url</name>
            <description>The client must give the SAXSD description
of the data he wants to transforms (content or url).He gives here
<br \>the url towards the accessible SAXSD resource.</description>
        </parameter>
        <parameter>
            <name>payload</name>
            <description>The client must gives the data he wants to
transform. He gives here the value of the payload he
sends.</description>
        </parameter>
```

```
    </specficParameters>
</tns:DynamicMediationTask>
```

ID:DATA_MEDIATION_AND_INVOCATION_NOOP_WITH_PARAMS

```
<?xml version="1.0" encoding="UTF-8"?><br \>
<tns:DynamicMediationTask
xmlns:tns="http://www.fiware.thalesgroup.com/DynamicMediationTasks"
xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
xsi:schemaLocation="http://www.fiware.thalesgroup.com/DynamicMediati
onTasks DynamicMediationTasks.xsd "><br \>
    <id>DATA_MEDIATION_AND_INVOCATION_NOOP_WITH_PARAMS</id>

<linkrel>/DynamicMediationTasks/DATA_MEDIATION_AND_INVOCATION_NOOP_W
ITH_PARAMS</linkrel>

<linkhref>http://example.org/DynamicMediationTasks/DATA_MEDIATION_AN
D_INVOCATION_NOOP_WITH_PARAMS</linkhref>
    <description>This method allows to search and invoke a service
capability with the given operation concept. After the invocation
<br \>the result is adapted to he given wanted output.</description>
    <specficParameters>
        <parameter>
            <name>usdUri</name>
            <description>The target service URL of the file
descriptor in USDL format with references towards a sawsdl <br
\>semantic definition</description>
            <cardinality>UNBOUNDED</cardinality>
        </parameter>
        <parameter>
            <name>usdUri</name>
            <description>The service id inside the USDL file. Need
this id if the USDL reference more than one service.</description>
        </parameter>
        <parameter>
            <name>operationConcept</name>
            <description>The client need to access a certain
operation of the service. In the case the client does not know
the<br \> service operation syntactic name, he provides the semantic
version of this operation.</description>
        </parameter>
        <parameter>
            <name>semanticInput</name>
```

```
            <description>The client has to give the list of
parameter he wants to send to the service. The payload will be
created based<br \> on these information. The parameter value must
be given with the semantic description of the
parameter.</description>
            <cardinality>UNBOUNDED</cardinality>
        </parameter>
        <parameter>
            <name>semanticOuput</name>
            <description>The client has to give the list of
parameter he wants to receive from the service. The parameter value
must<br \> be given with the semantic description of the
parameter.</description>
            <cardinality>UNBOUNDED</cardinality>
        </parameter>
    </specficParameters>
</tns:DynamicMediationTask>
```

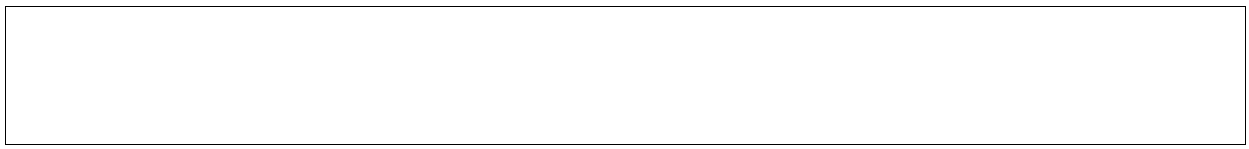
ID:DATA_MEDIATION_AND_INVOCATION_NOOP_WITH_SAXSD

```
<?xml version="1.0" encoding="UTF-8"?><br \>
<tns:DynamicMediationTask
xmlns:tns="http://www.fiware.thalesgroup.com/DynamicMediationTasks"
xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
xsi:schemaLocation="http://www.fiware.thalesgroup.com/DynamicMediati
onTasks DynamicMediationTasks.xsd "><br \>
    <id>DATA_MEDIATION_AND_INVOCATION_NOOP_WITH_SAXSD</id>

<linkrel>/DynamicMediationTasks/DATA_MEDIATION_AND_INVOCATION_NOOP_W
ITH_SAXSD</linkrel>

<linkhref>http://example.org/DynamicMediationTasks/DATA_MEDIATION_AN
D_INVOCATION_NOOP_WITH_SAXSD</linkhref>
    <description>This method allows to search and invoke a service
capability with the given operation concept. After the <br
\>invocation the result is adapted to the given wanted
output.</description>
    <specficParameters>
        <parameter>
            <name>usdUri</name>
            <description>The target service URL of the file
descriptor in USDL format with references towards a sawsdl <br
\>semantic definition</description>
            <cardinality>UNBOUNDED</cardinality>
```

```
        </parameter>
        <parameter>
            <name>usdUri</name>
            <description>The service id inside the USDL file. Need
this id if the USDL reference more than one service.</description>
        </parameter>
        <parameter>
            <name>operationConcept</name>
            <description>The client need to access a certain
operation of the service. In the case the client does not know<br \>
the service operation syntactic name, he provides the semantic
version of this operation.</description>
        </parameter>
        <parameter>
            <name>saxsd_content</name>
            <description>The client must give the SAXSD description
of the data (payload) he wants to transforms (content or url)<br \>
and the awaited response format.He gives here the value of the
SAXSD.</description>
        </parameter>
        <parameter>
            <name>saxsd_url</name>
            <description>The client must give the SAXSD description
of the data he wants to transforms (content or url) and <br \>the
awaited response format. He gives here the url towards the
accessible SAXSD resource.</description>
        </parameter>
        <parameter>
            <name>payload</name>
            <description>The client must gives the data he wants to
transform. He gives here the value of the payload <br \>he
sends.</description>
        </parameter>
        <parameter>
            <name>wanted_response_element</name>
            <description>The client gives here the element reference
inside the SAXSD description resource that contains <br \>the
description of the wanted response format.</description>
        </parameter>
    </specficParameters>
</tns:DynamicMediationTask>
```



12 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

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.eu and similar pages in order to understand the complete context of the FI-WARE project.

12.2 Copyright

12.3 Legal Notice

12.4 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, organisation and information.

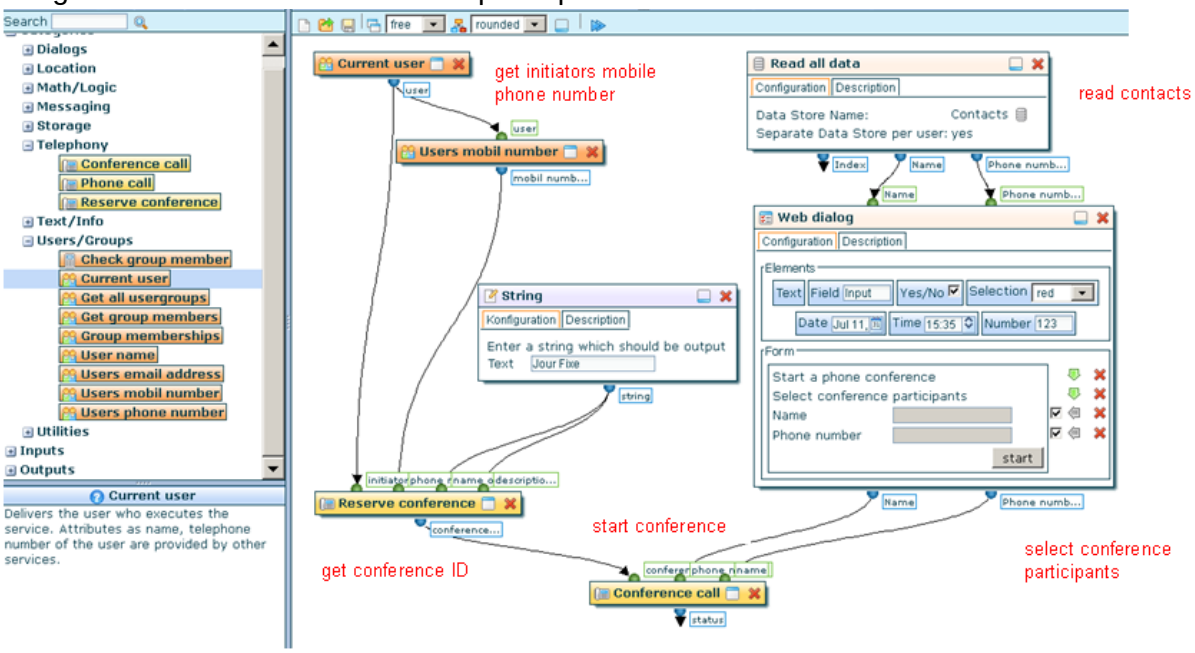
The Mashup Factory toolset supports a graphical composition style, which allows the combination of services and content from several areas (e.g. communication, multimedia, geolocation). It supports integrated APIs from developergarden.com (e.g. SMS, Conference Call) by Deutsche Telekom and external sources (e.g. Google geo data, translator, weather forecast).

12.5 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 realised by dedicated service descriptions and service lists.

12.5.1 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 catagorized 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:

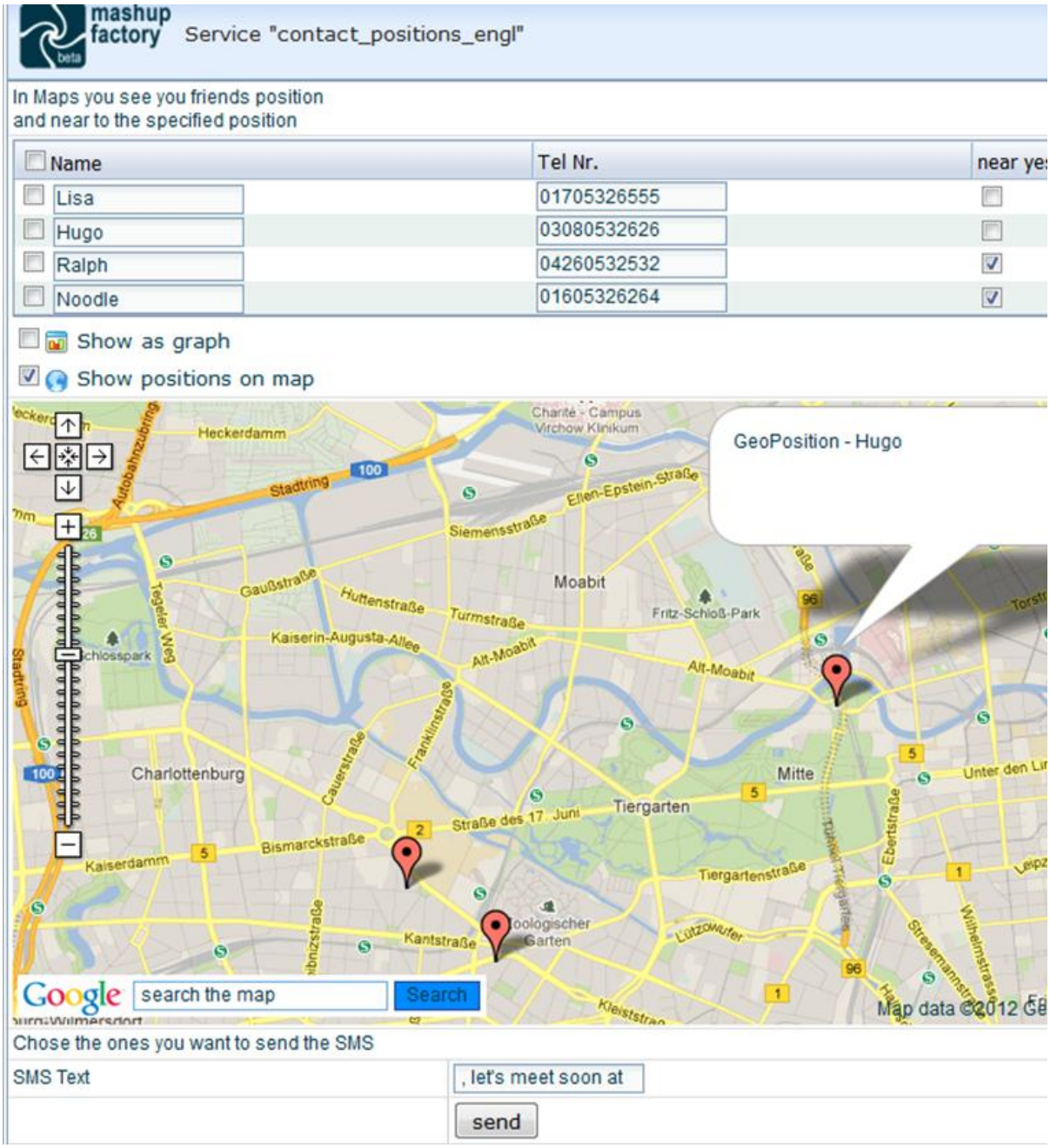
- a click-to-call (1-1) and a click-to-conference call for telephony
- email and SMS for messaging
- store, retrieve, modify and remove data for structured data storage
- a design-time based editor to configure user interaction structures with input and output parameters
- content services: weather, 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).

12.5.2 Composition Editor

The services are graphically representated 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 configurational 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 a 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 belows shows a screenshot of a service output with the geoposition of users displayed in google maps, with the option to send an SMS.



Output of a mashup

12.5.3 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 permission 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.

12.5.4 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 organised to groups. User attributes can be retrieved by a service composition at run time. Every service composition can be given permission 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, keep legal constraints concerning data security.

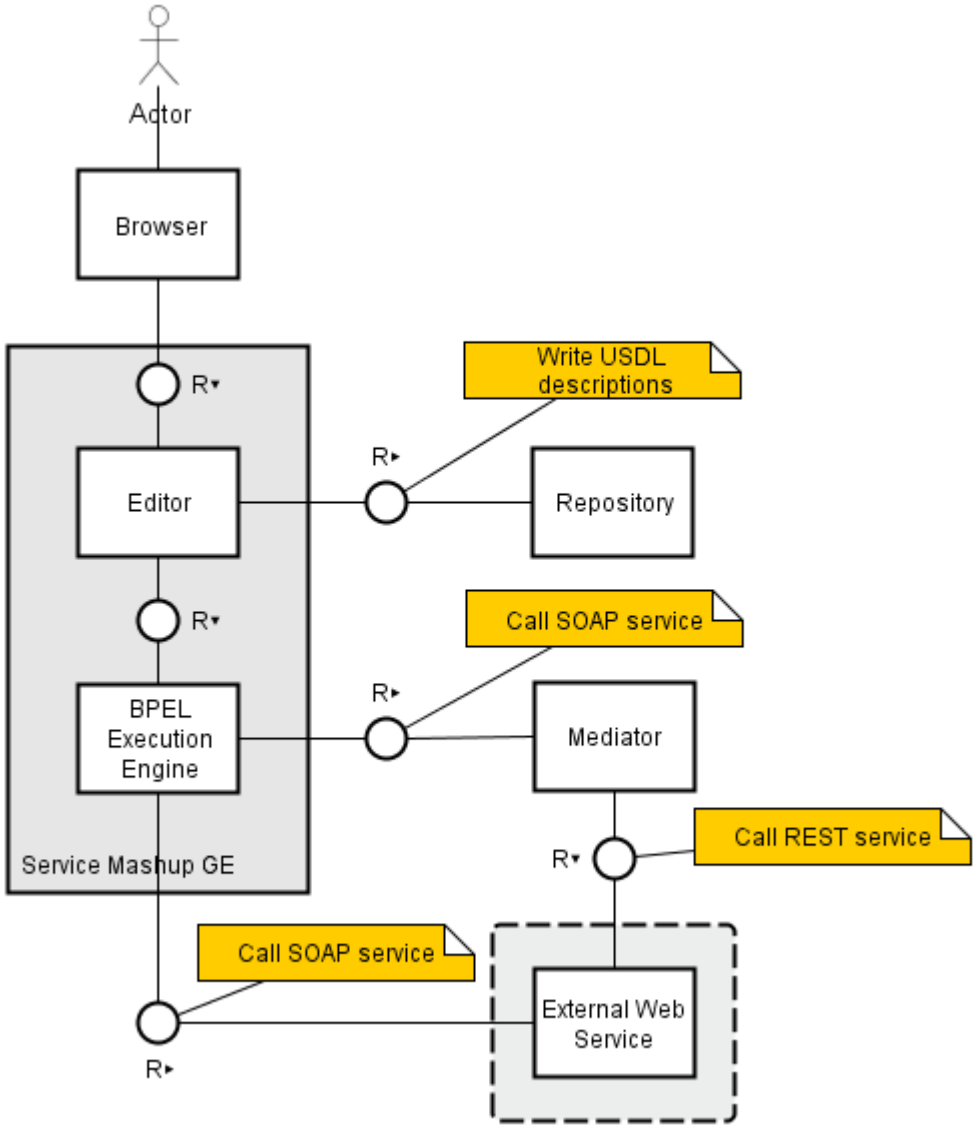
12.5.5 Example Scenarios

In the following section the composition process and some illustrative application scenarios will be described. Imagine a person who frequently organises (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 Mashup Factory which uses a weather service, SMS and a web based survey.
Other possible scenarios for supporting immmediate needs in communication, organisation 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 realising the scenarios, appropriate services must be integrated and perform their services with an adequate level of quality.

12.6 ServiceMashup Architecture



Service Mashup Architecture

The Mashup Factory follows the architecture of a Rich Internet Application. All user interaction takes place via 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.

12.6.1 Technical Interfaces

The Web browser communicates with the Mashup Factory server using HTML and Ajax technologies. The Web server needs to comply to 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

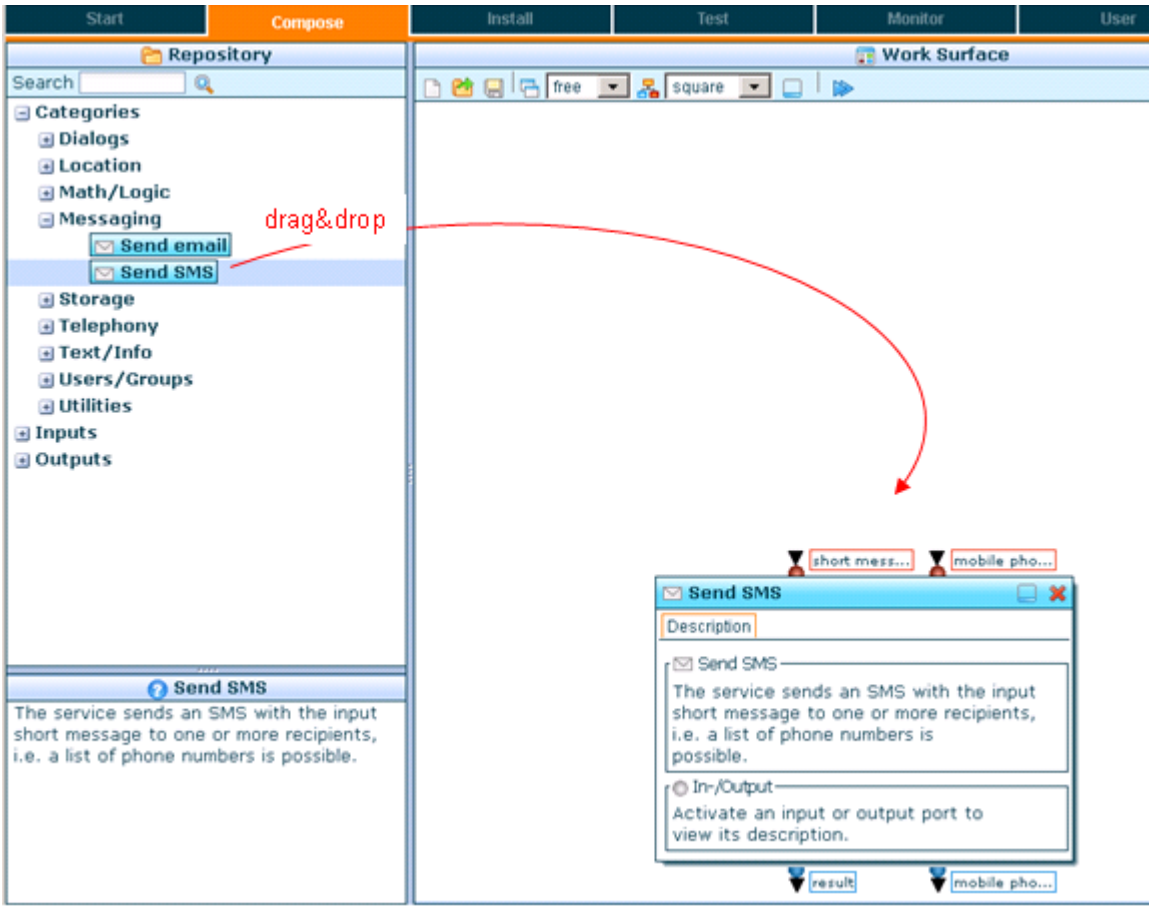
descriptions and other internal data an XML database is used that is also hosted in the servlet container.

12.7 Main Operations

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 examplary services.

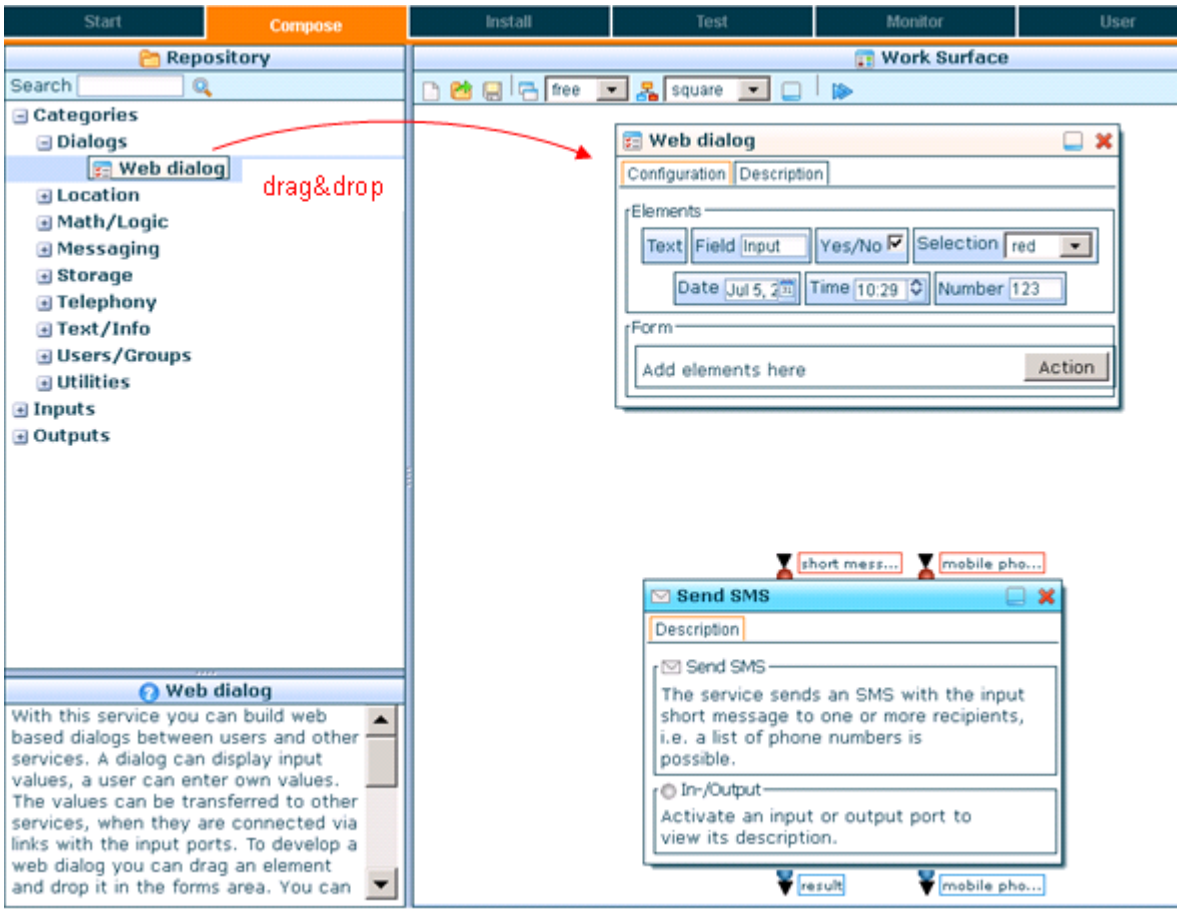
12.7.1 Send SMS Service

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.



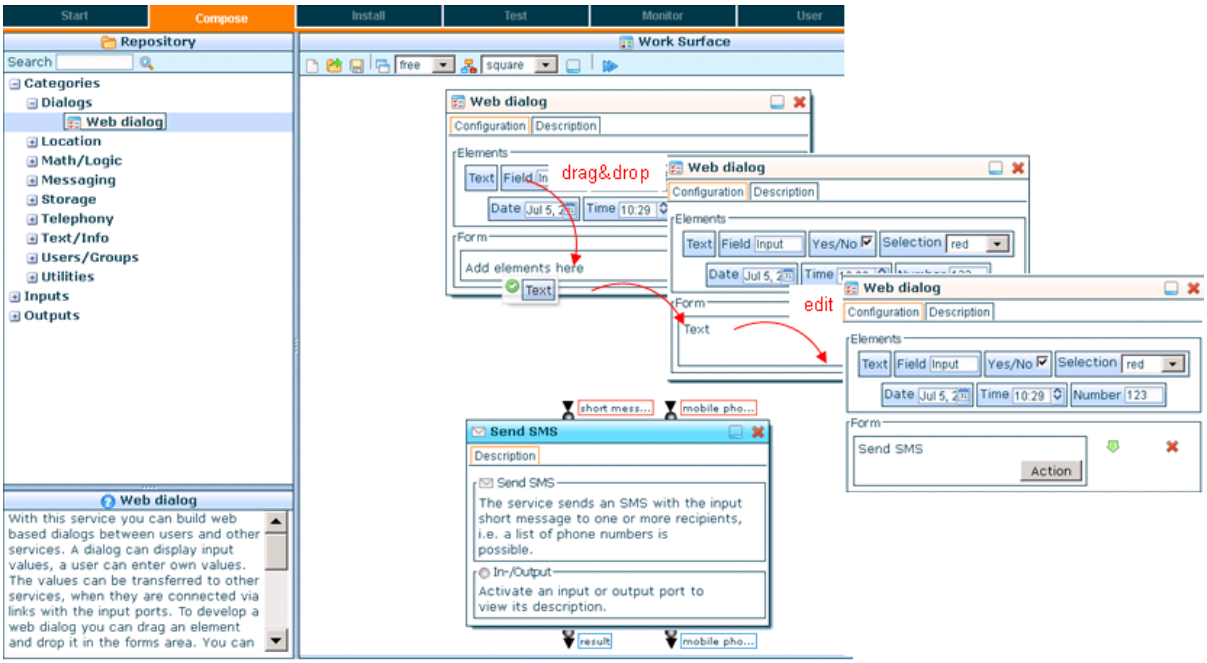
Send SMS Service - Step 1

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.



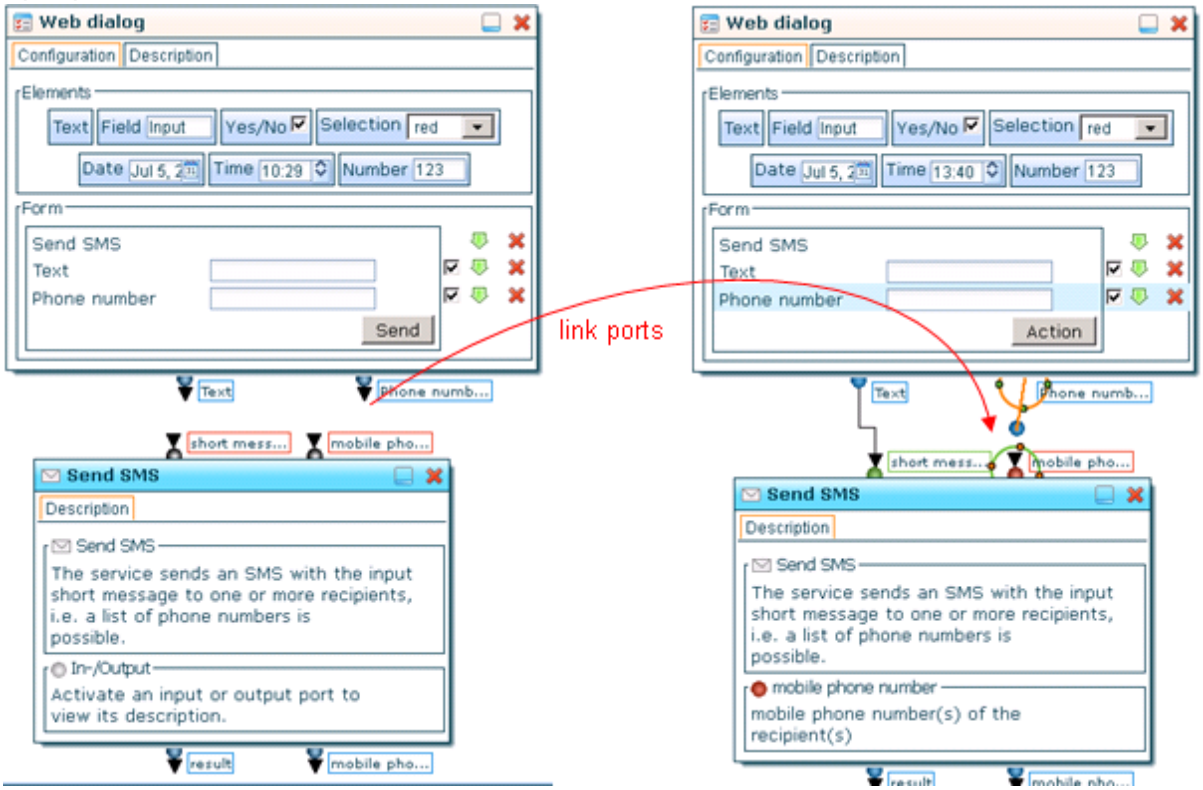
Send SMS Service - Step 2

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.



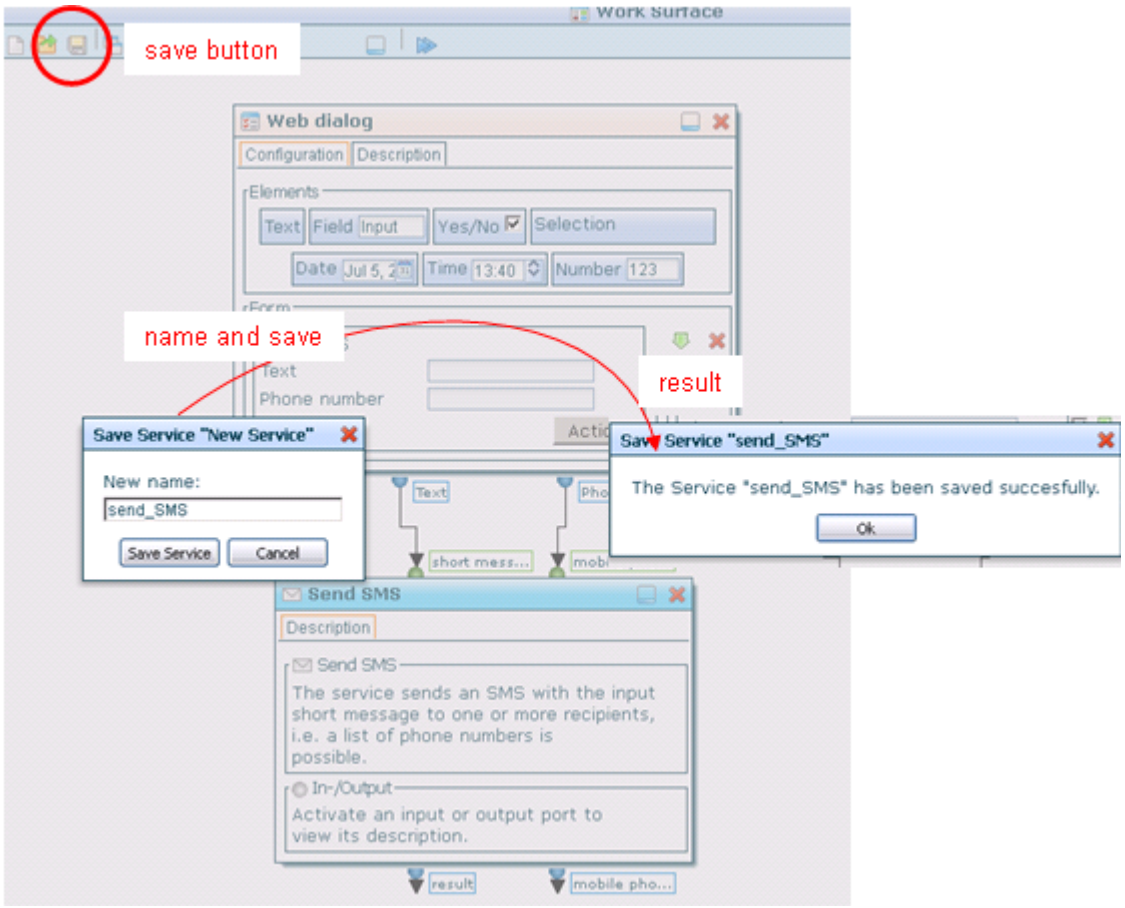
Send SMS Service - Step 3

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.



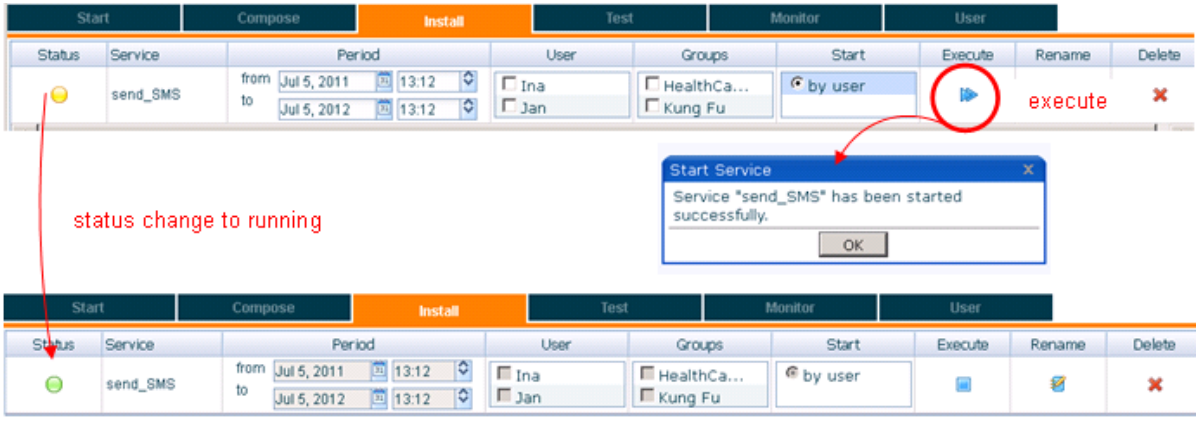
Send SMS Service - Step 4

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.



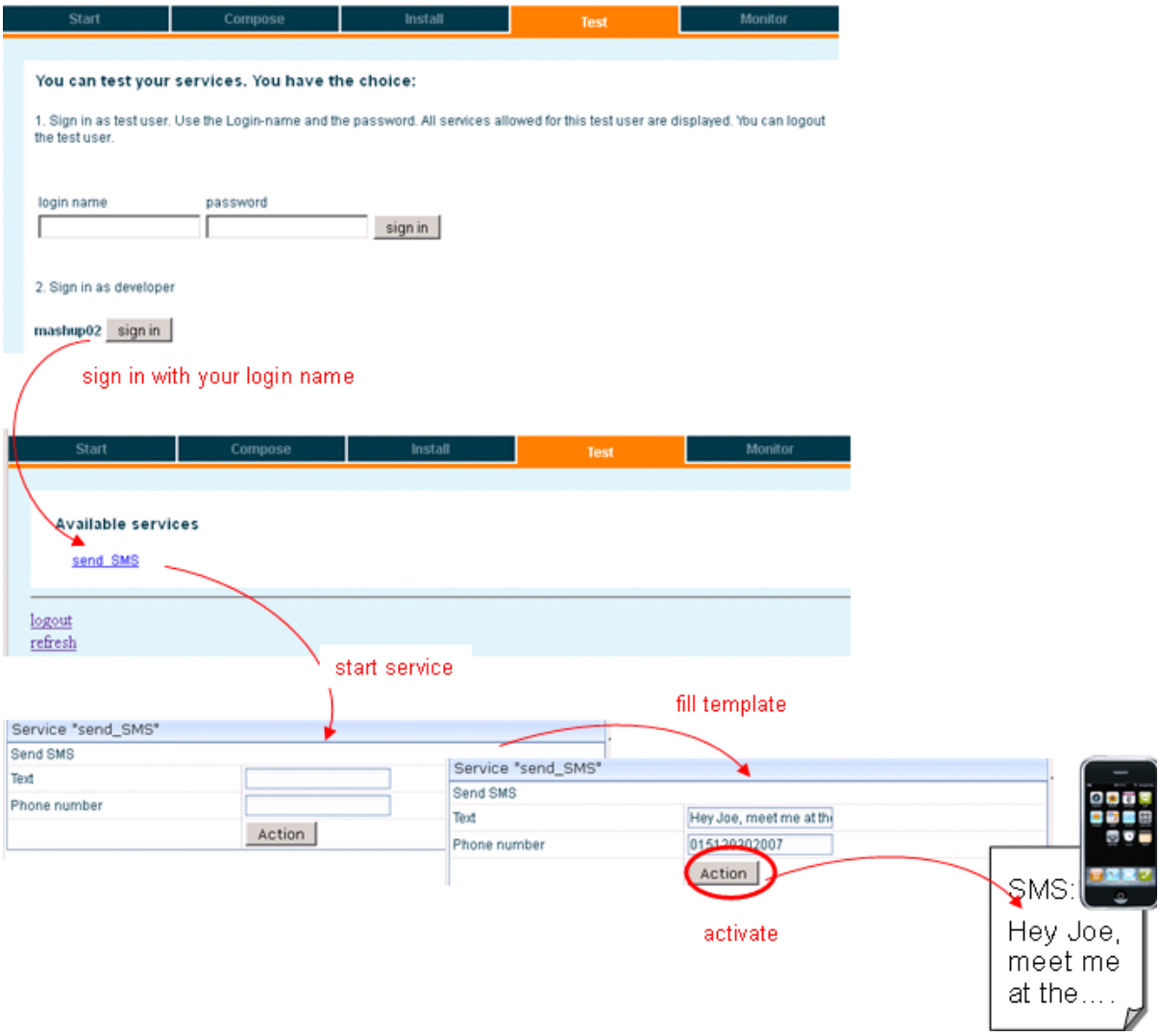
Send SMS Service - Step 5

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

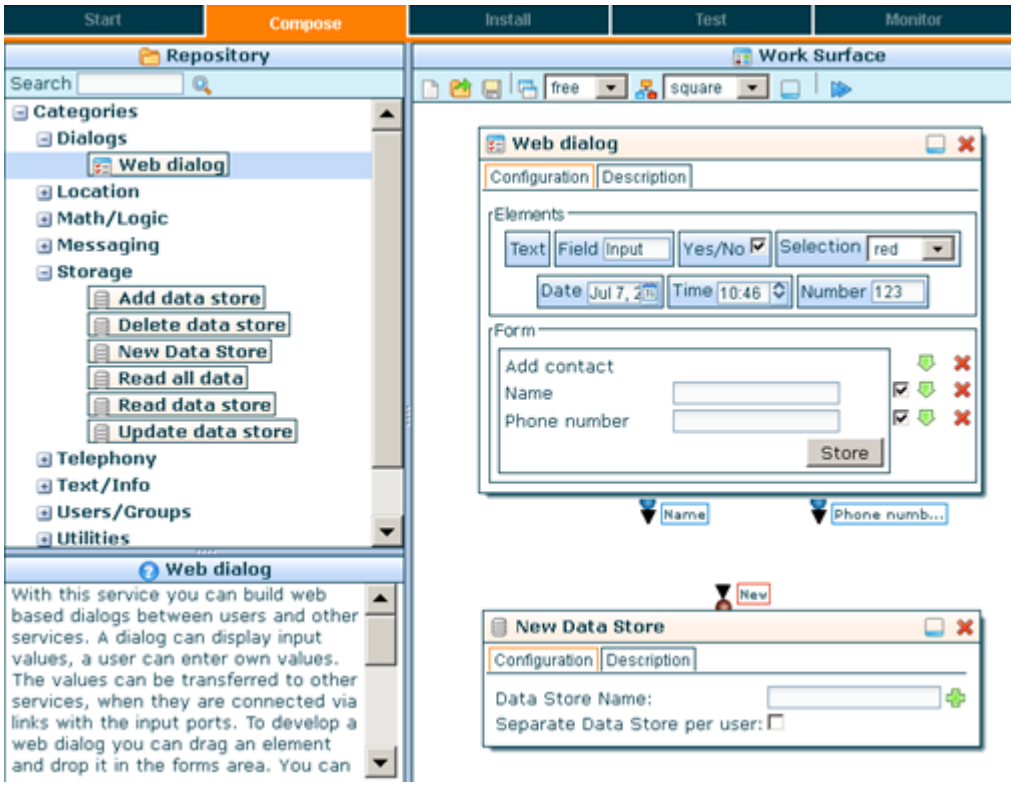
Test the new service and login under your user name as a developer. You find the new service as link and start it by pushing the link. A new tab is opened with the web dialog you have designed. Fill in data, activated the action button and the SMS is sent!



Send SMS Service - Step 7

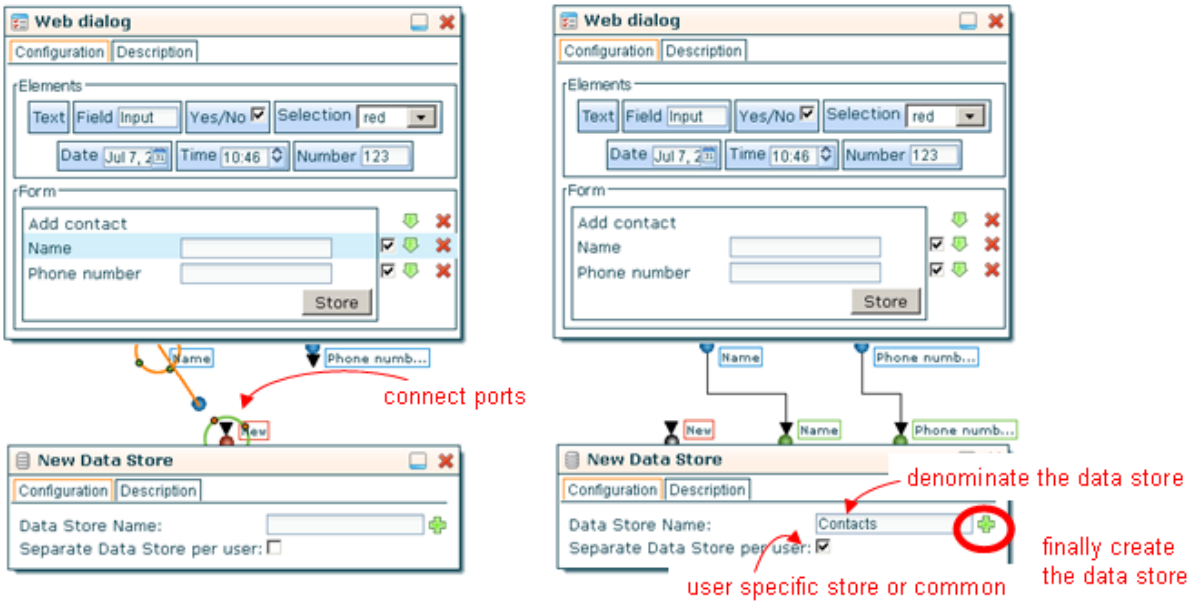
12.7.2 Using Data Stores

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 addressbook 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 are used in order to allow the user to enter the data



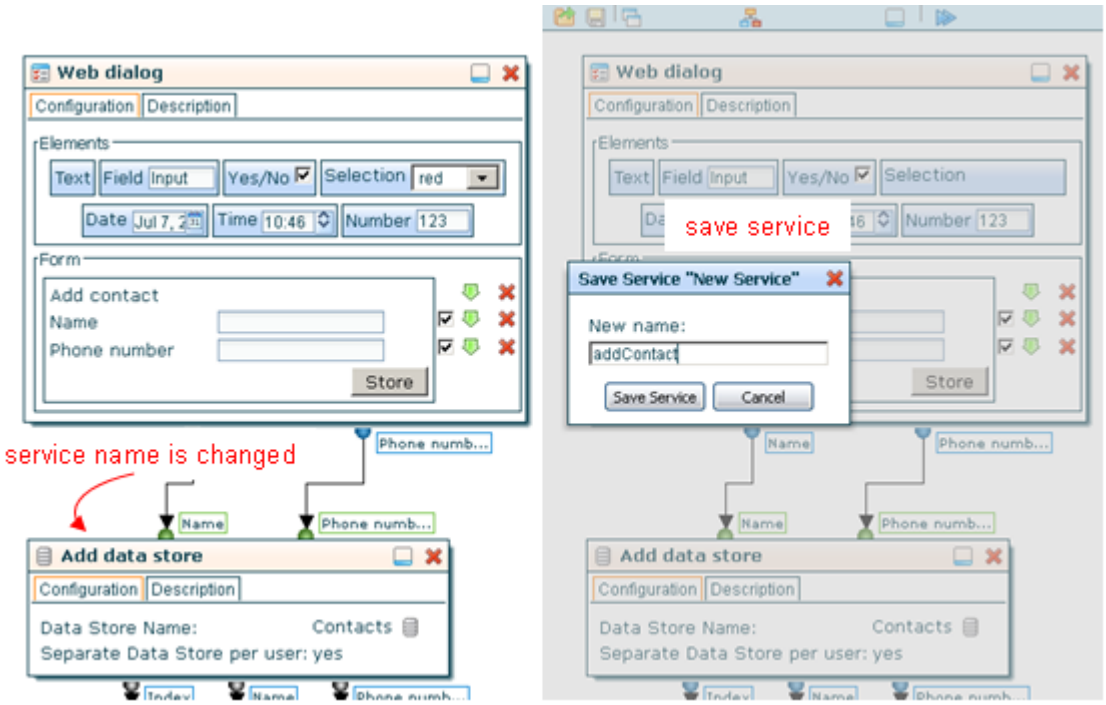
Using Data Stores - Step 1

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.



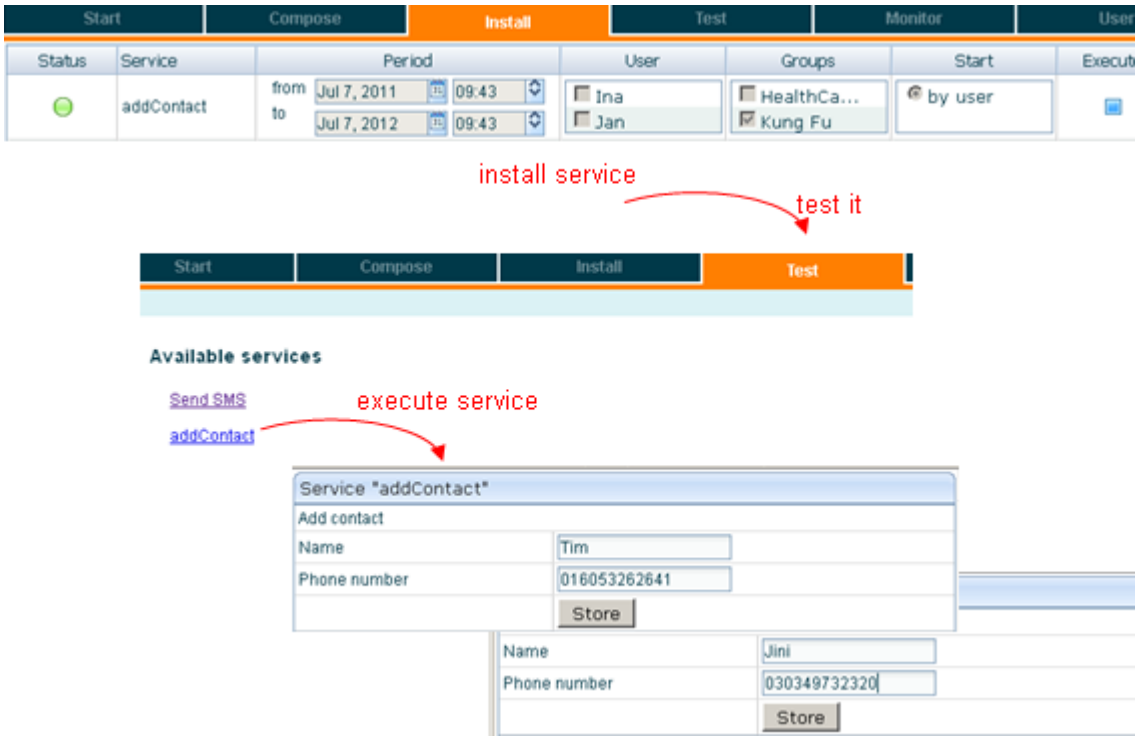
Using Data Stores - Step 2

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.

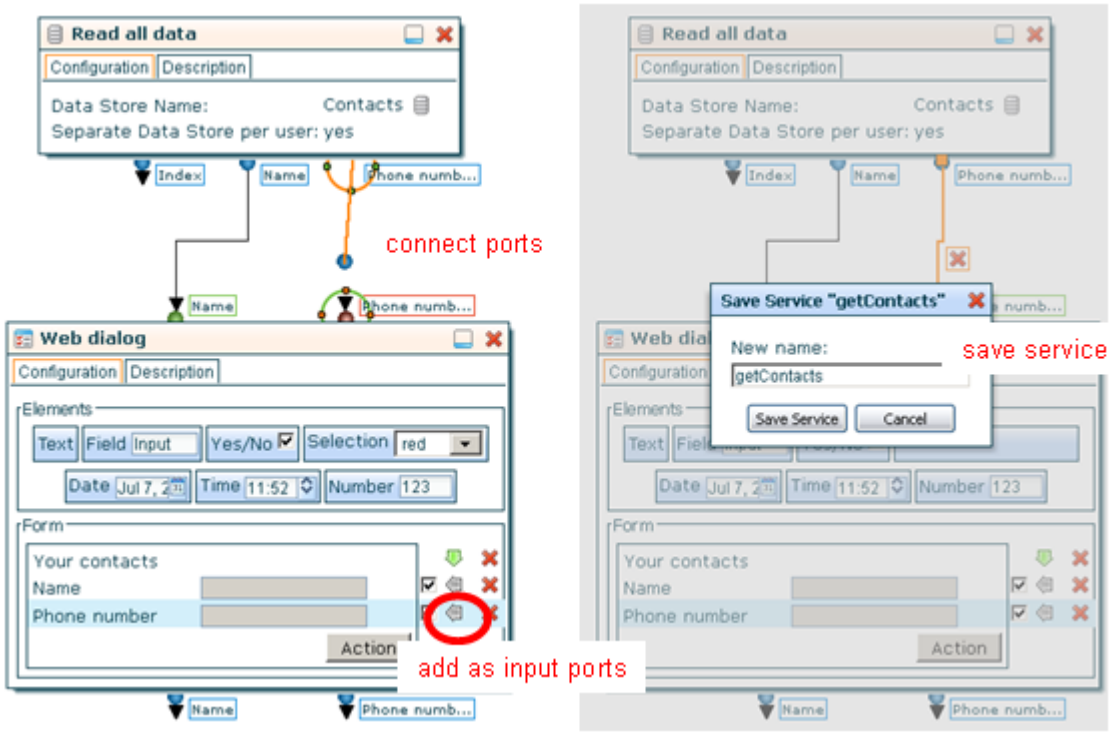


Using Data Stores - Step 4

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).

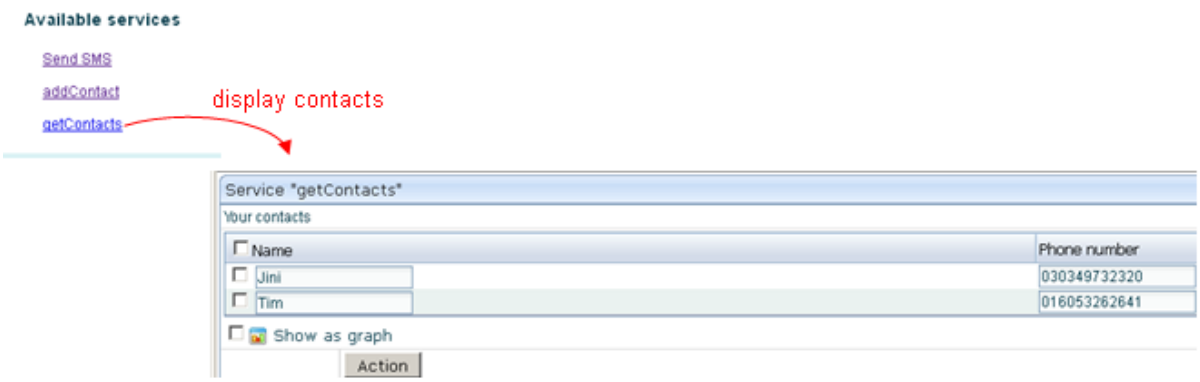
Using Data Stores - Step 5

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

12.8 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.

12.8.1 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 remodelled 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.

12.8.2 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 to connect 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, that 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).

12.9 Detailed Specifications

12.9.1 Open API Specifications

The Service Mashup GE Mashup Factory is not exposed as a service but as a Rich Internet Application, accessed throught 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

12.10 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

12.11 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.

13 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

13.1 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.eu and similar pages in order to understand the complete context of the FI-WARE project.

13.2 Copyright

- Copyright © 2012 by UPM

13.3 Legal Notice

Please check the following Legal Notice to understand the rights to use these specifications.

13.4 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 shareability. 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-self' 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 FIWARE'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-self 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. Different *wiring* editors are allowed provided that they give 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.

13.4.1 Target usage

FI-WARE strives to exploit the composability of the application and service technologies in order to support cross-selling and achieve 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.

13.5 Basic Concepts

13.5.1 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

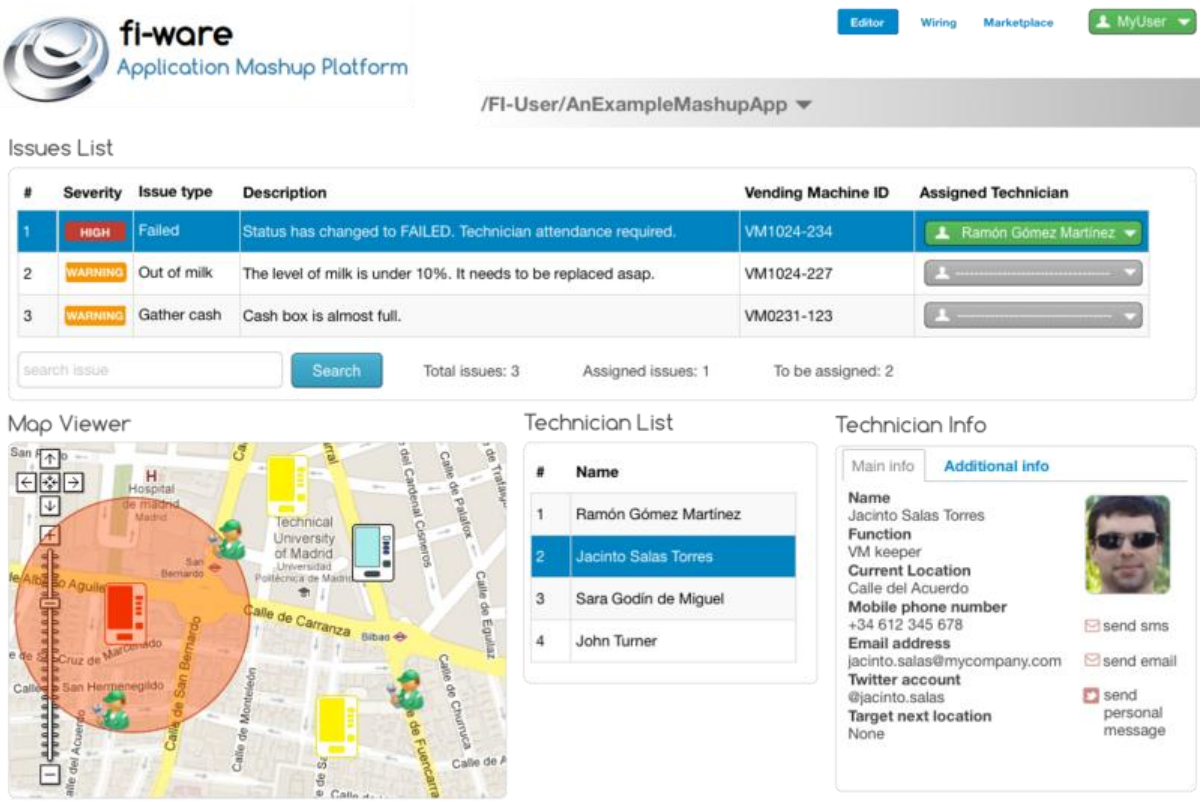
These *early* widgets *per se* are isolated applications that do not interact with each other. However, the Application Mashup GE aims at providing a mechanism to visually compose a fully-fledged web application from different widgets that can now interact with each other via events and data sharing. 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 and 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, Web 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

13.5.2 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 (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 also needed from which a user can select widgets from. 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:

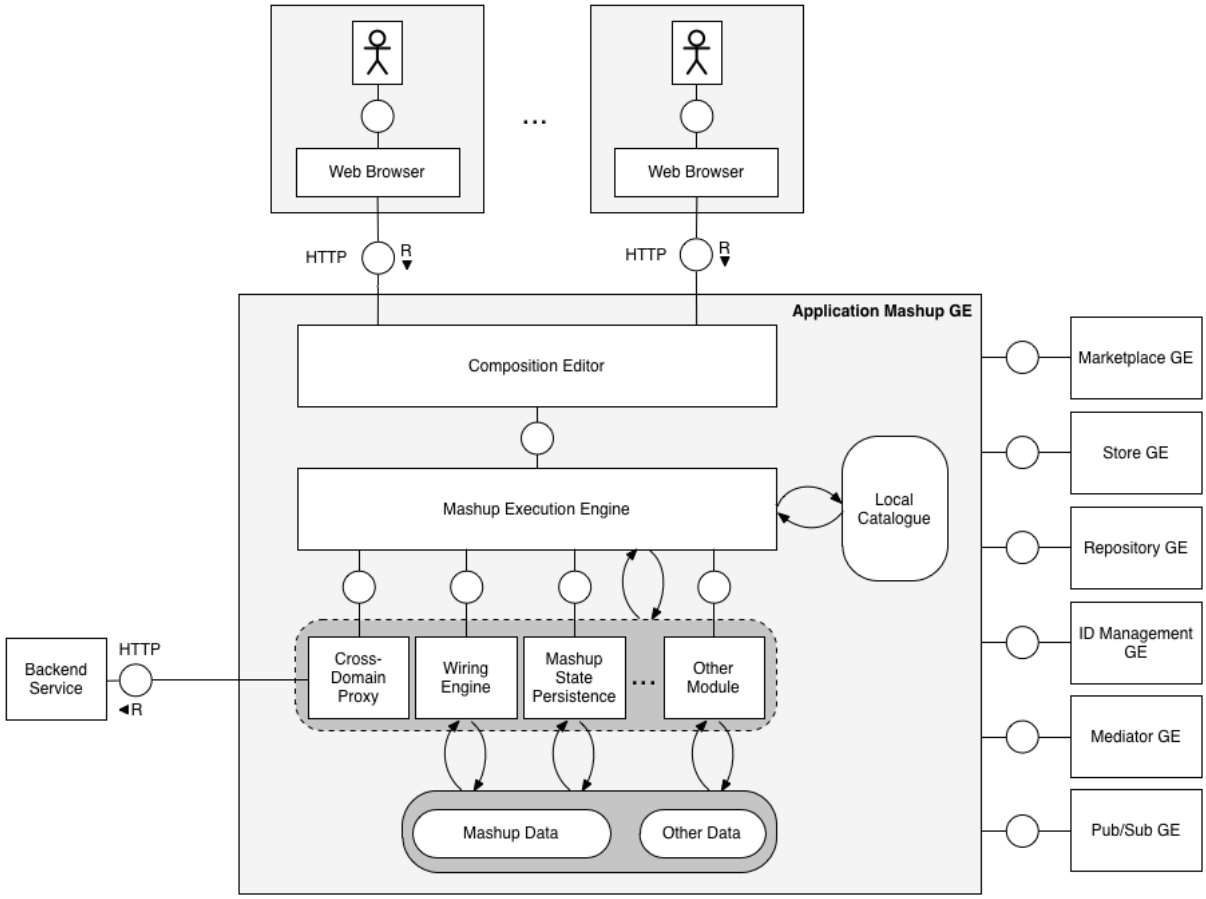
- The functionality and information sources are split into a set of widgets. There is one widget for each resource that will be made accessible from the website: management of bookings and registrations, management of resources, management of services. Widgets from a third party service provider capable 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).

13.6 Architecture

13.6.1 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.

13.6.2 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.

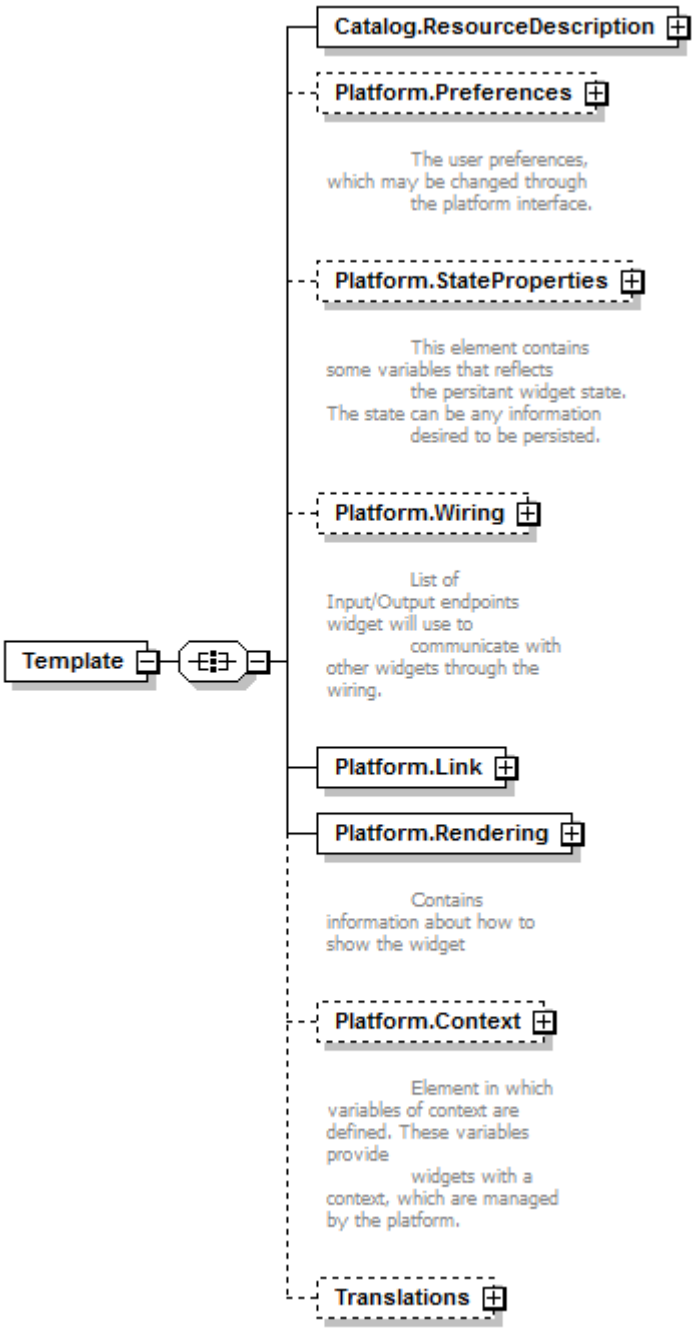
13.6.2.1 *Mashup and Widget Template*

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 are available at:

- MDL XML Template Schema
- WDL XML Template Schema

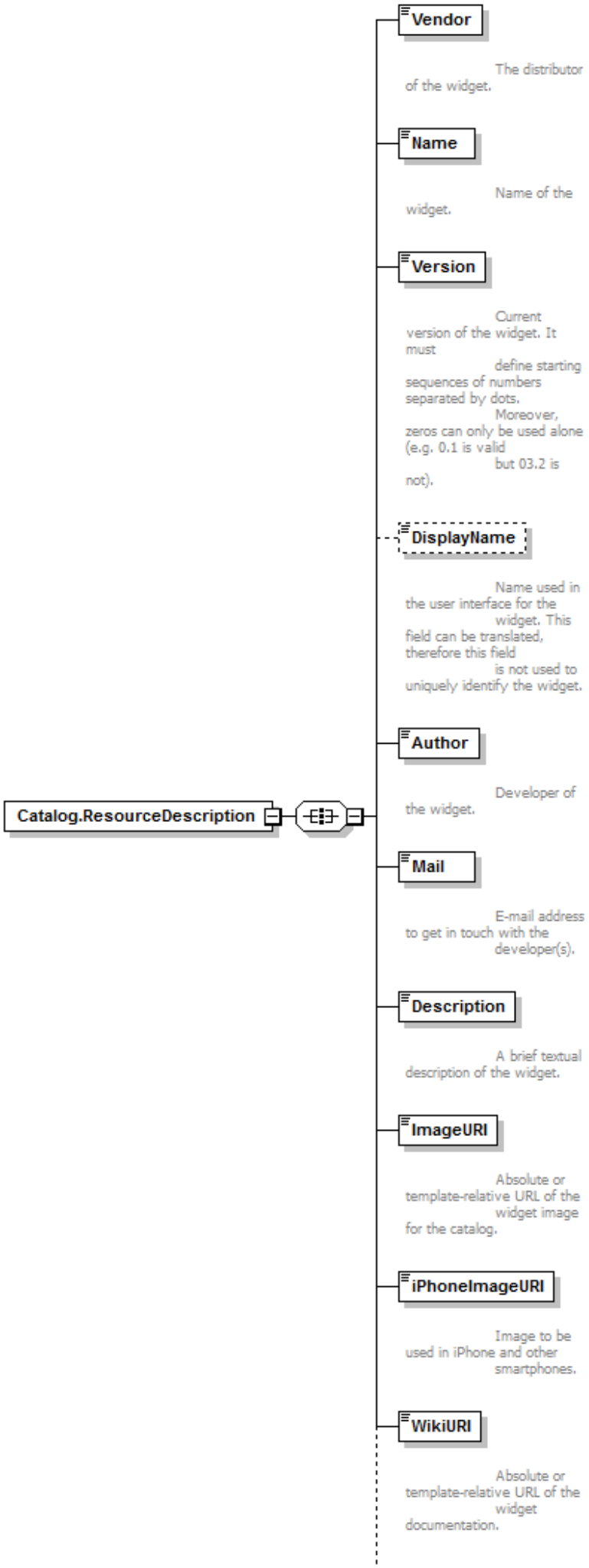
WDL Template description as a XML Schema Definition

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:


Catalog.ResourceDescription
Vendor
The distributor of the widget.
Name
Name of the widget.
Version
Current version of the widget. It must define starting sequences of numbers separated by dots. Moreover, zeros can only be used alone (e.g. 0.1 is valid but 03.2 is not).
DisplayName
Name used in the user interface for the widget. This field can be translated, therefore this field is not used to uniquely identify the widget.
Author
Developer of the widget.
Mail
E-mail address to get in touch with the developer(s).
Description
A brief textual description of the widget.
ImageURI
Absolute or template-relative URL of the widget image for the catalog.
iPhoneImageURI
Image to be used in iPhone and other smartphones.
WikiURI
Absolute or template-relative URL of the widget documentation.

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.

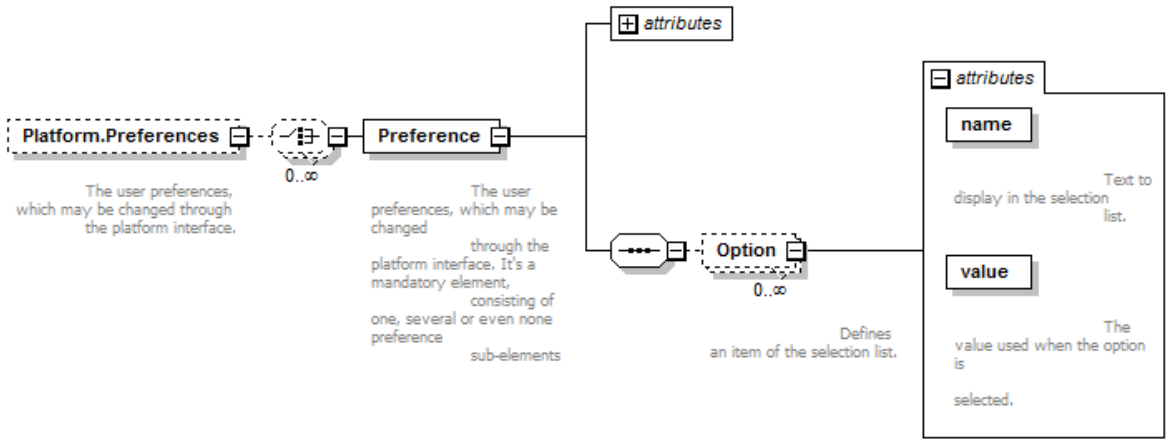
The *vendor*, *name* and *version* fields are the the widget's ID. Therefore, no such identifier can appear more than once in any collection of the Application Mashup GE stored resources (this includes widgets, mashups, operators, etc.).

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:

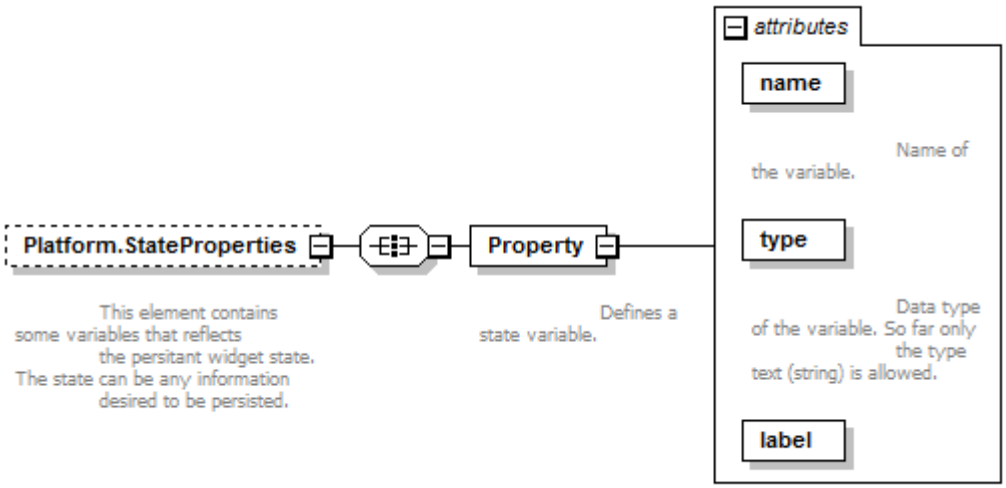
- **name:** name of the preference to be referenced in the source code.
- **type:** preference data type: text (string), number, Boolean, password and list.
- **description:** text that describes the preference.
- **label:** text that the preference will show in the user interface.
- **default:** preference 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

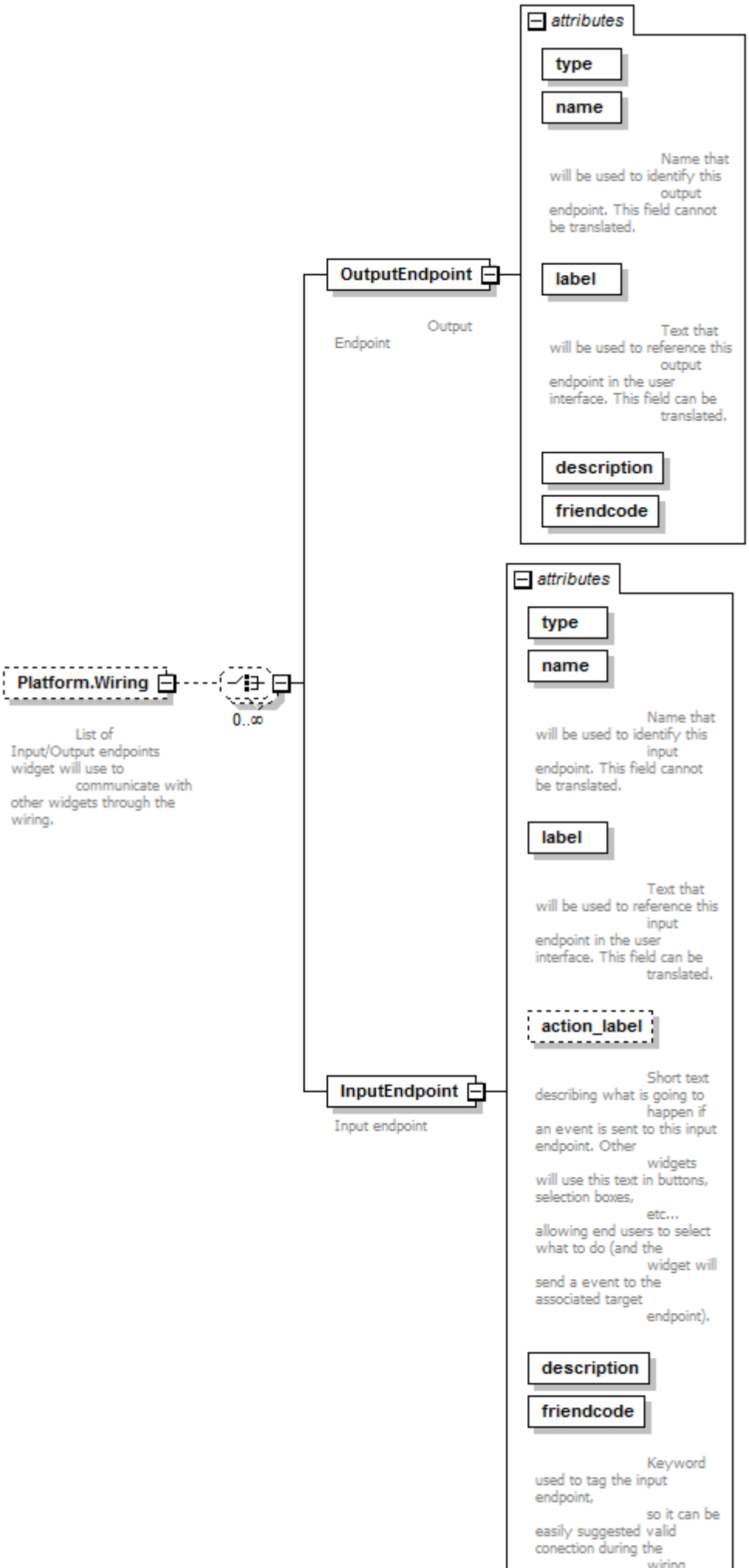
This element is required. It is made up of a list of **Property** elements and requires the following attributes:

- **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:


attributes
type
name
Name that will be used to identify this output endpoint. This field cannot be translated.
label
Text that will be used to reference this output endpoint in the user interface. This field can be translated.
description
friendcode
OutputEndpoint
Output Endpoint
attributes
type
name
Name that will be used to identify this input endpoint. This field cannot be translated.
label
Text that will be used to reference this input endpoint in the user interface. This field can be translated.
action_label
Short text describing what is going to happen if an event is sent to this input endpoint. Other widgets will use this text in buttons, selection boxes, etc... allowing end users to select what to do (and the widget will send a event to the associated target endpoint).
description
friendcode
Keyword used to tag the input endpoint, so it can be easily suggested valid conection during the
InputEndpoint
Input endpoint
Platform.Wiring
0..∞
List of Input/Output endpoints widget will use to communicate with other widgets through the wiring.

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:

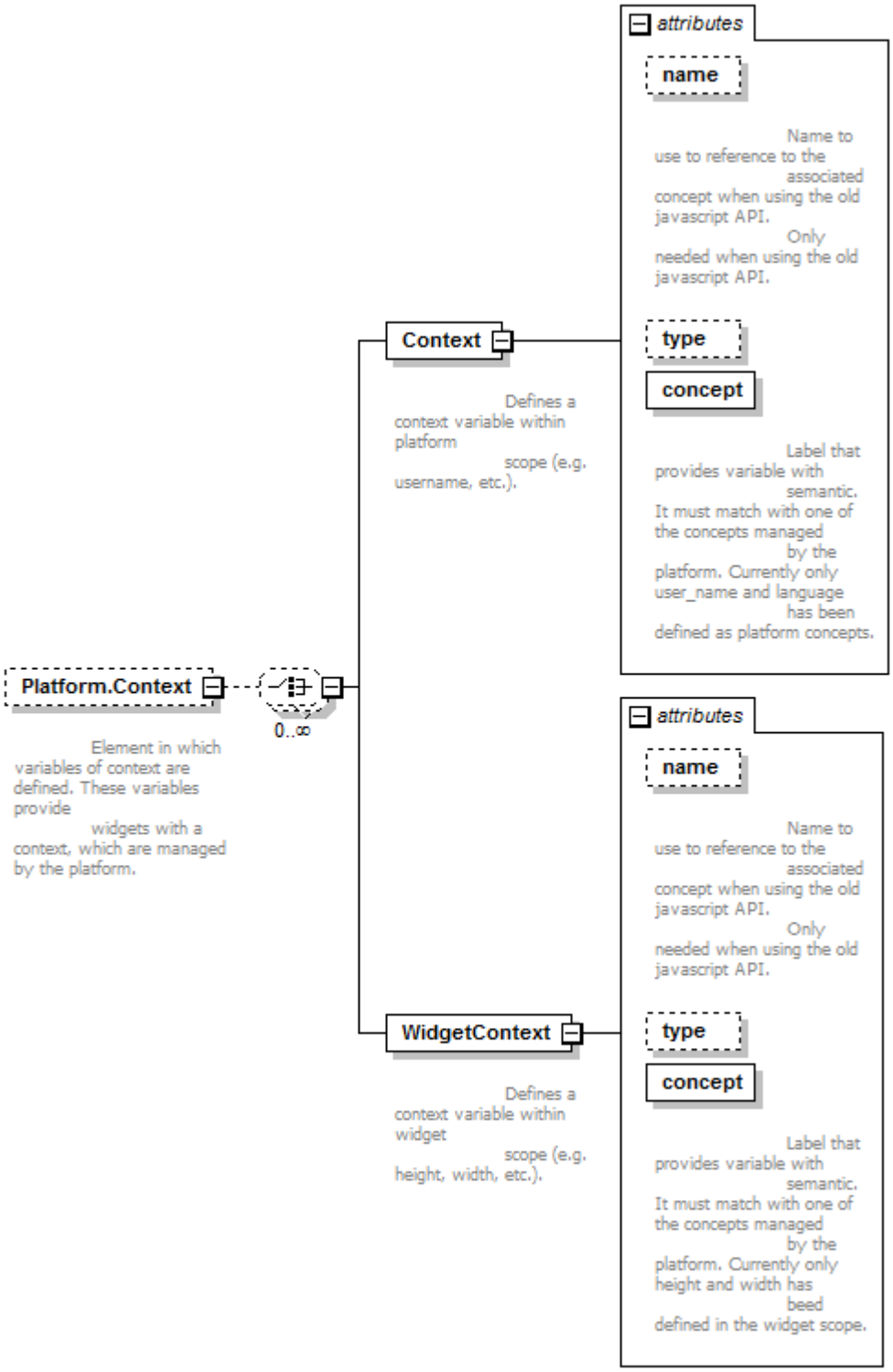
- **name:** output endpoint name.
- **type:** output endpoint data type: only "text" (string) datatype does make sense in here.
- **label:** text to be displayed in the user interface.
- **description:** text that describes the output.
- **friendcode:** keyword used as an output endpoint tag: it will 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:



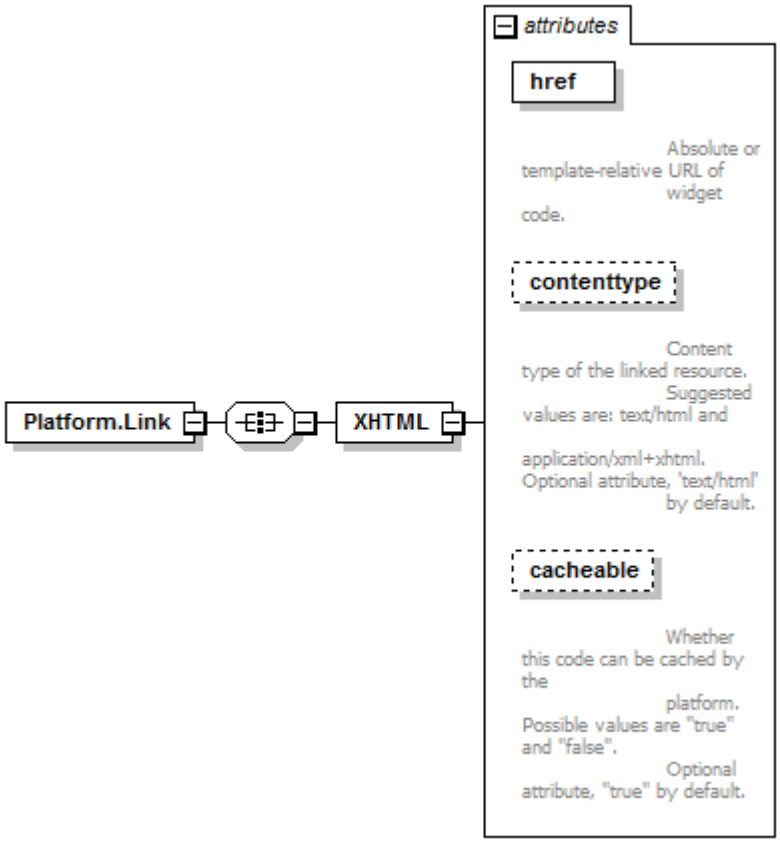
The Platform.Context element

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.



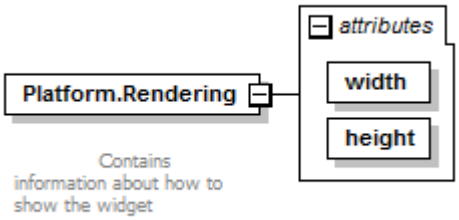
The Platform.Link element binds the template with the actual widget source code

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

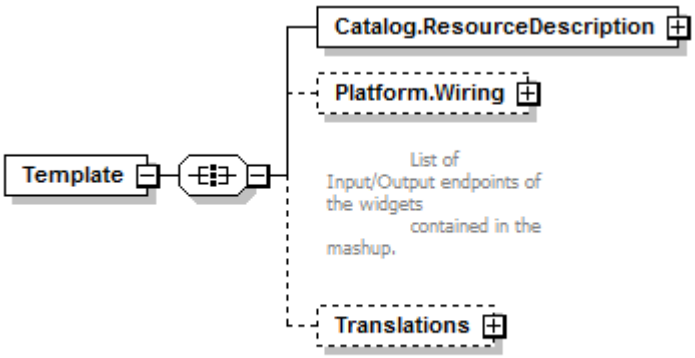
The last template XML element is `Platform.Rendering`. It specifies the default width and height of the widget once it is deployed in the user workspace.



The Platform.Rendering element

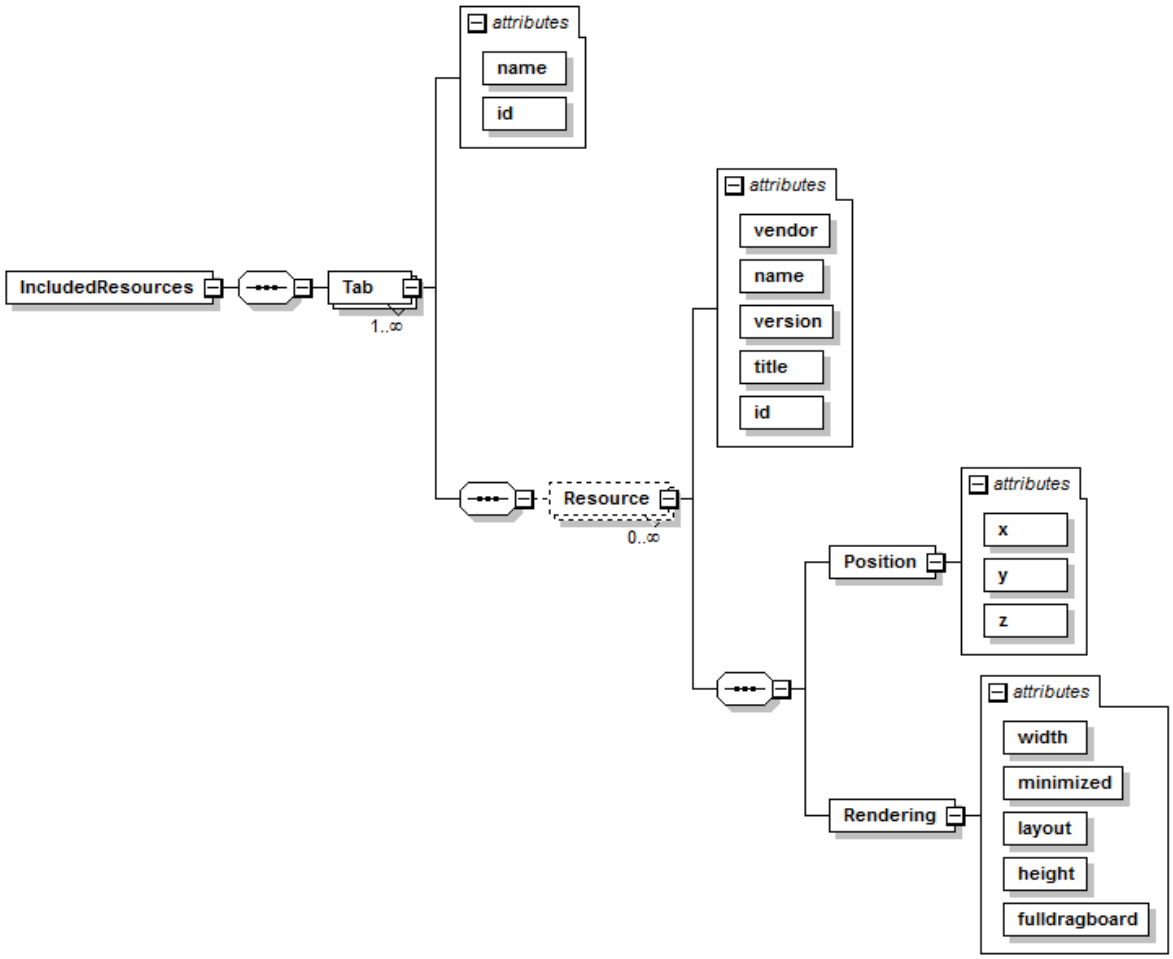
Width and **height** are its only subelements. They represent the initial width and height of the widget.

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.

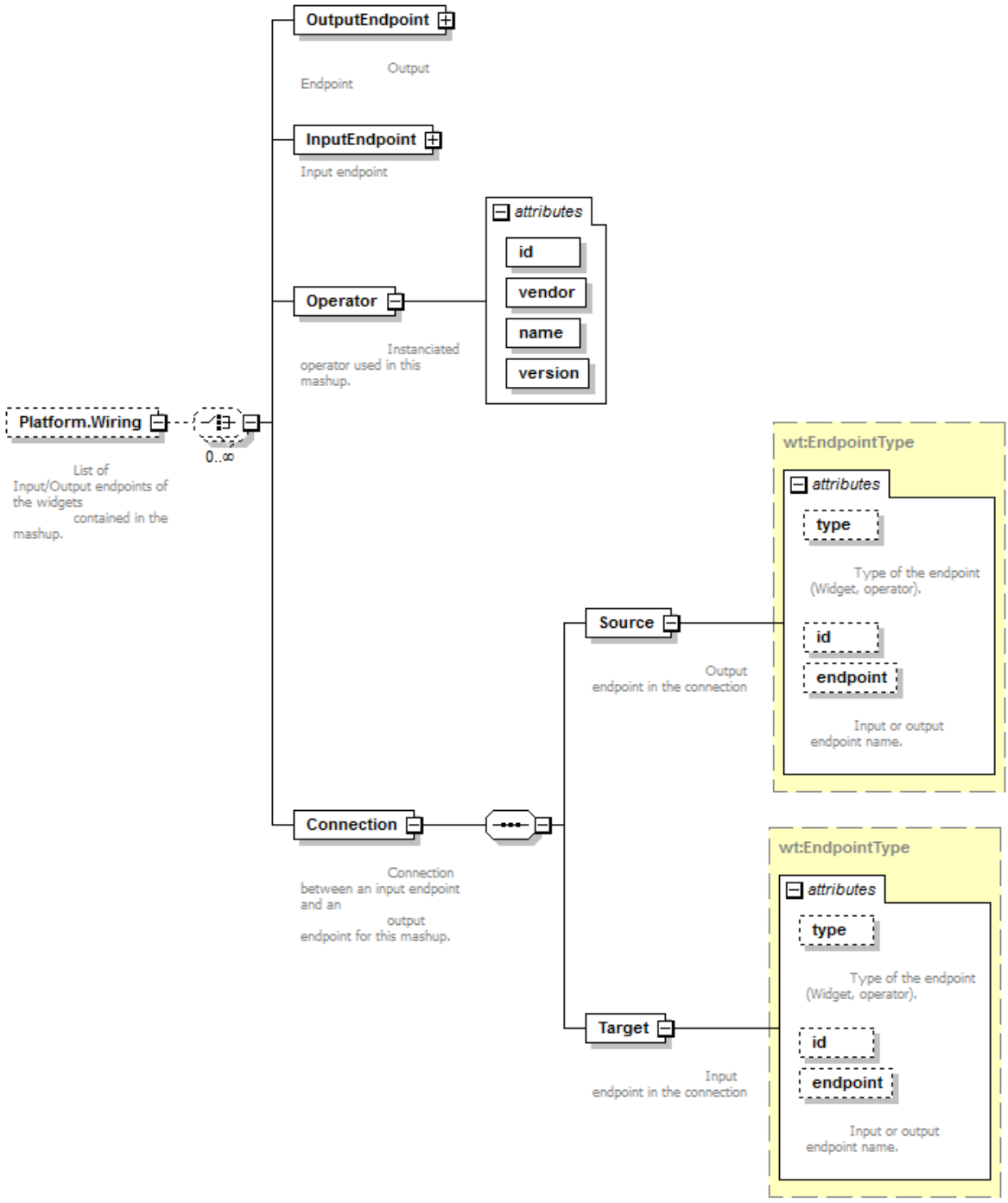
- **X:** the widget's x coordinate.
- **Y:** the widget's Y coordinate.
- **Z:** the widget's Z coordinate.

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 has 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.

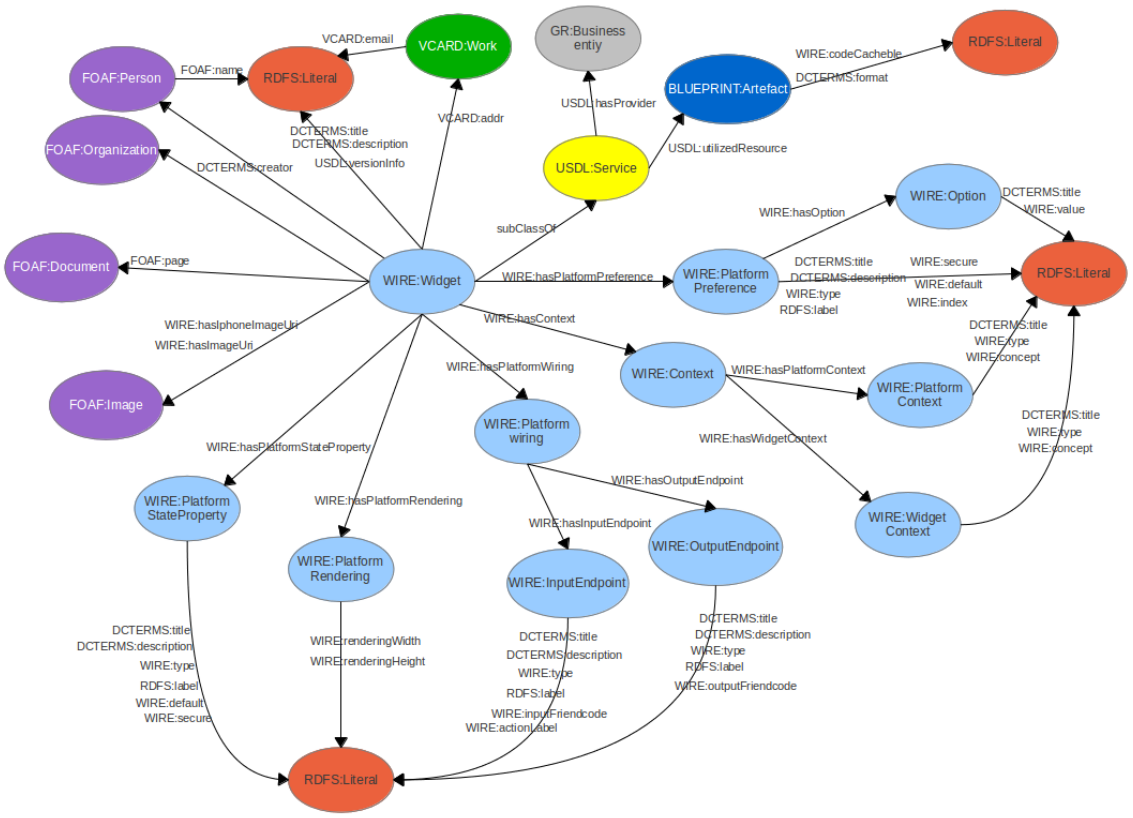
The **Target** element defines the input endpoint of the connection. It has the following attributes.

- **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.

13.6.2.2 *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.

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:hasContext, 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:hasContext, 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:Context
This class represents the context of the widget.
URI: http://wirecloud.conwet.fi.upm.es/ns/widget#Context
Properties include:
wire:hasPlatformContext, wire:haswidgetContext
Used with: wire:hasContext

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:PlatformContext`
This class represents a platform context variable.
URI: http://wirecloud.conwet.fi.upm.es/ns/widget#PlatformContext
Properties include:
`dcterms:title, wire:type, wire:concept`
Used with: `wire:hasPlatformContext`

Class: `wire:widgetContext`
This class represents a widget context variable.
URI: http://wirecloud.conwet.fi.upm.es/ns/widget#widgetContext
Properties include:
`dcterms:title, wire:type, wire:concept`
Used with: `wire:haswidgetContext`

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`

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`

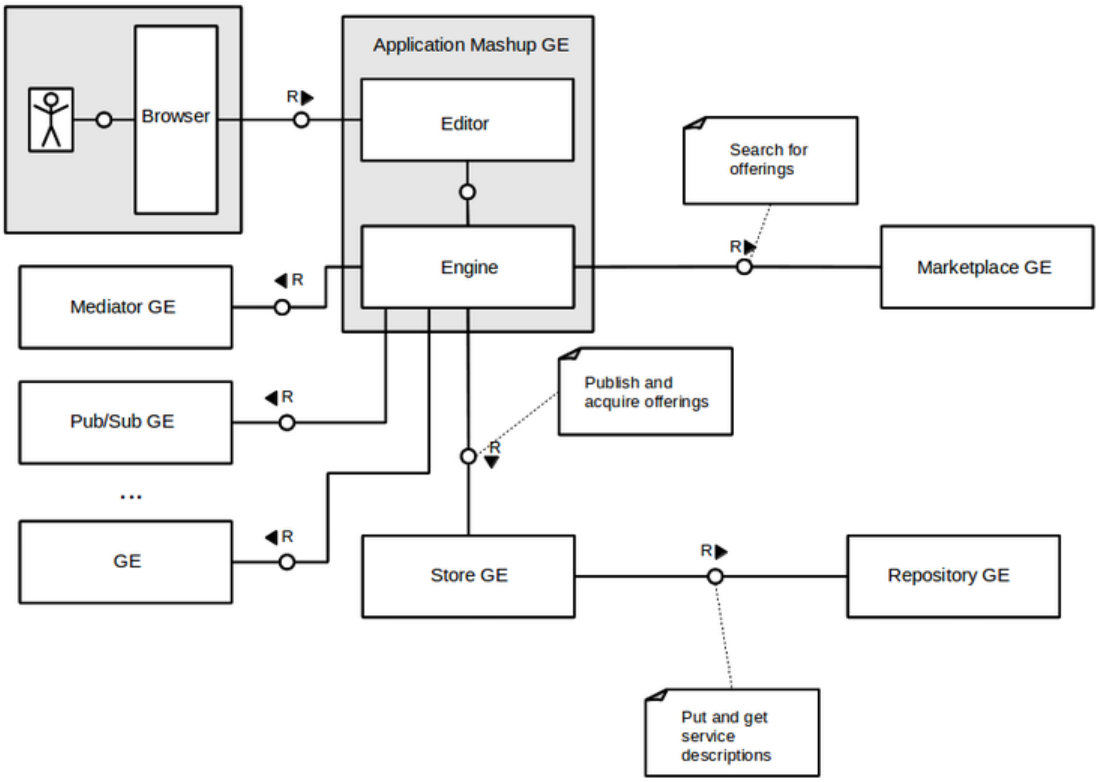
Property: `wire-m:readonly`
This property states whether a mashup configuration element is read only.
URI: http://wirecloud.conwet.fi.upm.es/ns/mashup#readonly
Range: `rdfs:Literal`

13.6.2.3 *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.

13.7 Main Interactions

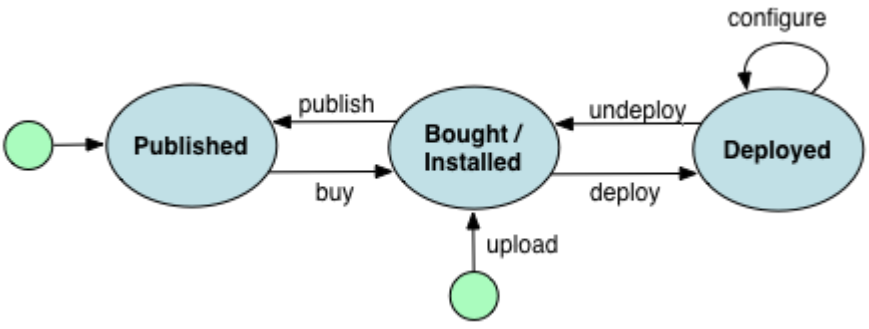
This section describes in detail all the interactions that the Application Mashup GE must support both with users and with other FI-WARE GEs.
The Application Mashup GE is closely related to other FI-WARE Generic Enablers, especially those concerning the business infrastructure and the provision of data sources. The figure below depicts some of these relationships:



How the Application Mashup GE relates to the other Generic Enablers

13.7.1 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 shareability. 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 tehy 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*.

13.7.2 Interaction diagrams

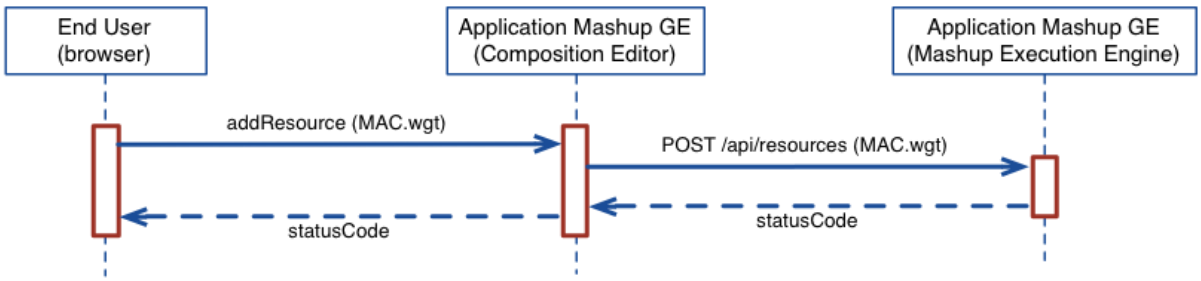
The Application Mashup Generic Enabler must be designed and developed to enable, at least, the interactions shown in this section. They cover the user-platform interactions needed to visually create a web application mashup, plus the main interactions between the platform and other generic enablers.

13.7.2.1 *User-Platform Interactions*

The interactions that the Application Mashup GE must support with regard to its users are as follows.

Upload a Mashable Application Component to the Local Catalogue

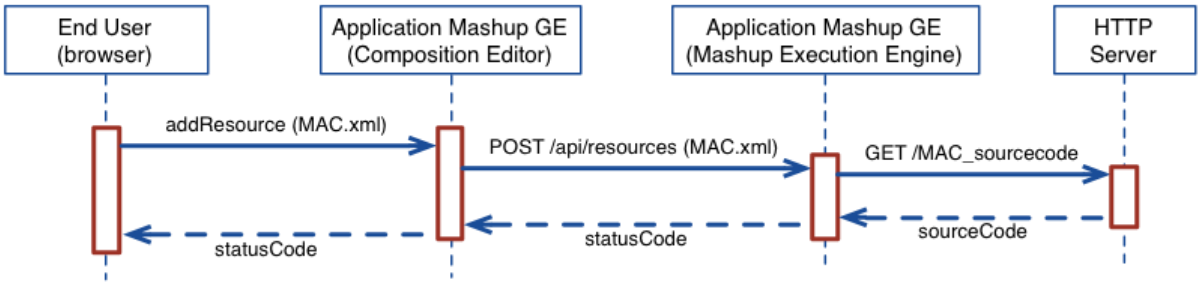
MAC developers must be able to upload their own developed resources to the local catalogue of the Application Mashup GE. End users must also be able to upload the MACs they already have stored in their local hard disk to the local catalogue. The implementation of the GE must enable users to select their 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.

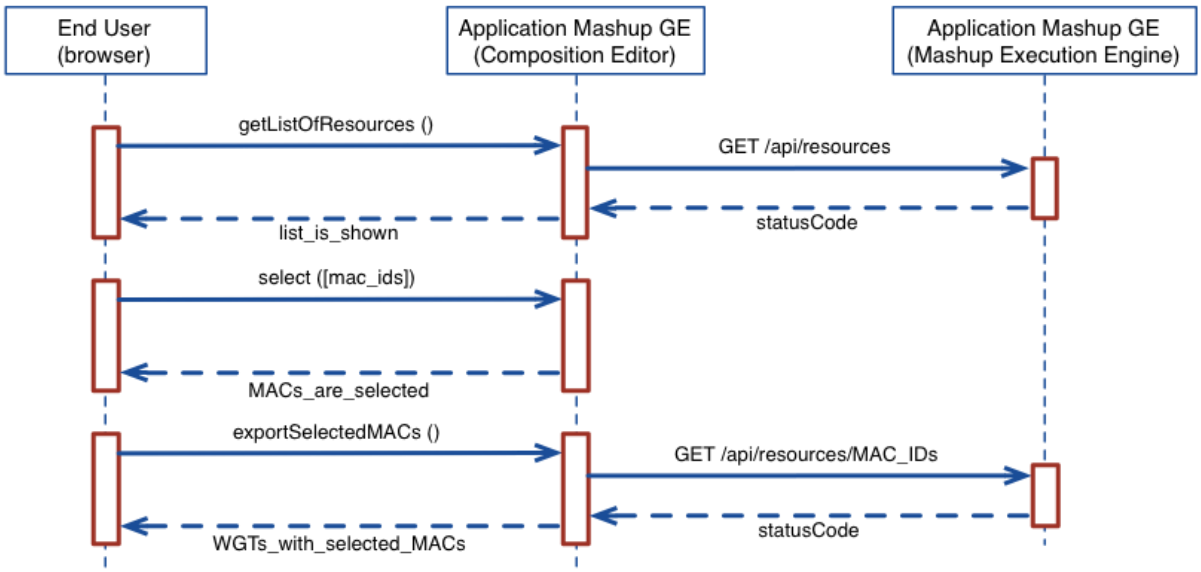


Uploading a MAC from its XML template to the Local Catalogue

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.

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.

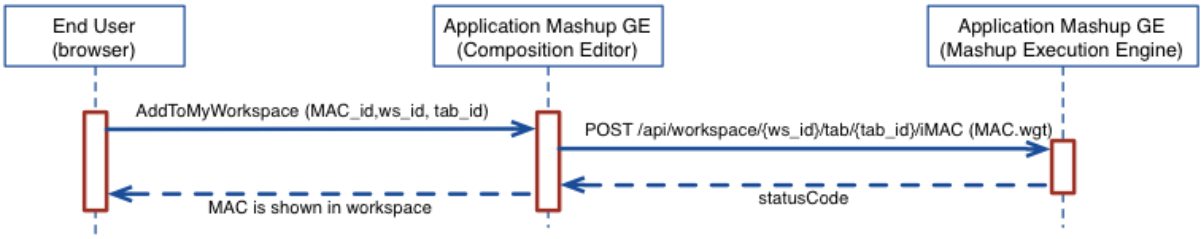


Exporting (downloading) a packaged MAC from the Local Catalogue

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.

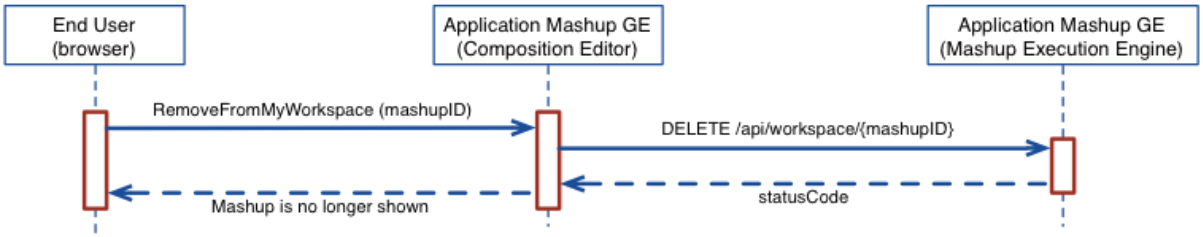
As a result of this invocation, the engine will get the MAC template from the local catalogue and will execute the MAC. It will also be available in the Mashup Editor mashup developer workspace. Its state will switch to **deployed**.



Interaction with the Mashup Execution Engine to deploy both mashups and widgets

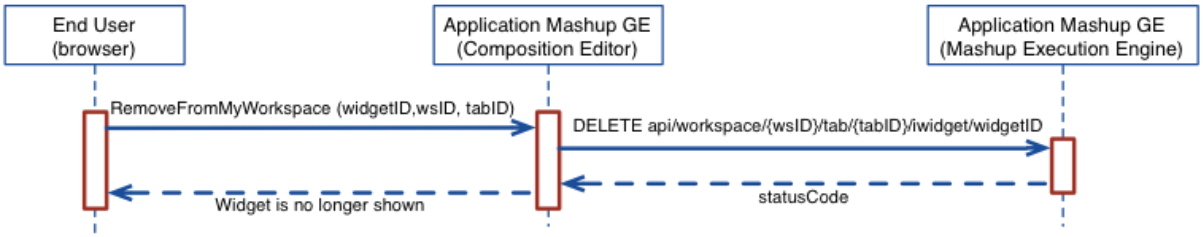
Undeploy a MAC. Remove an instance from execution
The operation ***Undeploy MAC*** removes a mashup application or a widget from execution. Mashup developers invoke this operation from the mashup composition editor when they want to delete the whole mashup application or just a single widget.

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.

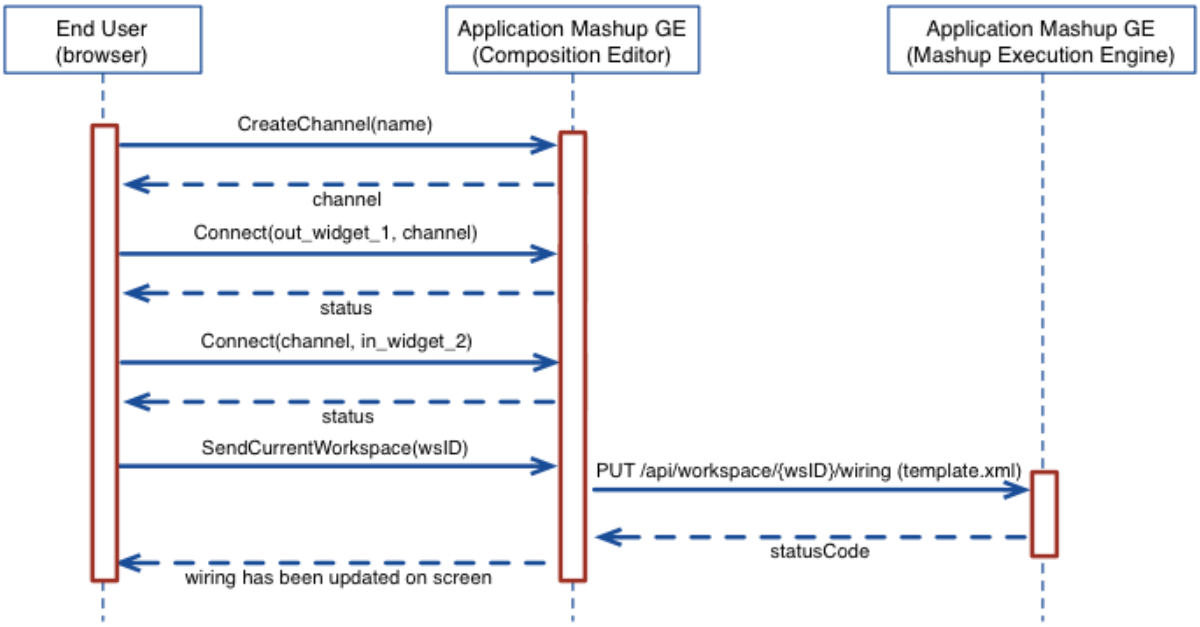


Interaction needed to undeploy a widget

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.

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.



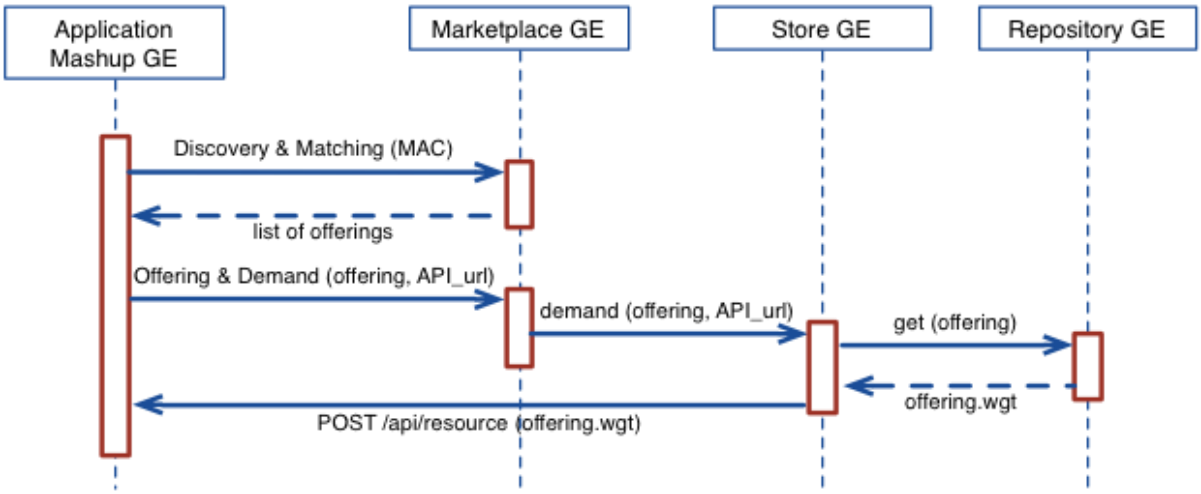
Widget Interconnection Management process

13.7.2.2 *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.

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.

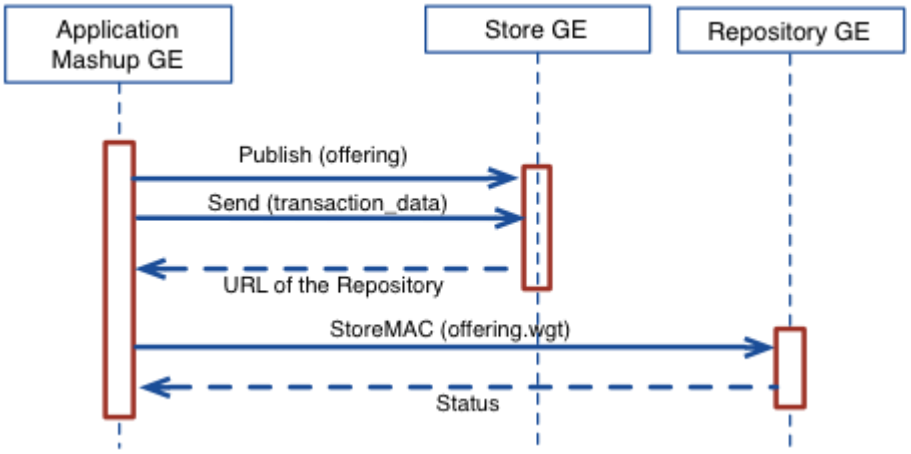


Buying a new MAC from a Store

Publish a MAC to a Store

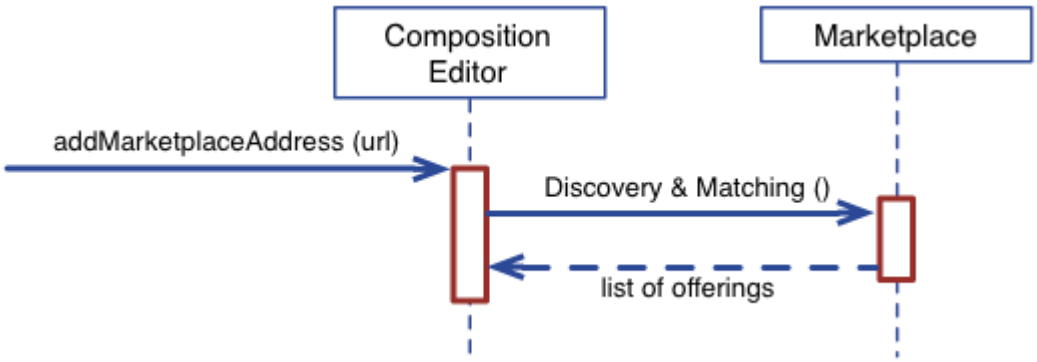
Once users have either developed and uploaded a new widget to the local catalogue or created their own mashup application, the Application Mashup GE must enable users to contact the Store GE to publish their brand new MAC.

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

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

13.8 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.

13.9 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:

13.9.1 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.

13.9.2 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.

13.9.3 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.

13.9.4 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.

13.10 Detailed Specifications

13.10.1 Open API Specifications

The Application Mashup GE offers two separate APIs that cannot be combined because of 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

13.10.2 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

13.11 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

13.12 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.

14 FIWARE OpenSpecification Apps WidgetAPI

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

14.1 Introduction to the *Widget* API

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14.1.1 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 gain access to a remote REST API or to resolve cross-domain problems, a widget needs to use a proxy through the Widget API.

14.1.2 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

14.1.3 API Change History

Revision Date	Changes Summary
Apr 27, 2012	• Initial version

14.1.4 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.

14.2 *Widget* API

14.2.1 MashupPlatform.http

14.2.1.1 ***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.

14.2.1.2 *Methods*

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).

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).

14.2.2 MashupPlatform.wiring

14.2.2.1 *Methods*

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.

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.

14.2.3 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.

14.2.3.1 *Methods*

MashupPlatform.prefs.get(key)
Retrieves the value of a preference.

- *key* - Name of the preference to fetch.

MashupPlatform.prefs.registerCallback(callback)
Registers a callback for listening preference changes.

- *callback* - Callback function that will be called when widget's preferences are changed.

15 FIWARE OpenSpecification Apps ApplicationMashupAPI

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

15.1 Introduction to the *Application Mashup* API

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15.1.1 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.

15.1.2 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.

15.1.3 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
Apr 18, 2013	• Revised version
Nov 2, 2012	• Initial version

15.1.4 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.

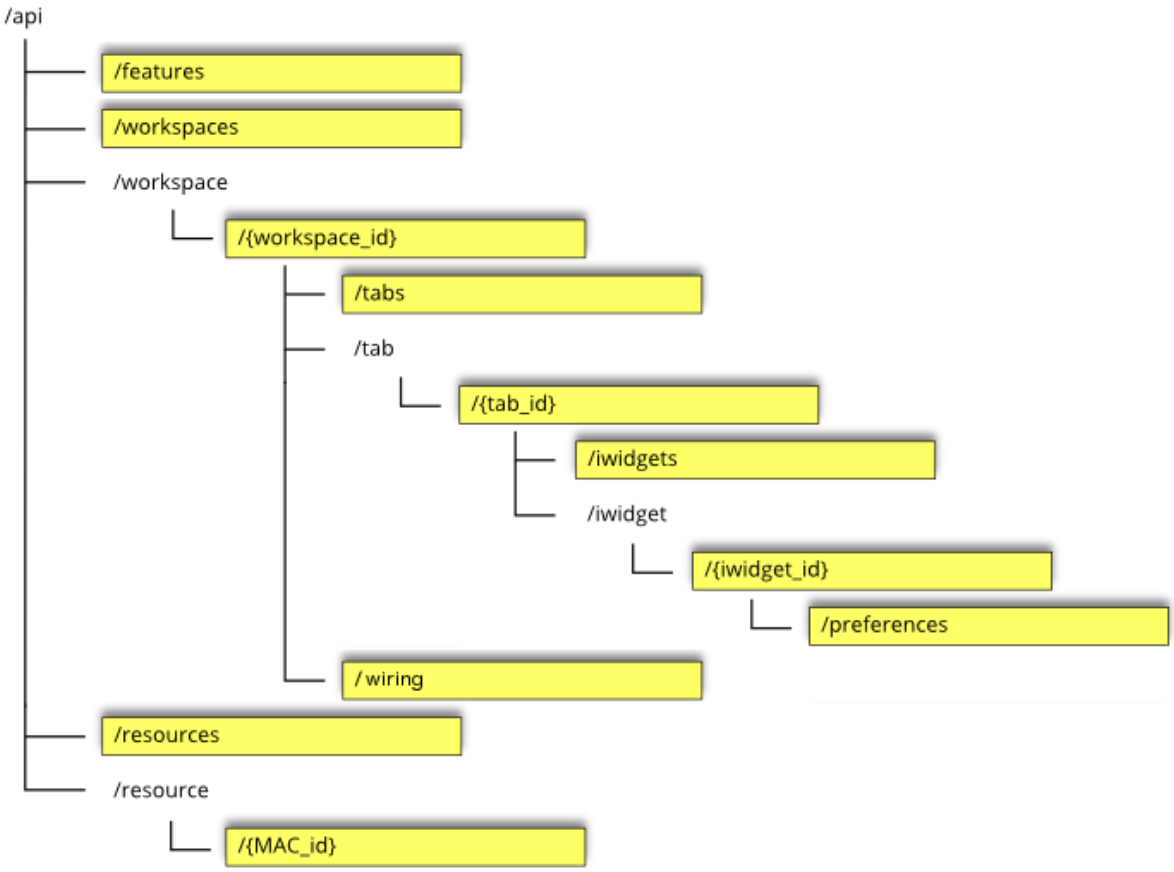
15.1.5 Additional Resources

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.

15.2 General *Mashup Application* API Information

15.2.1 Resources Summary

The following figure summarizes the resources considered in the Application Mashup RESTful API



15.2.2 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).

15.2.3 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.

15.2.4 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.

15.2.5 Resource Identification

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

15.2.6 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, ...

15.2.7 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.

15.2.7.1 *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.

15.2.8 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".

15.2.9 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"
}
```

15.2.10 Faults

15.2.10.1 *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:

```
<error>Resource already exists</error>
```

JSON Example:

```
{
    "error": "Resource already exists"
}
```

Fault Element	Associated Error Codes	Expected in All Requests?
Bad Request	400	YES

Unauthorized	401	YES
Forbidden	403	YES
Not Found	404	YES
Request Entity Too Large	413	YES
Internal Server error	50X	YES

15.3 API Operations

15.3.1 Managing Workspaces

The description of the operations is shown in the next table:

Verb	URI	Description	Mandatory/optional
GET	/api/workspaces	Get a list of all workspaces owned by the user	Mandatory
POST	/api/workspaces	Creates 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	Creates 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 iwidget information	Mandatory
POST	/api/workspace/{workspace_id}/tab/{tab_id}/iwidget/{iwidget_id}/preferences	Update iwidget preferences	Mandatory

DELETE	/api/workspace/{workspace_id}/tab/{tab_id}/iwidget/{iwidget_id}	Removes an iwidget from a tab	Mandatory

15.3.1.1 *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
  }
]
```

15.3.1.2 *Creating Workspaces*

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":{}
}
```

15.3.1.3 *Creating Workspaces from Mashup*

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.

15.3.1.4 *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":{}
}
```

15.3.1.5 *Deleting Workspaces*

Example request:

```
DELETE /api/workspace/81 HTTP/1.1
Accept: application/json
```

Example response:

```
HTTP/1.1 204 No Content
```

15.3.1.6 *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.

15.3.1.7 *Creating Workspace Tabs*

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":"Tab2"
}
```

15.3.1.8 *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
```

15.3.1.9 *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.

15.3.1.10 *Update IWidget Status*

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
```

15.3.1.11 *Update IWidget 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
```

15.3.1.12 *Remove IWidget 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
```

15.3.2 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

15.3.2.1 *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",
      ...
   }
}
```

15.3.2.2 *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",
   ...
}
```

15.3.2.3 *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

   ...
```

15.3.2.4 *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
```

15.3.3 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.

500 Internal Server Error
: A generic error message, returned when no other specific message is suitable.

16 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.
```

16.1 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.eu and similar pages in order to understand the complete context of the FI-WARE project.

```
Disclaimer: The sustainability of this Architecture Description
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16.4 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

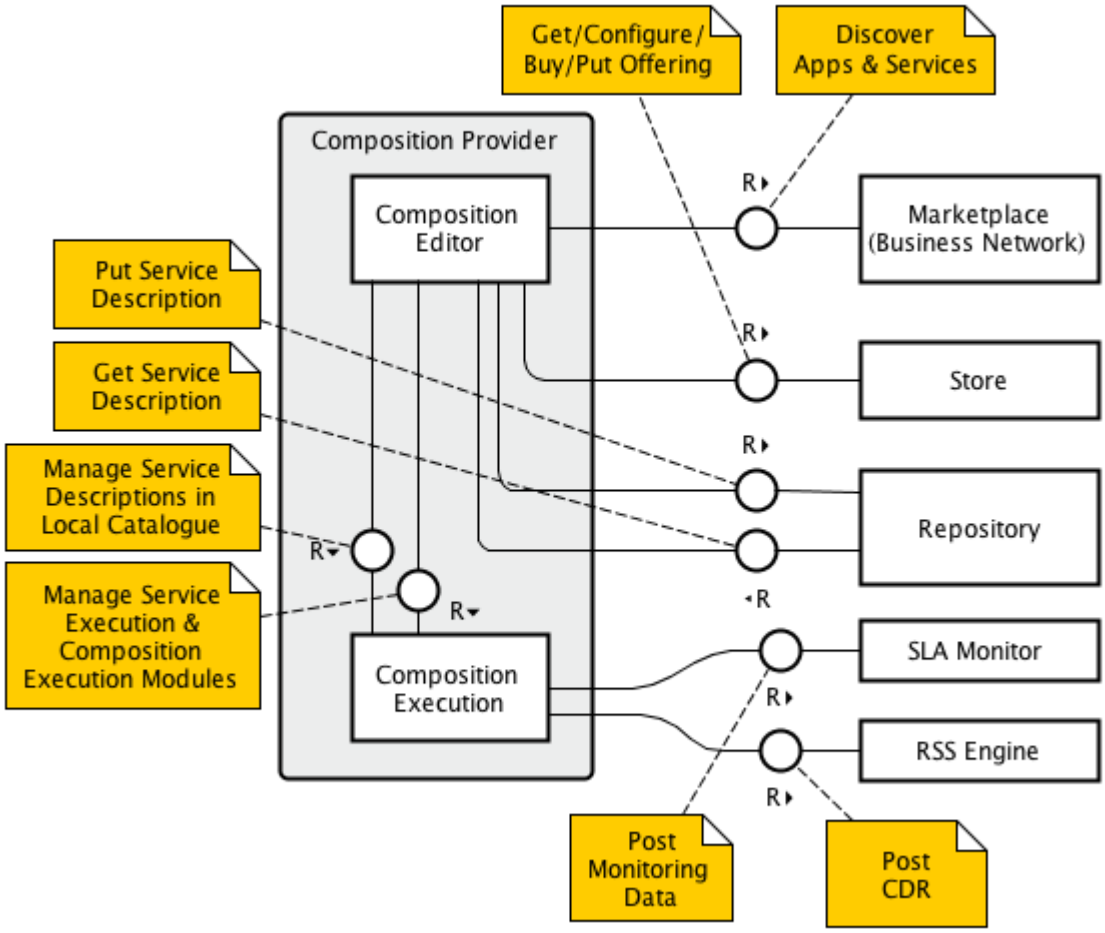
particular time. Essentially the composition engine is creating the workflow step-by-step during runtime, and different composition decisions can be taken depending on external constraints or on the return values of previously executed services.
As an intermediary step, the composed service specification 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.

16.4.1 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

16.5 Composition Provider Architecture



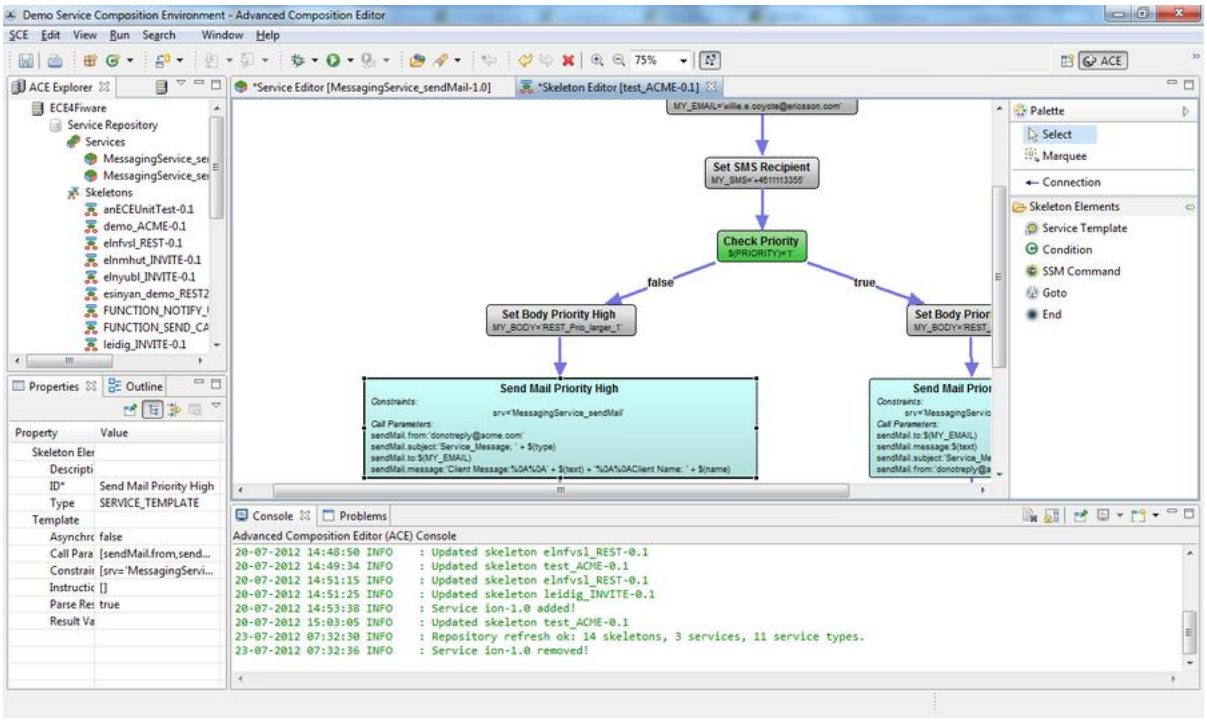
Composition Provider Architecture

16.6 Basic Concepts

The Service Composition GE offers two main functions: composition creation and composition execution.

16.6.1 Composition Creation

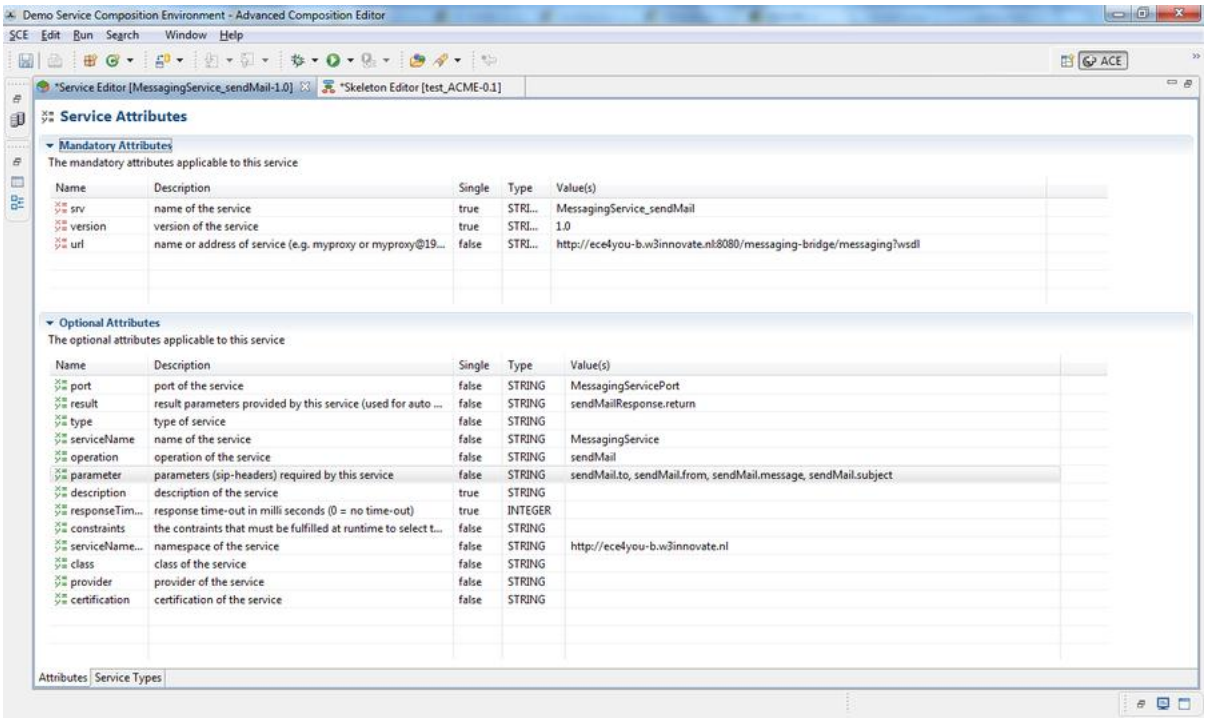
The editor allows the creation of composed services (also denoted as skeletons). The following figure shows the main graphical user interface exposed by the editor. There the user can define service descriptions (to describe how the component services can be invoked) and create compositions by adding 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

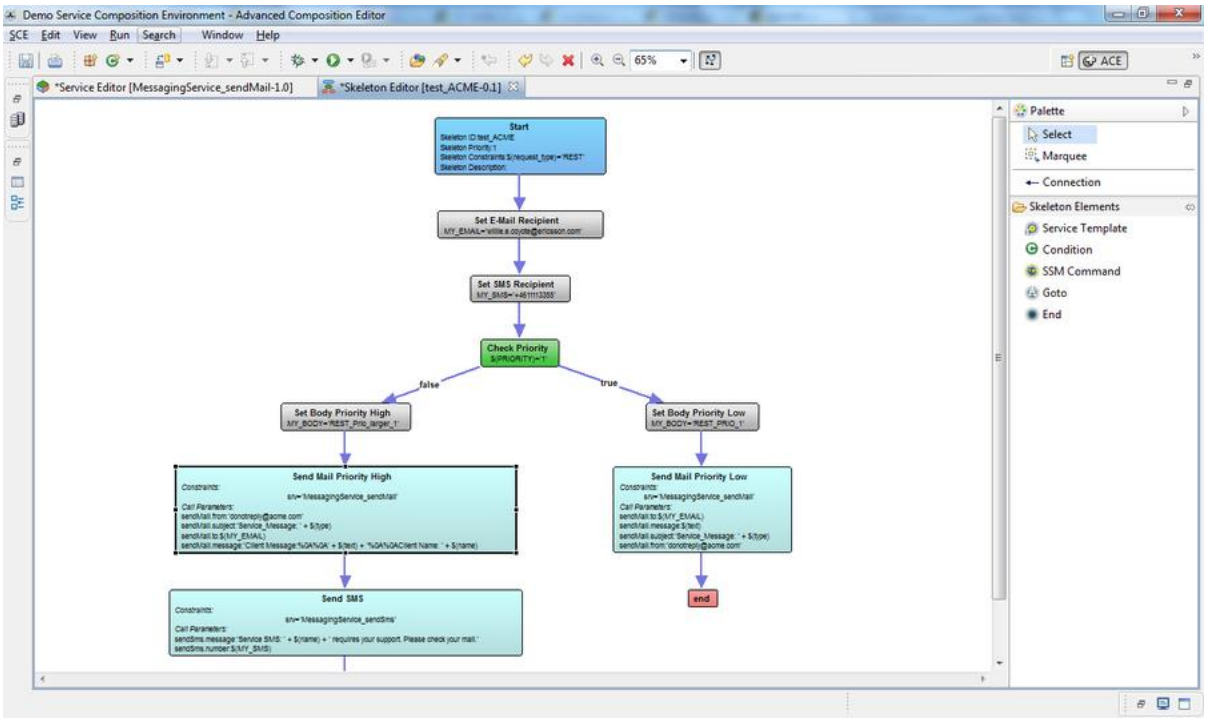
The skeletons provide the business logic, the data and control flow, and service templates (placeholders that are bound to specific service implementation during each invocation). Several services might be suitable to implement a service template. These services can have different input and output parameters 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.



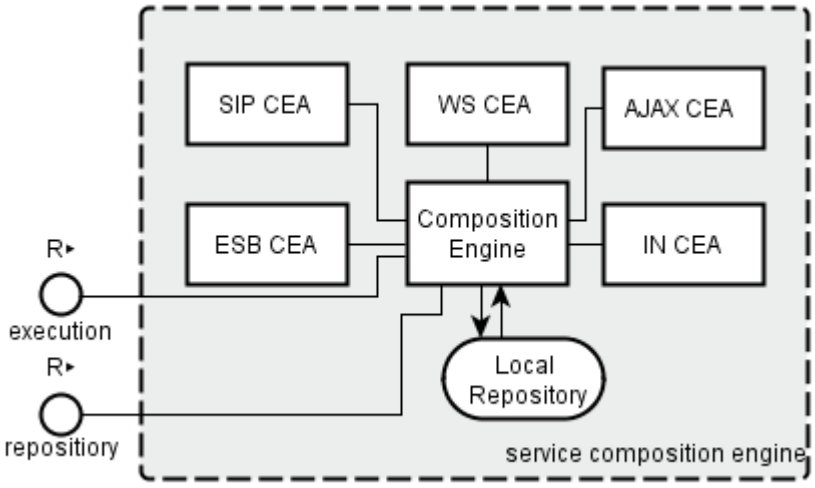
Composition Editor - Service Composition (skeleton) Example

Specification 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, events can be filtered, events can be 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, new value. These events are the only way of communication between components using different technologies. The SSM employs a subscribe/notify model.

16.6.2 Execution



Execution Environment Architecture

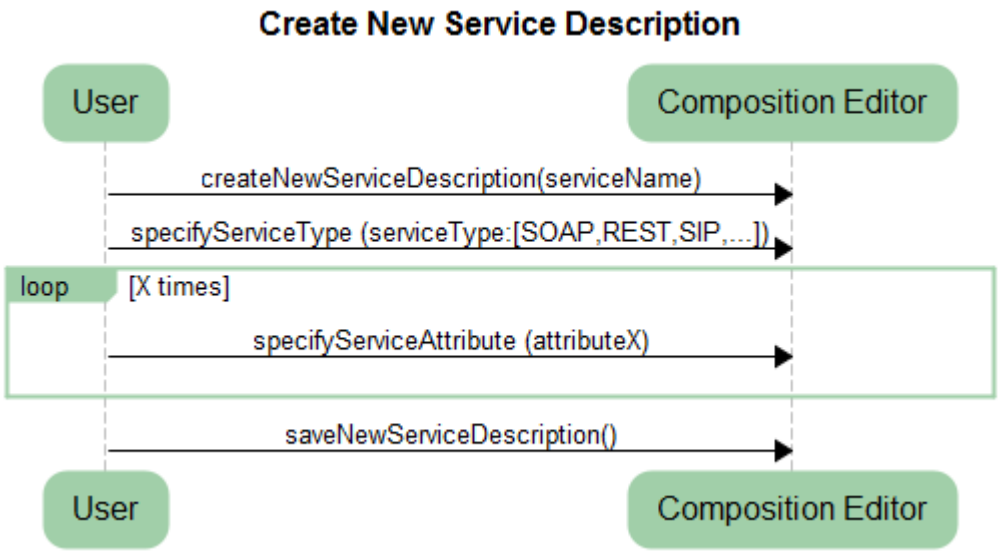
Composite applications descriptions - the skeletons - are retrieved end executed by the engine. Protocol-level details related to the interaction with modules are left to the Composition Execution Agents (CEAs), which are responsible for enforcing composition decisions in the corresponding platform in 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 careated 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 a basic life-cycle functionality for service and skeleton descriptions including import/export and enabling/disabling them to be triggered for execution.

16.7 Main Interactions

16.7.1.1 *Create Composite Services*

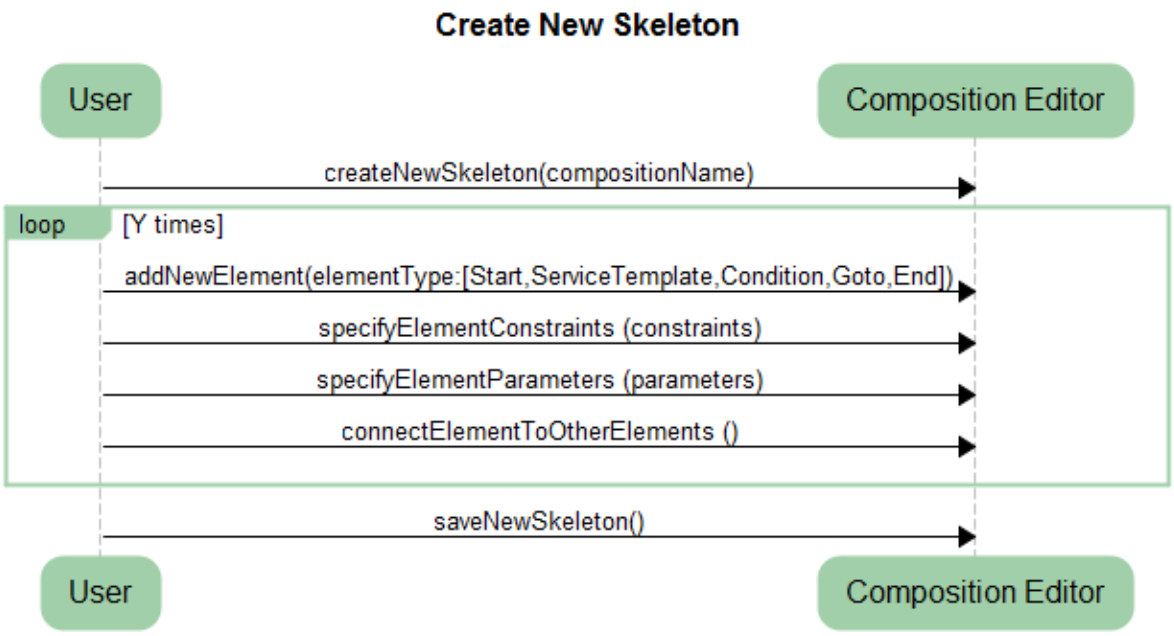
This functionality allows the end user to create a new composition skeleton using graphical representation for data and control flow and for service placeholders. This is the main function and will be detailed further. Note that this functionality is not available as an API to be used from other architecture 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

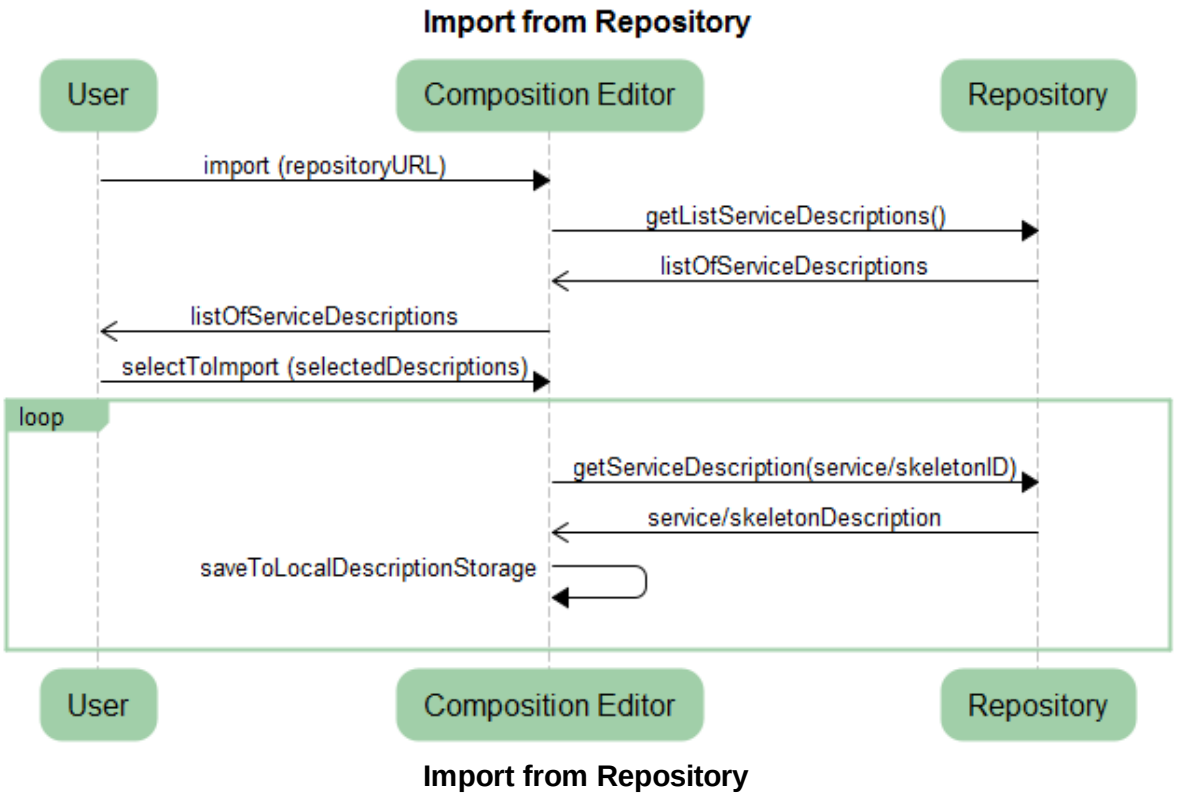
- **Create/Edit Skeletons**
  In building the composition several building blocks are added iteratively, using the GUI. The building blocks expose data flow, control, and service invocation functionality (e.g. StartElement ServiceTemplate, Condition, StateManager Command, Goto, End). Connections between 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

16.7.1.2 *Import Service Descriptions and Skeletons*

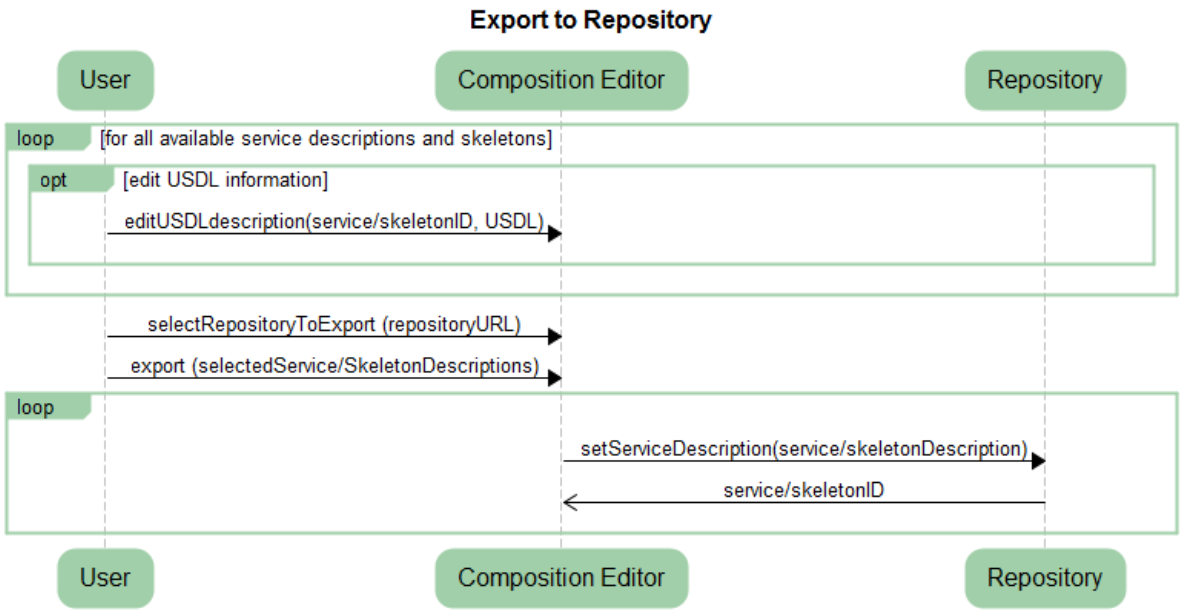
This operation imports (composed) service descriptions from a Repository GE to the local descriptions storage. Out of the list of available service descriptions and compositions only a subset may be selected. Note that from the perspective of the Repository and the USDL description part there is no differentiation 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

16.7.1.3 *Export Service Descriptions and Skeletons*

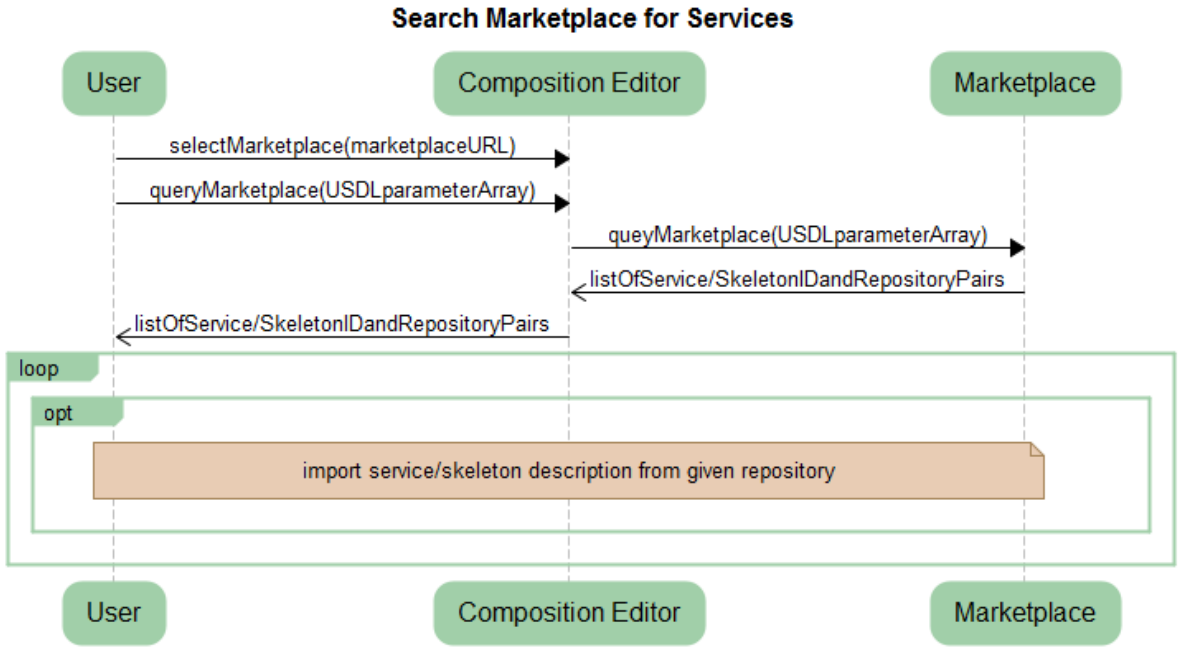
This operation exports (composed) service descriptions from the local descriptions storage to a Repository GE. Out of the list of available service descriptions and compositions only a subset may be selected. The description of a (composed) service may contain a USDL description providing a high level 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

16.7.1.4 *Search Marketplace for Services*

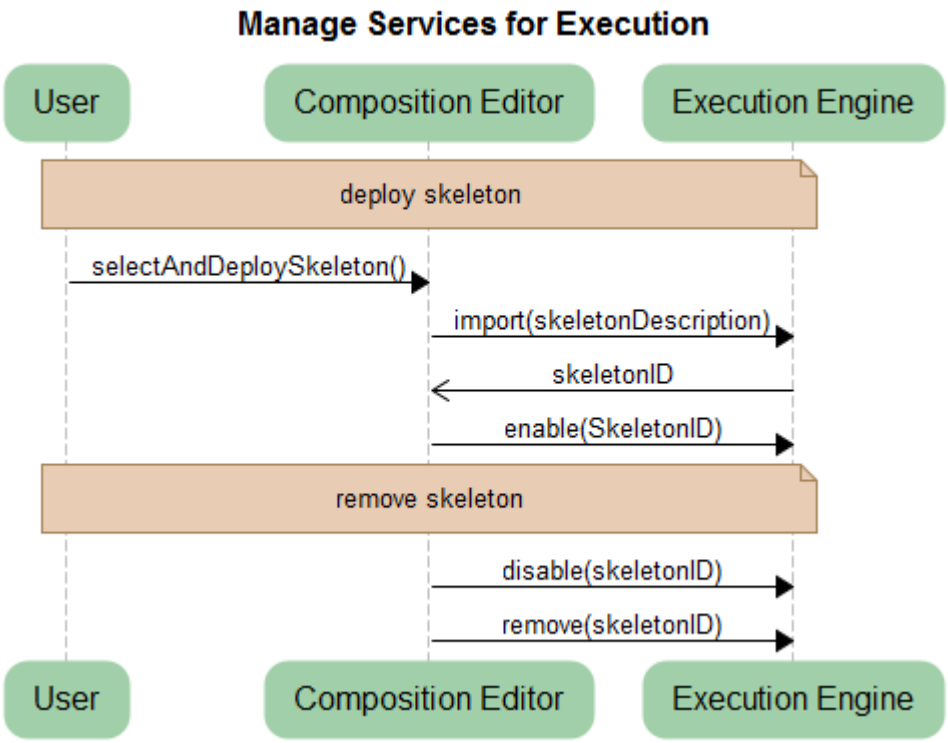
The Composition Editor may allow end users to search for the service they need. To do so, Marketplaces need to be queried, and the editor may allow detailed query construction based on constraints on USDL and other technical service description parameters.



Search in Marketplace

16.7.1.5 *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.

16.8 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, Casandra, ...).
- **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.

16.9 Detailed Specifications

16.9.1 Open API Specifications

- FIWARE.OpenSpecification.Apps.ServiceCompositionREST

16.9.2 Other Relevant Specifications

none

16.10 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

16.11 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.

17 FIWARE OpenSpecification Apps ServiceCompositionREST

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.
```

17.1 Introduction to the *Service Composition* API

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17.1.1 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.

17.1.2 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.

17.1.3 API Change History

Revision Date	Changes Summary
May 3, 2012	• Initial version
October 29, 2012	• Revised 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 Service Composition architecture.

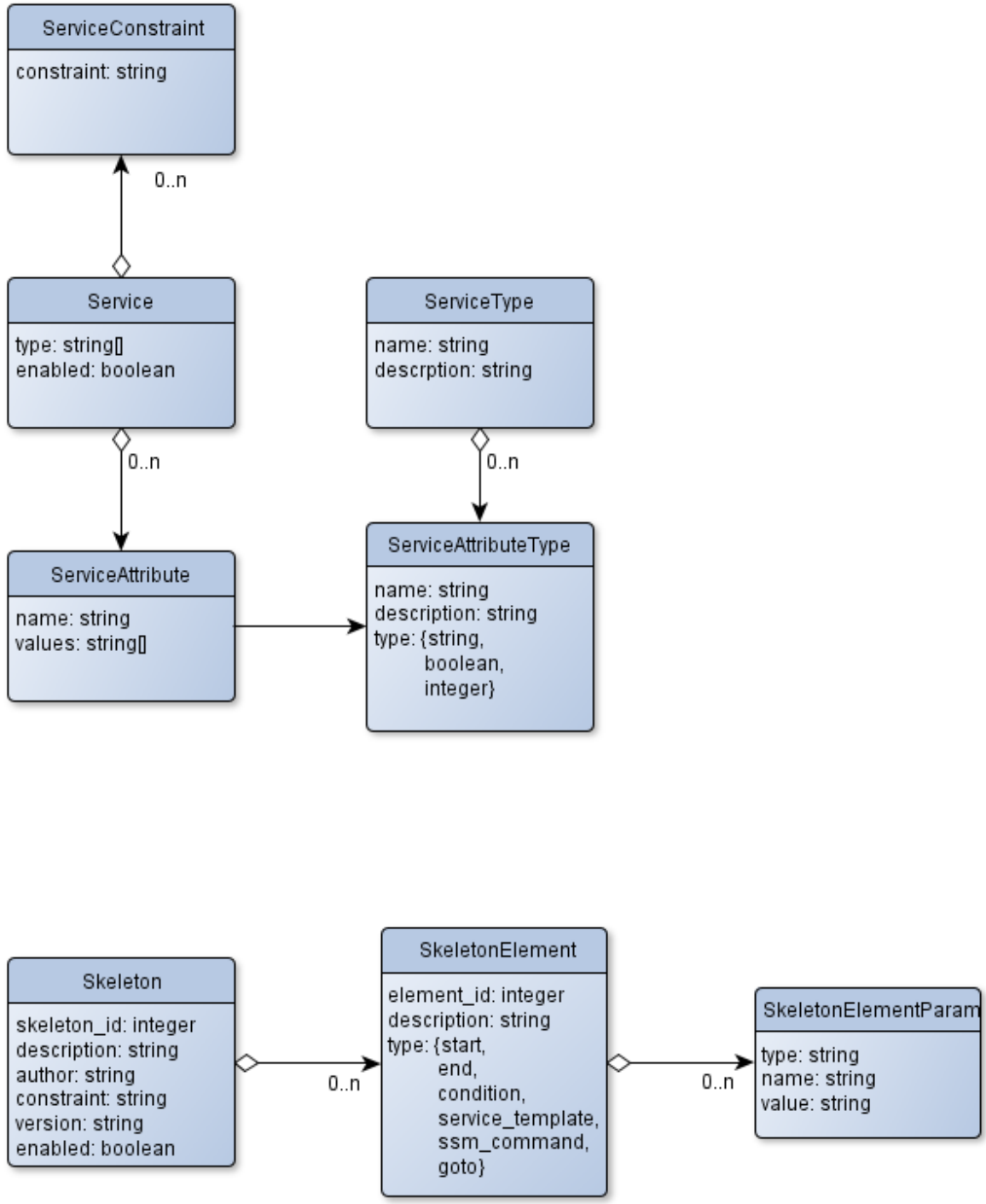
17.2 General *Service Composition* API Information

17.2.1 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).

17.2.2 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)	-

17.2.3 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).

17.2.4 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.

17.2.5 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.

17.2.6 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.

17.2.7 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}

17.2.8 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.

17.2.8.1 *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.

17.2.9 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

17.2.10 Faults

17.2.10.1 *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

17.3 API Operations

17.3.1 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.

17.3.1.1 *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

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

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": [
    ...
    ]
  },
  ...
]
```

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.

17.3.2 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.

17.3.2.1 *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

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

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.

Result Format
The result format is similar to the request body examples given when importing descriptions.

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.

17.3.3 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.

17.3.3.1 *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

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

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.

17.3.4 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

17.3.4.1 *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

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

Request/Response Body
The request ore response body should be empty.

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.

18 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

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.eu and similar pages in order to understand the complete context of the FI-WARE project.

18.2 Copyright

18.3 Legal Notice

18.4 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.

18.4.1 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 that offers 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 at simplifying 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 also ontologies, to describe the semantics of the tasks into which the composition is decomposed. 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.

18.4.1.1 *User roles*

For the purpose of this description, two main separate 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.

18.5 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 other SOA services. Conceptually, this approach can be decomposed in few main concepts described in the following sections:

18.5.1 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.

18.5.2 Light-weighted Semantic-enabled Composition

This approach for the modeling of a service composition describes each composition task using semantic descriptions according to some standardized semantic schema (WSMO/OWL-S) and in particular to some 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.

18.5.3 Semi-automatic Execution Composition Generation

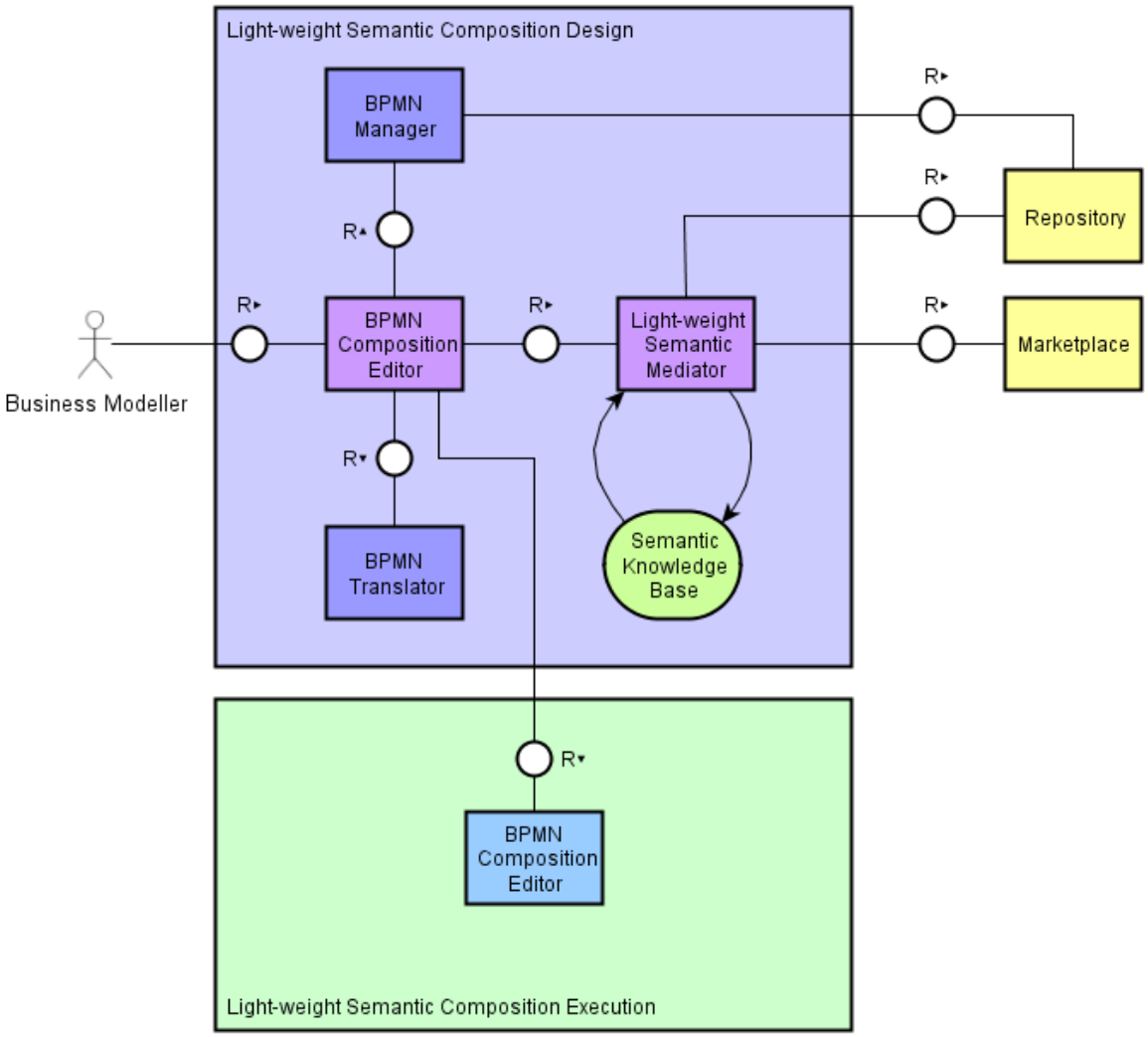
This concept refers to a semantically annotated service composition with tasks bound that cannot be executed. A complete service composition including the technical bindings and the data flow mappings needs to be generated out of the semantically annotated composition

18.5.4 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.

18.6 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 compositions 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:

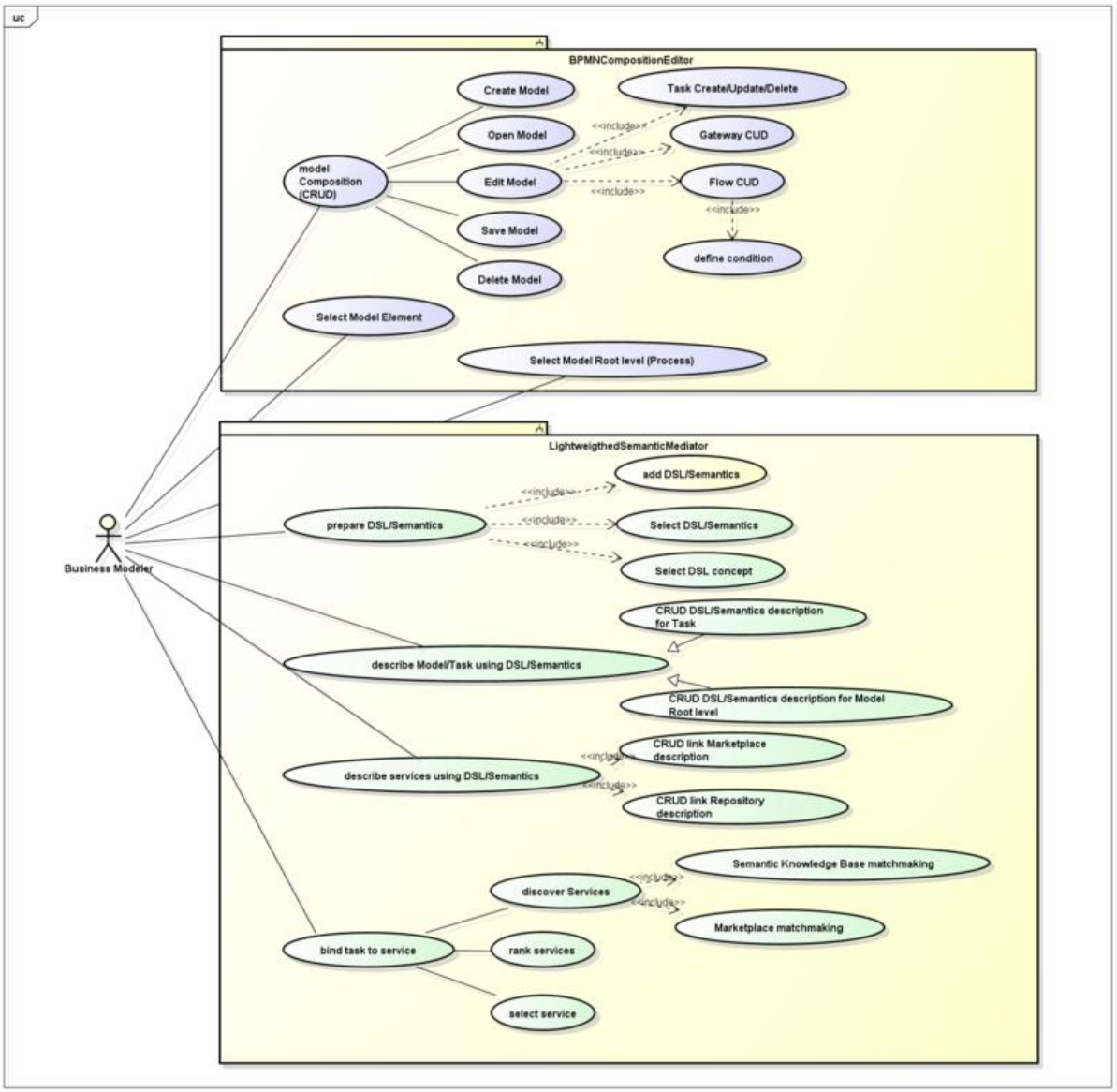
- Marketplace is used to query and retrieve USDL service descriptions for those services matched to composition tasks through semantic matchmaking, thanks to links contained within their semantic descriptions.
- Repository contains the technical descriptions (i.e. WSDL , WADL , etc) of services aggregated in the composition and the composition models (BPMN).

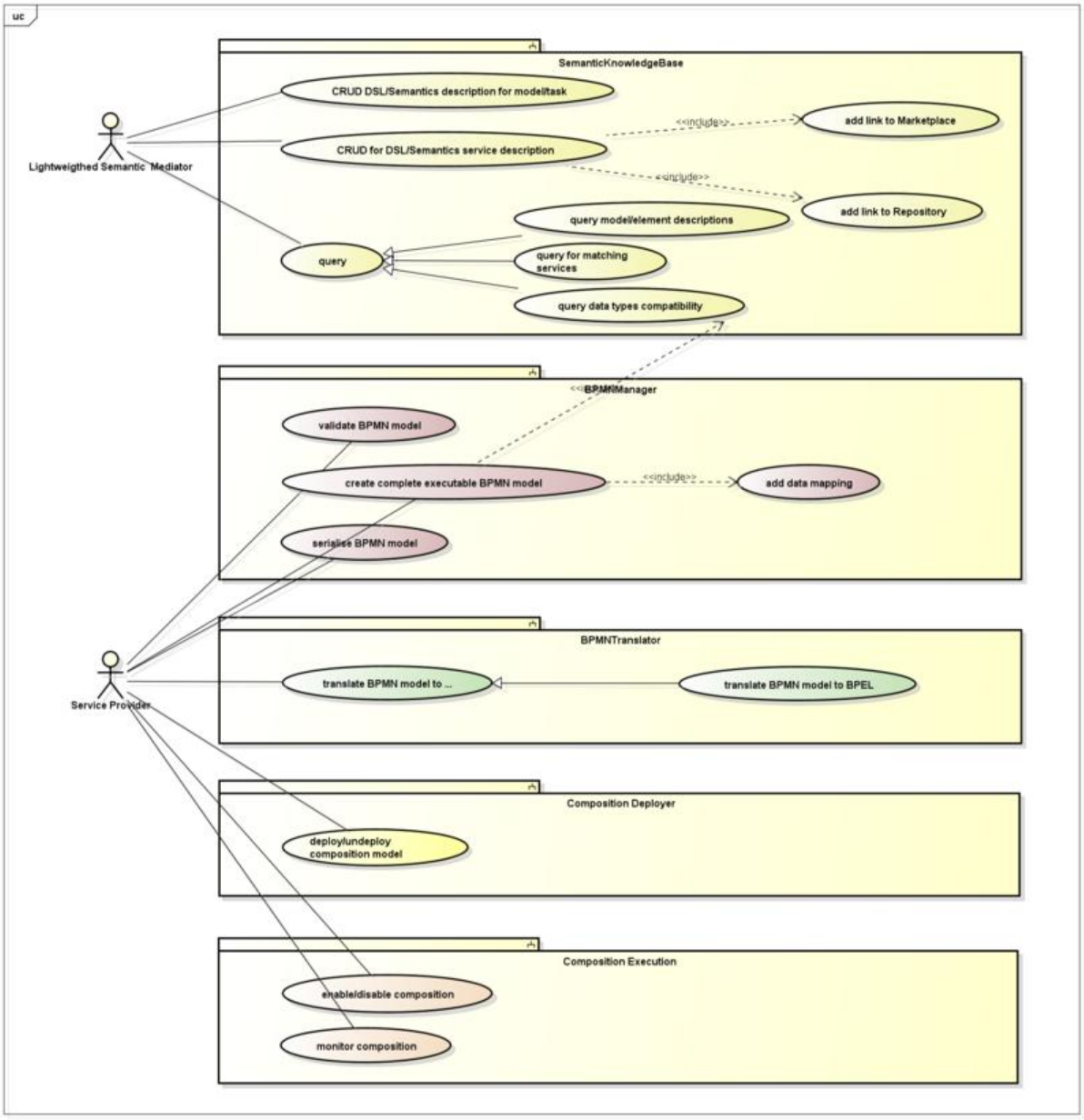
The Composition Execution layer contains the Composition Execution component, which deploys, enables and executes the service compositions, upon remote invocation by a service consumer.
Main interactions performed by the components that comprise this GE are described in next section, grouped by a functional classification.

18.7 Main Operations

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

18.7.1 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, that 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.

18.7.2 Prepare DSL/Semantics

In the GE 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.

18.7.3 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.

18.7.4 Describe Service using DSL/Semantics (Service Providers)

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. 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.

18.7.5 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.

18.7.6 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.

18.7.7 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 anytime.

18.7.8 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.

18.7.9 Modeling a BPMN Composition

A business modeler, through the BPMN Composition Editor, can either:

- Create a new BPMN composition model.

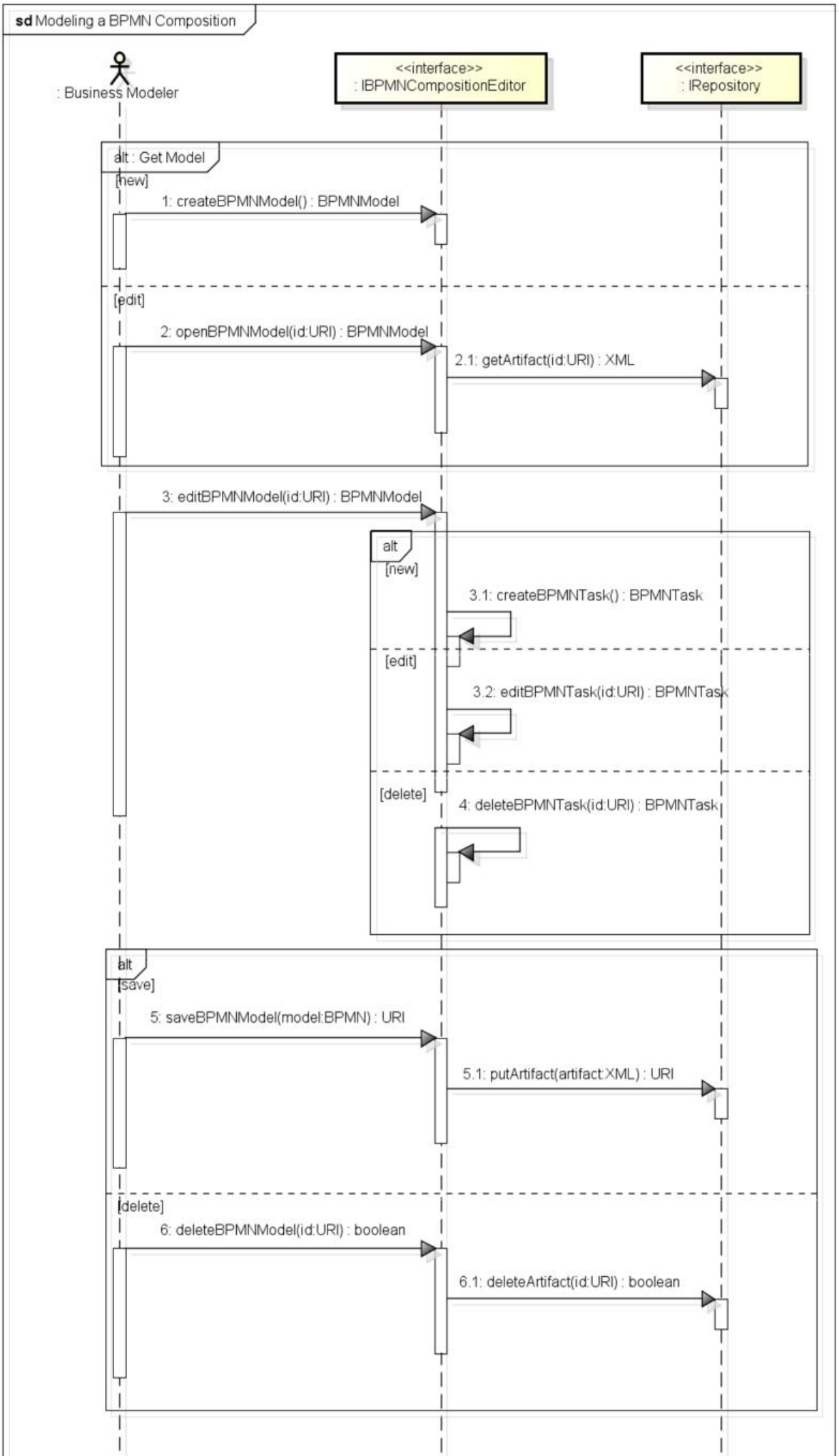
or

- 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 to serialize 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.

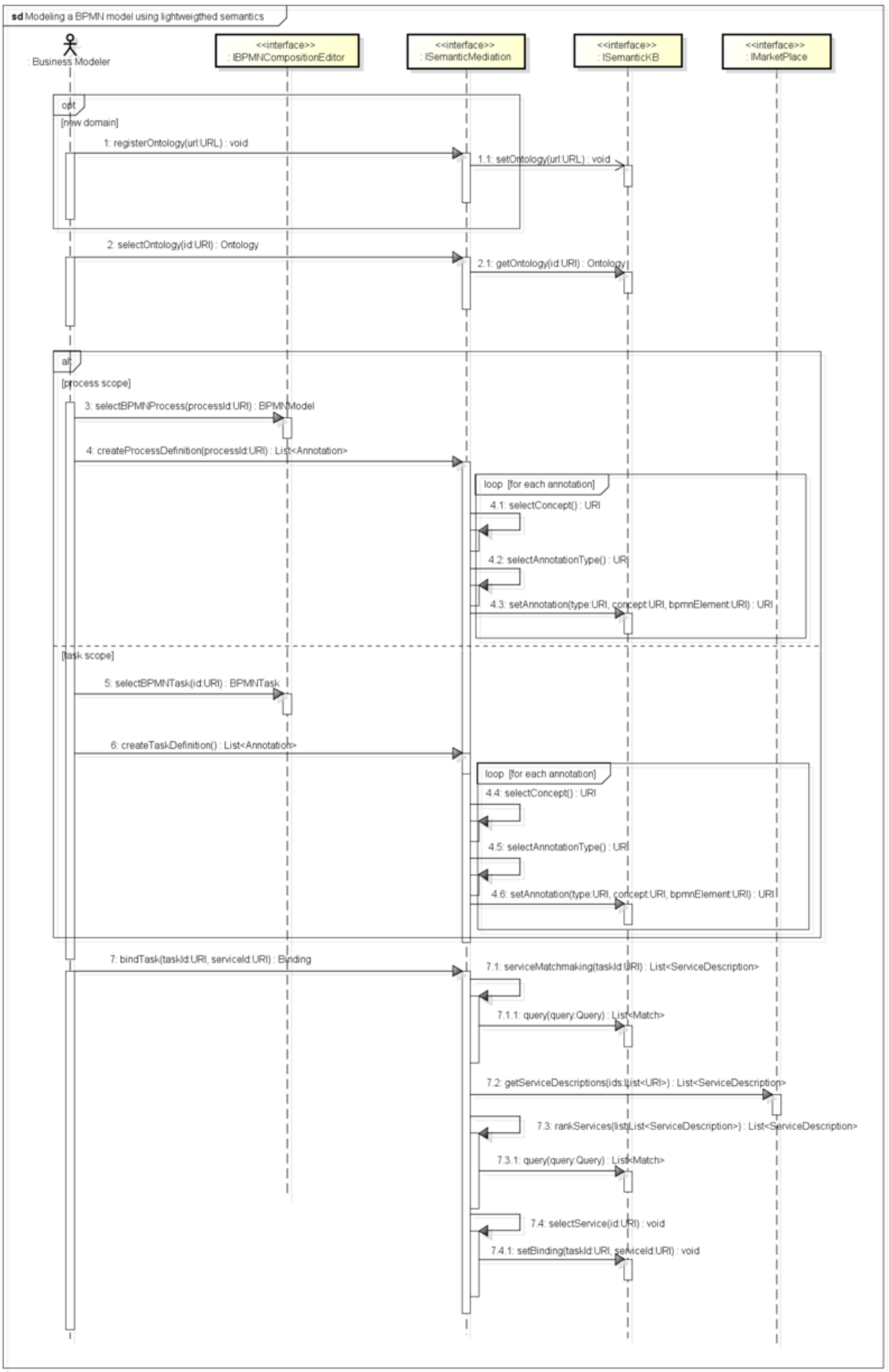

sd Modeling a BPMN Composition
: Business Modeler
<<interface>>
: IBPMNCompositionEditor
<<interface>>
: IRepository
alt : Get Model
[new]
1: createBPMNModel() : BPMNModel
[edit]
2: openBPMNModel(id:URI) : BPMNModel
2.1: getArtifact(id:URI) : XML
3: editBPMNModel(id:URI) : BPMNModel
alt
[new]
3.1: createBPMNTask() : BPMNTask
[edit]
3.2: editBPMNTask(id:URI) : BPMNTask
[delete]
4: deleteBPMNTask(id:URI) : BPMNTask
alt
[save]
5: saveBPMNModel(model:BPMN) : URI
5.1: putArtifact(artifact:XML) : URI
[delete]
6: deleteBPMNModel(id:URI) : boolean
6.1: deleteArtifact(id:URI) : boolean

18.7.10 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 bounds the task to it.

The next UML sequence diagram describes the overall process in detail, decomposed by operation and involved components.


sd Modeling a BPMN model using lightweigthed semantics
: Business Modeler
<<interface>> : IBPMNCompositionEditor
<<interface>> : ISemanticMediation
<<interface>> : ISemanticKB
<<interface>> : IMarketPlace
opt
[new domain]
1: registerOntology(url:URL) : void
1.1: setOntology(url:URL) : void
2: selectOntology(id:URI) : Ontology
2.1: getOntology(id:URI) : Ontology
alt
[process scope]
3: selectBPMNProcess(processId:URI) : BPMNModel
4: createProcessDefinition(processId:URI) : List<Annotation>
loop [for each annotation]
4.1: selectConcept() : URI
4.2: selectAnnotationType() : URI
4.3: setAnnotation(type:URI, concept:URI, bpmnElement:URI) : URI
[task scope]
5: selectBPMNTask(id:URI) : BPMNTask
6: createTaskDefinition() : List<Annotation>
loop [for each annotation]
4.4: selectConcept() : URI
4.5: selectAnnotationType() : URI
4.6: setAnnotation(type:URI, concept:URI, bpmnElement:URI) : URI
7: bindTask(taskId:URI, serviceId:URI) : Binding
7.1: serviceMatchmaking(taskId:URI) : List<ServiceDescription>
7.1.1: query(query:Query) : List<Match>
7.2: getServiceDescriptions(ids:List<URI>) : List<ServiceDescription>
7.3: rankServices(list:List<ServiceDescription>) : List<ServiceDescription>
7.3.1: query(query:Query) : List<Match>
7.4: selectService(id:URI) : void
7.4.1: setBinding(taskId:URI, serviceId:URI) : void

Modeling a composition using light-weighted semantics

18.7.10.1 *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.

18.7.10.2 *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). Each annotation (concretized by a selected ontology concept, given its URI and its type) is stored within the Semantic Knowledge Base, given 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.
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.
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. Selected service is bound to the task in the Semantic Knowledge Base.

18.7.11 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.

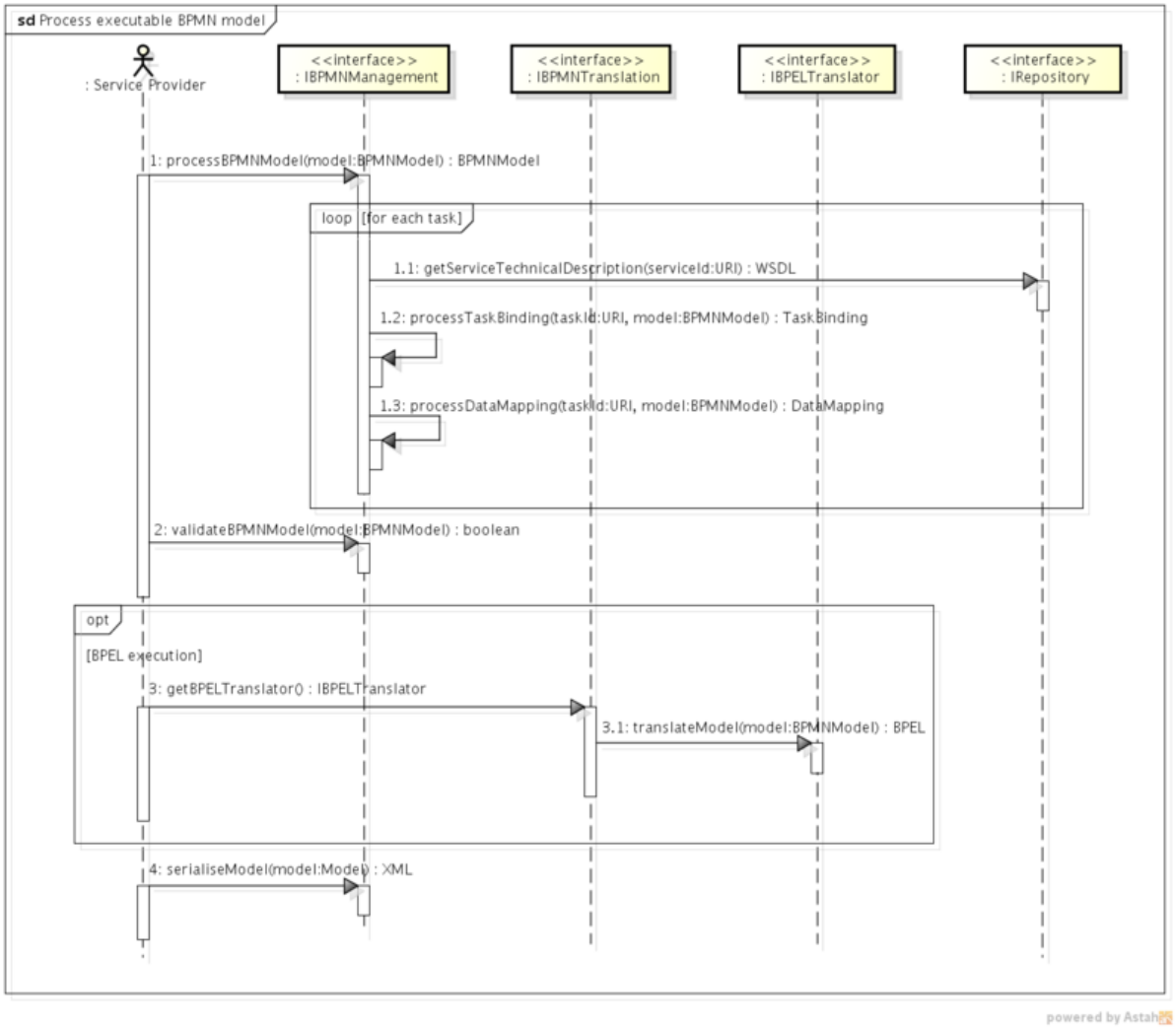
This procedure is initiated by the service provider through the Light-weighted Semantic Composition Editor, by invoking to process the BPMN model. This procedure conducts two main jobs for each composition task:

- 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 work flow.

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.

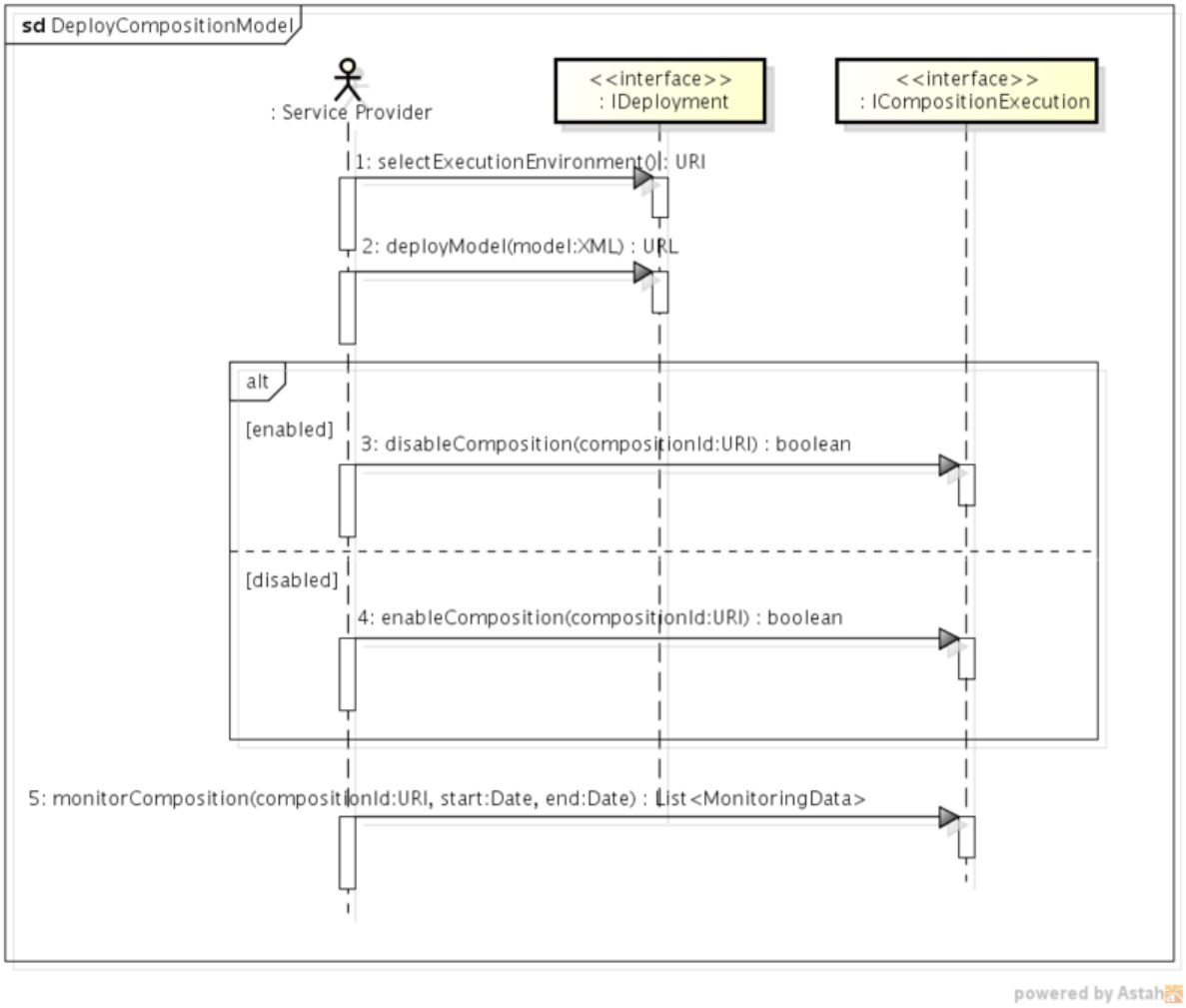
Finally, the executable composition model is serialized into XML or any other standardized serialization schema for interchange, as determined by the selected target execution language (BPMN XSD/XMI, BPEL XSD, etc).



Process a complete executable BPMN composition model

18.7.12 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

18.8 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.

18.9 Detailed Specifications

18.9.1 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

18.10 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

18.11 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.

19 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

19.1 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.eu and similar pages in order to understand the complete context of the FI-WARE project.

19.2 Copyright

19.3 Legal Notice

19.4 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.

- A *Store GE* is responsible for managing service offerings. To do this, it supports the registration of offerings published by an *aggregator* and updates 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 model of the service represented by a *USDL* document in a *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 downloadable service. To do this, the *Store GE* defines an API for implementation 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 applications 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 the purchase of the offering and will either make sure that the customer is given access to the web service or will 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.

19.5 Basic Concepts

19.5.1 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 the FIWARE platform user information, whereas the *Store GE* will use the information offered by 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 offered 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:

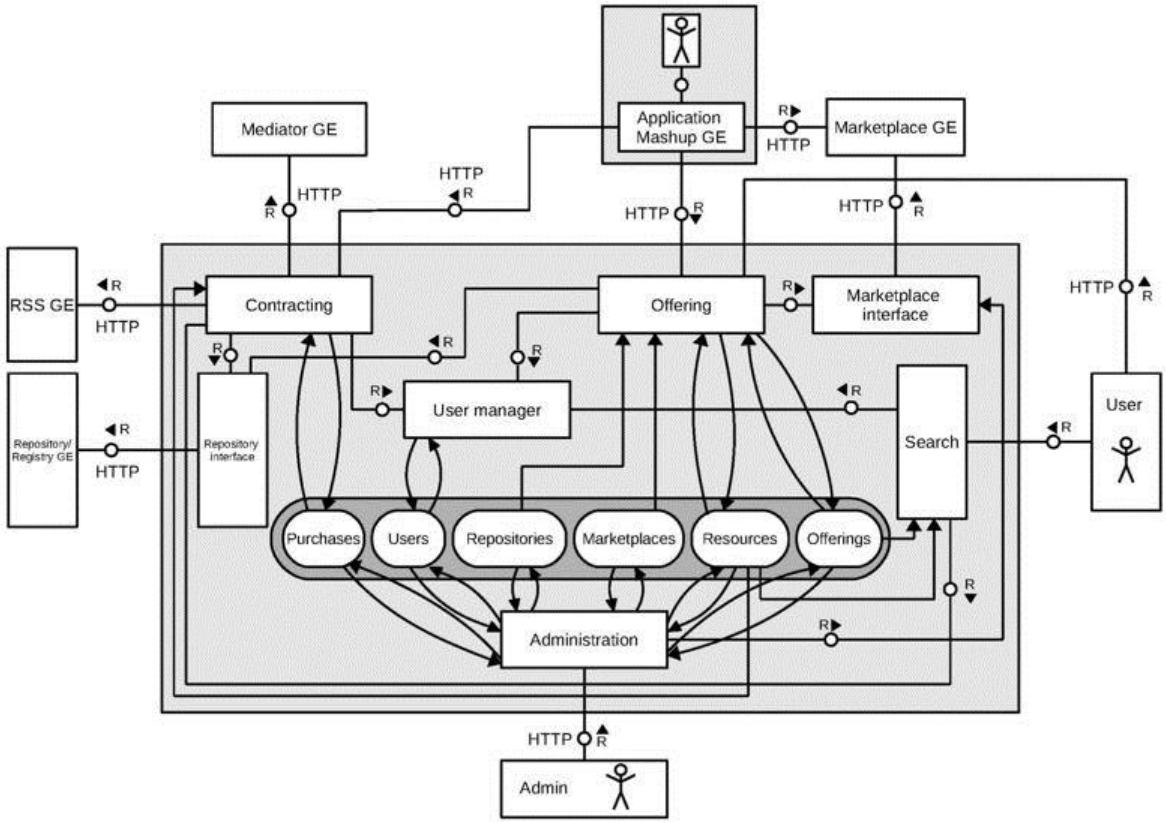
- **Admin:** This role is responsible for system administration. System administration includes database administration, as well as the registration of instances of the *Repository GE* for storing the models of offered services in the *Store GE*. It is also responsible for registering the instance of 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.

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.

19.5.2 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. This diagram illustrates the importance of the Application Mashup GE, clarifying that users will be able to use the Store GE via its web portal and other enablers will be able to contact the defined API to manage and purchase offerings previously discovered in the Marketplace GE. Notice that the Store GE will first connect to 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.). Finally, the Store GE will also connect to the Mediator GE and the Revenue Share System GE. The Mediator GE will be used to both access the payment gateway during the purchasing process and to contact and notify the provider of the purchased service, whereas the Revenue Share System GE will be used to divide the purchased offering payments among their respective stakeholders.



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.

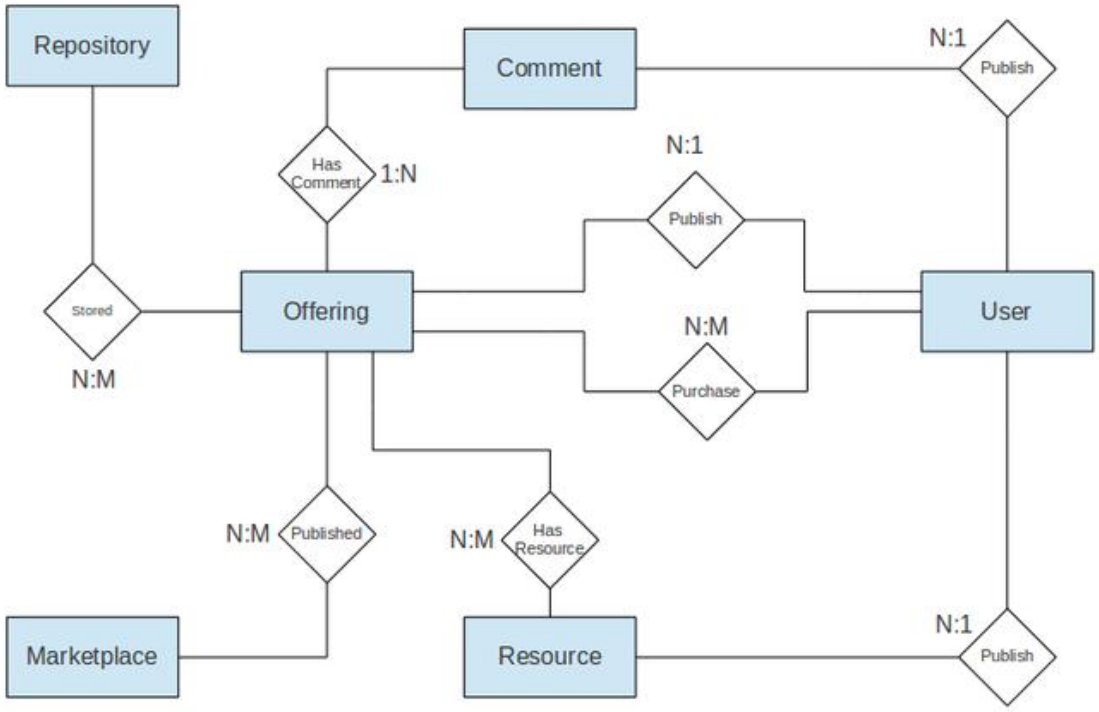
The *Administration* module is used by users with the Admin role to manage the Store GE and to register the Store GE instance in the instances of the Marketplace GE. This module reads and writes to all data models and contacts the Marketplace GE module in order to register the Store GE.

The *Offering* module is used to manage user-specific offerings. This module manages the provider offerings, i.e. 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. Finally, this module also contacts the User Manager module, which it uses to manage the roles of the users sending the requests.
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.
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 Share 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 defines 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 Share System GE for distribution among stakeholders.
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.

19.5.3 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 the real components offered, such as an application or access to a specific API.



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.
    - TAGs: This attribute will contain a series of *TAGs* used to classify the offering.
    - Image: This attribute will contain the image associated with the offering.
    - Related images: This attribute will contain a series of 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.
    - Type: This attribute will specify the resource type. Type will specify whether the resource is downloadable, like an application or a widget, or associated with API access.
    - Download link/Endpoint: This attribute will contain the information necessary to access the resource. It will contain the download link for downloadable resources and the API endpoint for APIs.
    - Description: This attribute will contain a resource description.

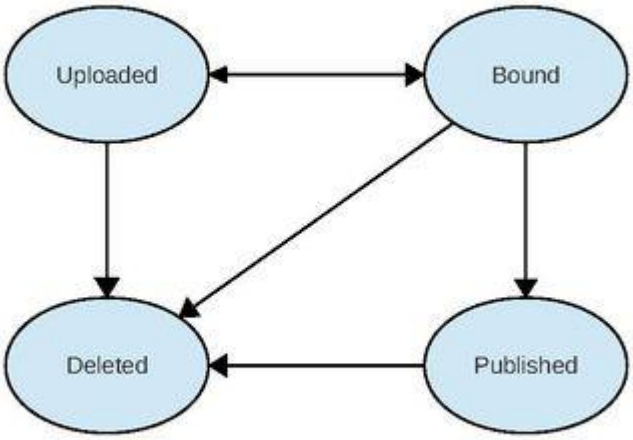
Note that the resources in the *Store GE* will be identified using the resource provider user name, the *Name* attribute and the *Version* attribute. Therefore, the combination of these three elements has to be unique.

- **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 different roles played by the user.
    - Default Tax Address: This attribute will contain the default tax address provided by the user.
- **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.
- **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.

19.5.4 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.

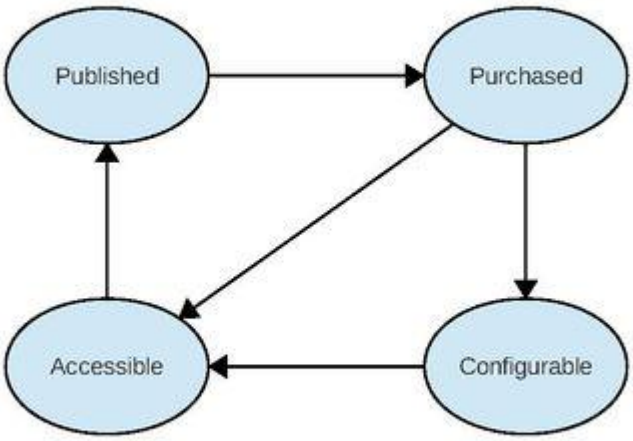


Offering life cycle from provider viewpoint

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. Additionally, a Published offering is no longer editable, nor is it possible to modify the information of the USDL document, or link or unlink resources. 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. This way, any buyers that have already purchased the offering 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

19.5.5 Charging

The Store GE is responsible of charge 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 renovation.
- *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 use information from an external accounting component included in an SDR document (Described below). It is necessary to take into account that exists different types of pay-per-use models, In this case, 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.

19.5.5.1 *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.
- *Correlation number*: Sequence number.
- *RecordType*: Type of pay-per-use that has been monitored (i.e event, time, 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.

19.5.6 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.

19.5.6.1 *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 do this, we will assume that 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 downloadable resource containing the code of the different Widgets used. Additionally, the Store GE will interact from the interface 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, as well as a service icon. Note at this point that 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.

19.5.6.2 *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 case, the user is assumed to be using the Store GE web portal and to purchase an offering with resources associated with the subscription model web service API. Additionally, the user is assumed to have permits 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.

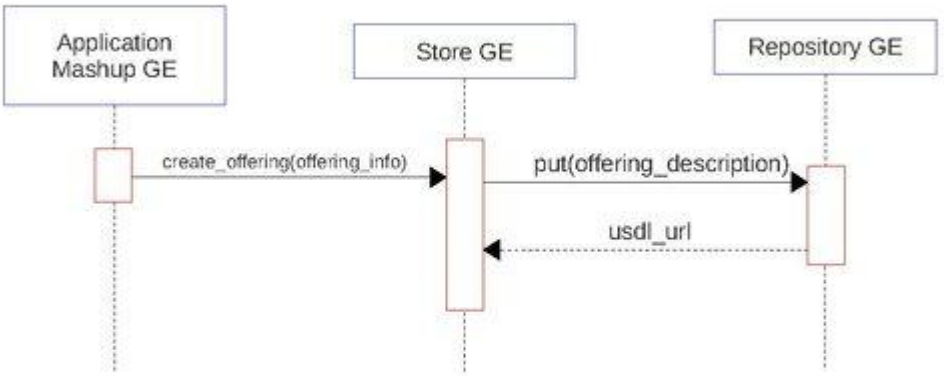
19.6 Main Interactions

19.6.1 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.

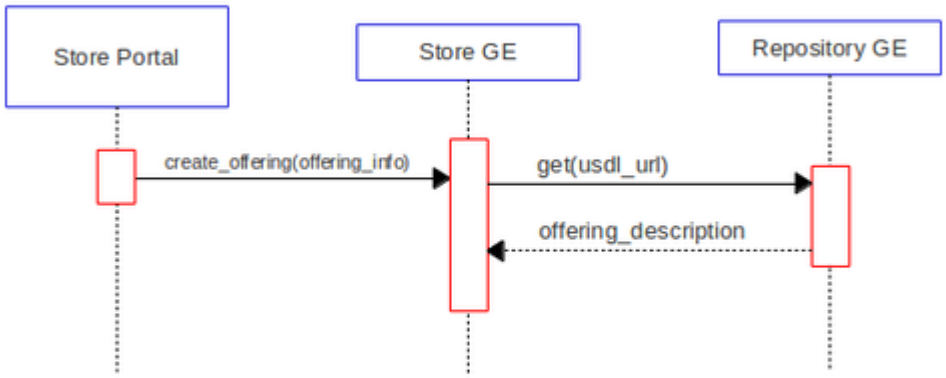
19.6.1.1 *Creating an offering*

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

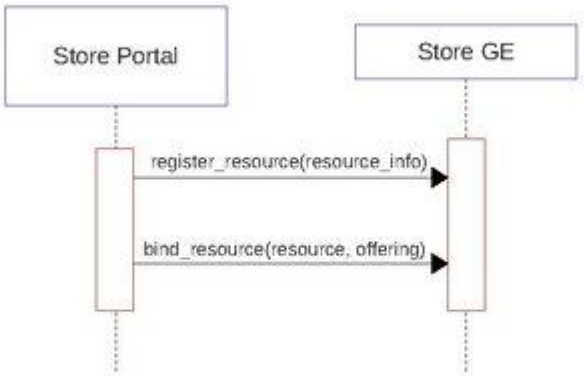
It shows how just one request is required to create a new offering. This request provides the offering information, which will be composed of the USDL description of the offering, as well as a series of images related to the offering and the offering icon. The Store GE receives the request to create 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

19.6.1.2 *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.

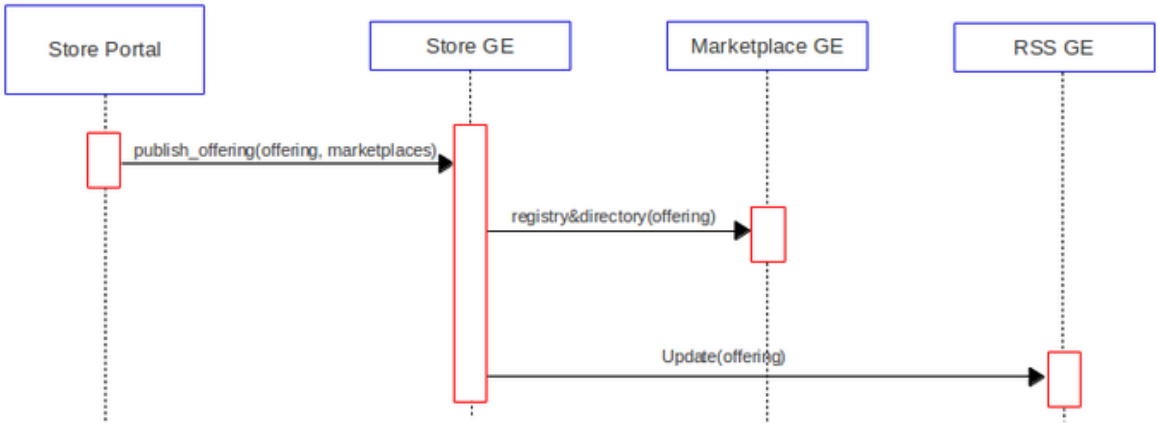


Registering and linking a resource

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.

19.6.1.3 *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.

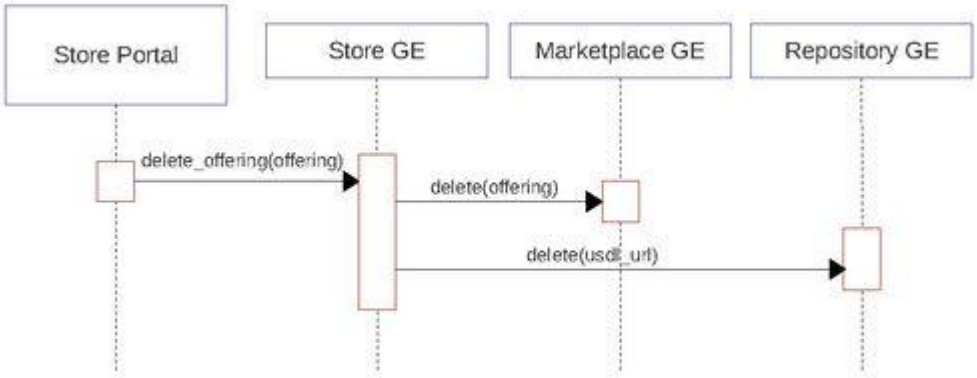


Publishing an offering

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.

19.6.1.4 *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.

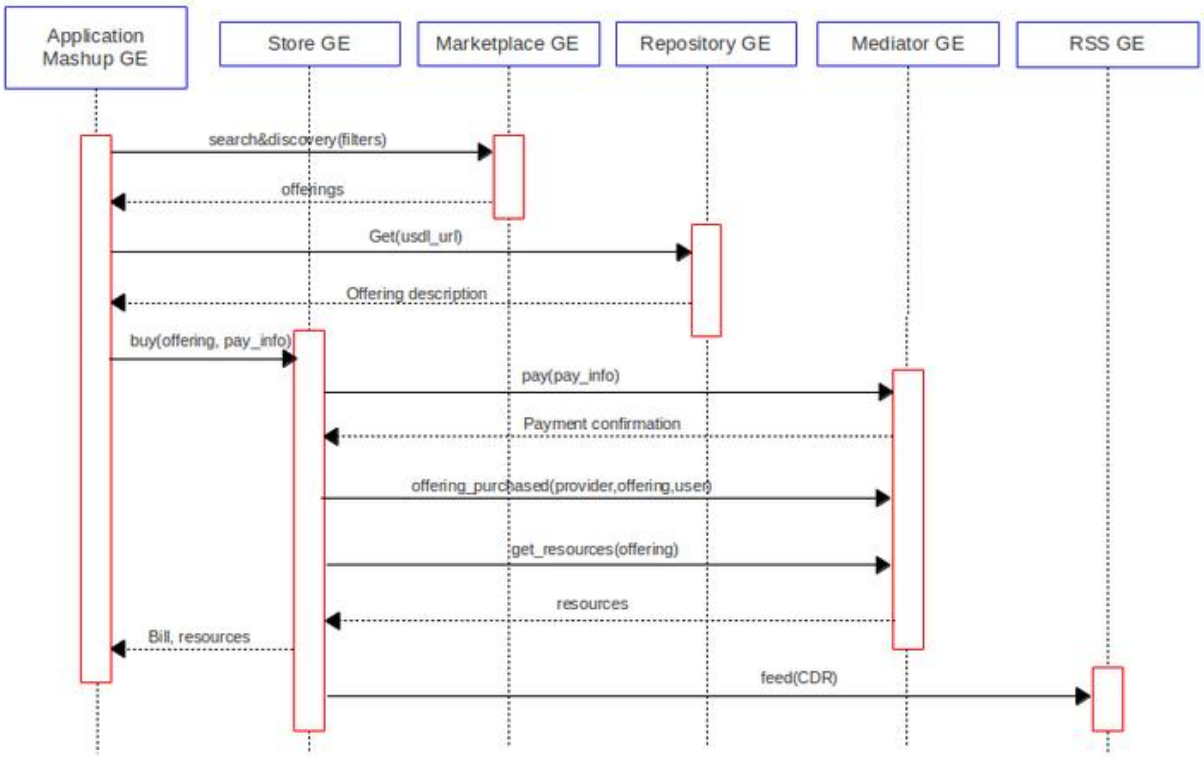


Removing an offering

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.

19.6.1.5 *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 be 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.



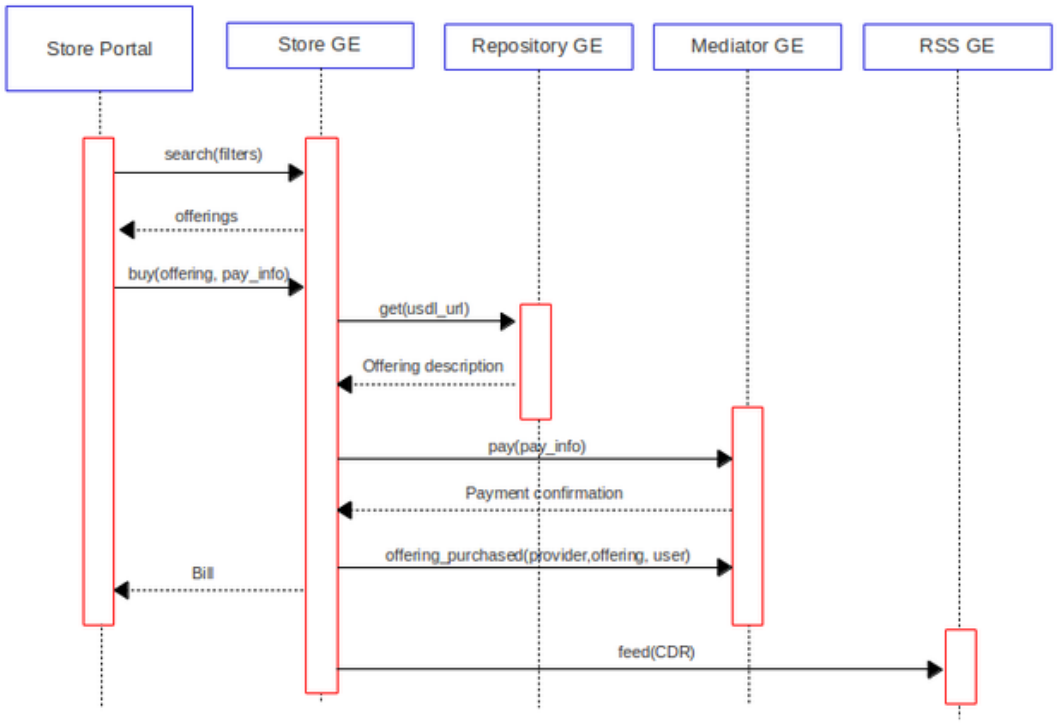
Searching the Marketplace GE and purchasing an offering

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, providing the payment information. 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.

19.6.1.6 *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 accesible via API). In this diagram, the user is assumed to be using the Store GE web portal.



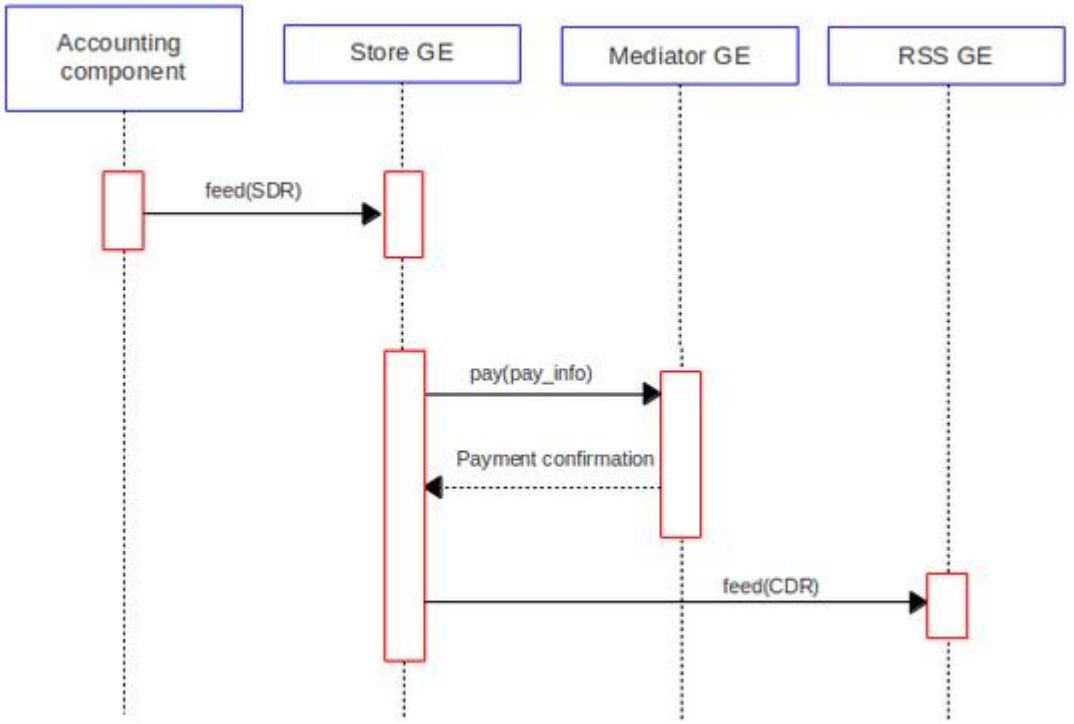
Searching the Store GE and purchasing an offering

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 search 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 make the payment by contacting the respective payment gateway via the Mediator GE, using the previously accessed payment information. The Store GE receives payment confirmation and contacts and notifies the service provider that user or organization now has access to the APIs defined by 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.

19.6.1.7 *Feeding the Store GE with accounting info*

The figure below shows the interactions that take place when feeding the Store GE with accounting info related to the use of a service whose offering implies 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 info 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 makes the payment by contacting the respective payment gateway via the Mediator GE. For making this payment, the Store GE uses the payment information contained in the customer profile. The Store GE receives the payment confirmation and feeds the RSS with a CDR document containing the aforementioned payment information.

19.7 Detailed Specifications

19.7.1 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

19.7.2 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.

20 Store_Open_API_RESTful_Specification

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

20.1 Introduction to the *Store* API

Please check the FI-WARE Open Specifications Legal Notice to understand the rights to use FI-WARE Open Specifications.
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, including open source licenses that require patent pledges.
If the owner (UPM) 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.

20.1.1 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.

20.1.2 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 informatio 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

20.1.3 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
Jan 16, 2013	• Initial version

20.1.4 How to Read This Document

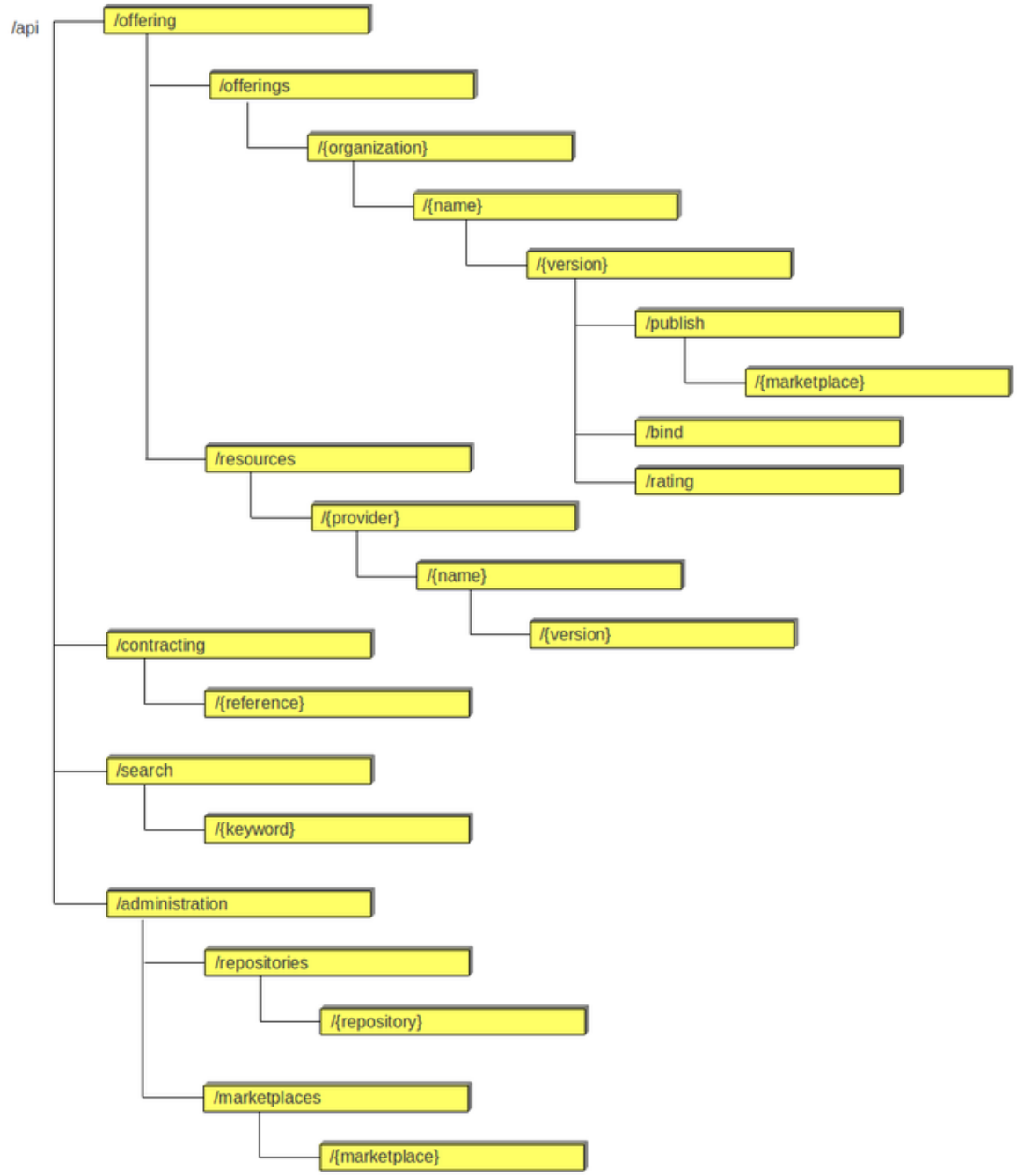
It is assumed that the reader is familiar with the REST architecture style. Within the document, some special notations are applied to differentiate some special words or concepts. The following list summarizes these special notations.

- 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.

20.2 General *Store* API Information

20.2.1 Resources Summary



20.2.2 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).

20.2.3 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/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.

20.2.4 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.

20.2.5 Resource Identification

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

20.2.6 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, ...

20.2.7 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.

20.2.7.1 *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.

20.2.8 Faults

20.2.8.1 *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

20.3 API Operations

20.3.1 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

20.3.1.1 *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"
   ]
}
```

20.3.1.2 *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
```

20.3.1.3 *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
```

20.3.1.4 *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
```

20.3.2 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

20.3.2.1 *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"
   ]
```

```
}
```

20.3.2.2 *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
```

20.3.2.3 *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
```

20.3.2.4 *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
```

20.3.3 Managing Offerings

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

Verb	URI	Description	Mandatory/Optional
GET	/api/offering/offerings	Get a list of all offerings	Mandatory
POST	/api/offering/offerings	Creates a new offering	Mandatory
GET	/api/offering/offerings/{organization}	Get a list of all offerings of an organization	Mandatory
GET	/api/offering/offerings/{organization}/{name}	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

20.3.3.1 *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":"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": [],
          "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},
      }
   ]
}
```

20.3.3.2 *Creating offerings*

Example request:

```
POST /api/offering/offering HTTP/1.1
Content-Type: application/json
Accept: application/json

{
  "name": "example_offering",
  "version": "1.0",
  "image": "",
  "related_images": [],
  "repository": "example_repository",
  "offering_description": "raw USDL document (RDF XML, N3 , Turtle)"
}
```

Example response:

```
HTTP/1.1 201 Created
Vary: Cookie
```

20.3.3.3 *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
```

20.3.3.4 *Updating offerings*

```
PUT /api/offering/offerings/UPM/example/1.0 HTTP/1.1
Content-type: application/json
Accept: application/json
```

```
{
  "name": "example_offering",
  "version": "1.0",
  "image": "",
  "related_images": [],
  "offering_description": "raw USDL document"
}
```

Example response

```
HTTP/1.1 200 OK
Vary: Cookie
```

20.3.3.5 *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
```

20.3.3.6 *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
```

20.3.3.7 *Rating offerings*

Example request

```
POST /api/offering/offerings/UPM/example/1.0/rating HTTP/1.1
Accept: application/json

{
    "rating": "5",
    "comment": "Good offering"
}
```

Example response

```
HTTP/1.1 201 Created
Vary: Cookie
```

20.3.4 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

20.3.4.1 *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

{
   [
      {
          "name":"example_resource",
          "provider": "admin",
          "version": "1.0",
          "type": "download",
          "state": "uploaded",
          "description": "Example resource",
          "offerings": []
      }
   ]
}
```

20.3.4.2 *Creating resources*

Example request:

```
GET /api/offering/resources HTTP/1.1
Content-type: application/json
```

```
Accept: application/json
{
   {
        "name":"example_resource",
        "provider": "admin",
        "type": "download",
        "version": "1.0",
        "state": "uploaded",
        "link": "http://linktodownload.com/resource"
        "description": "Example resource",
        "offerings": []
   }
}
```

Example response:

```
HTTP/1.1 201 Created
Content-Type: application/json
Vary: Cookie
```

20.3.4.3 *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
```

20.3.4.4 *Updating resources*

Example request:

```
PUT /api/offering/resources/admin/example_resource/1.0 HTTP/1.1
Accept: application/json

{
```

```
    {
        "name":"example_resource",
        "provider": "admin",
        "type": "download",
        "version": "1.0",
        "state": "uploaded",
        "link": "http://linktodownload.com/resource"
        "description": "Example resource",
        "offerings": []
    }
}
```

Example response:

```
HTTP/1.1 200 OK
Vary: Cookie
```

20.3.5 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

20.3.5.1 *Purchasing an offering*

Example request:

```
POST /api/contracting HTTP/1.1
Content-type: application/json
Accept: application/json
{
    {
        "offering": {
            "organization": "UPM",
            "name": "example_offering",
            "version": "1.0"
         },
         "billing_info": {
```

```
            ...
        },
        "tax_address": "Example street"
    }
}
```

Example response:

```
HTTP/1.1 201 Created
Vary: Cookie
```

20.3.5.2 *Getting a purchase info*

```
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",
    }
}
```

20.3.6 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

20.3.6.1 *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": [],
          "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},
}
    ]
}
```

20.3.7 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.

403 Forbidden

The request cannot 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.

21 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	[TBD TBD]
Owner	Telefónica I+D, Pablo Arozarena Llopis

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.eu 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 Legal Notice to understand the rights to use these specifications.

21.4 Overview

The Revenue Sharing System (RSS) GE is in charge of distributing the revenues originated by the usage of a given application among several stakeholders involved. In particular, it focuses on sharing part of the revenue generated by an application between the marketplace provider and the service provider(s) responsible for the application. 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 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:

- Application download

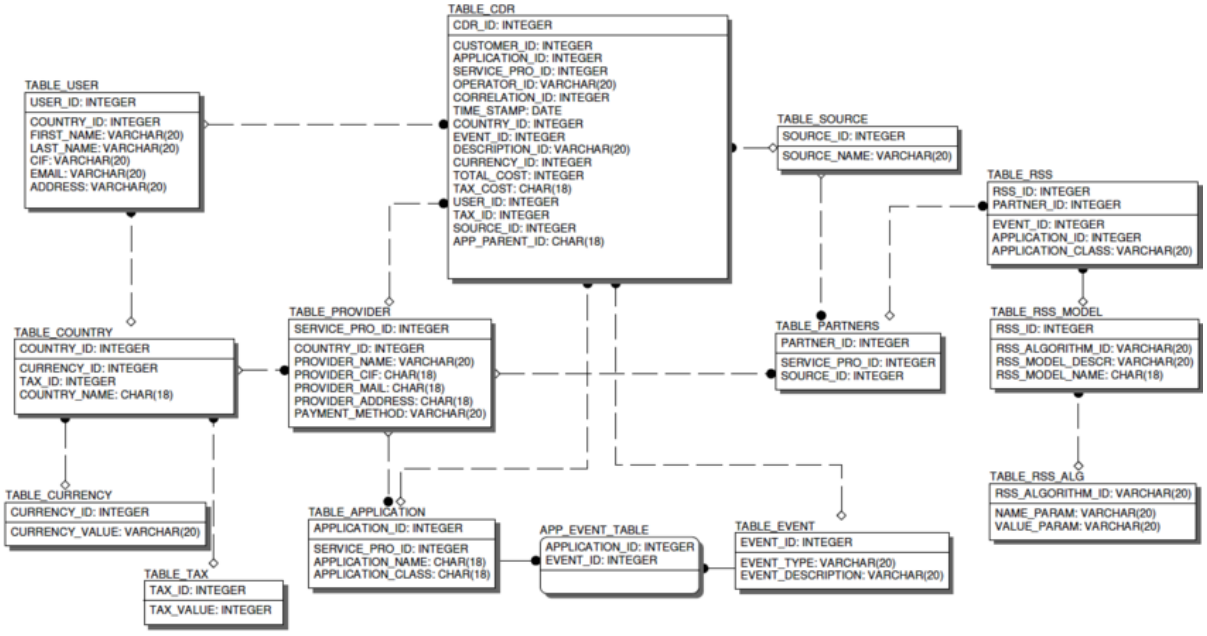
- Subscription
- Application usage (pay per use)

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 than the one used for pay per use metrics. The RSS GE exposes an APIs for other components to send charging information. It also features a GUI which can be used by FI-WARE administrators to manage revenue sharing models, access reporting information and perform additional administration tasks.

21.5 Basic Concepts

21.5.1 Data Model

The RSS GE data model is depicted in the diagram below (note not all actual details are shown):



The main data artifacts are described in the following paragraphs:

21.5.1.1 *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).

21.5.1.2 *CDRs*

CDRs provide charging information related to the usage of applications and services available in FI-WARE. 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 (MSISDN).
- *Service Provider id*: Provider of the service.
- *Product class*: Application category.
- *Refund reason*: Free text describing reason for refund CDRs.

21.5.1.3 *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* (UE accounts)
        - *Bank office address* (UE accounts).

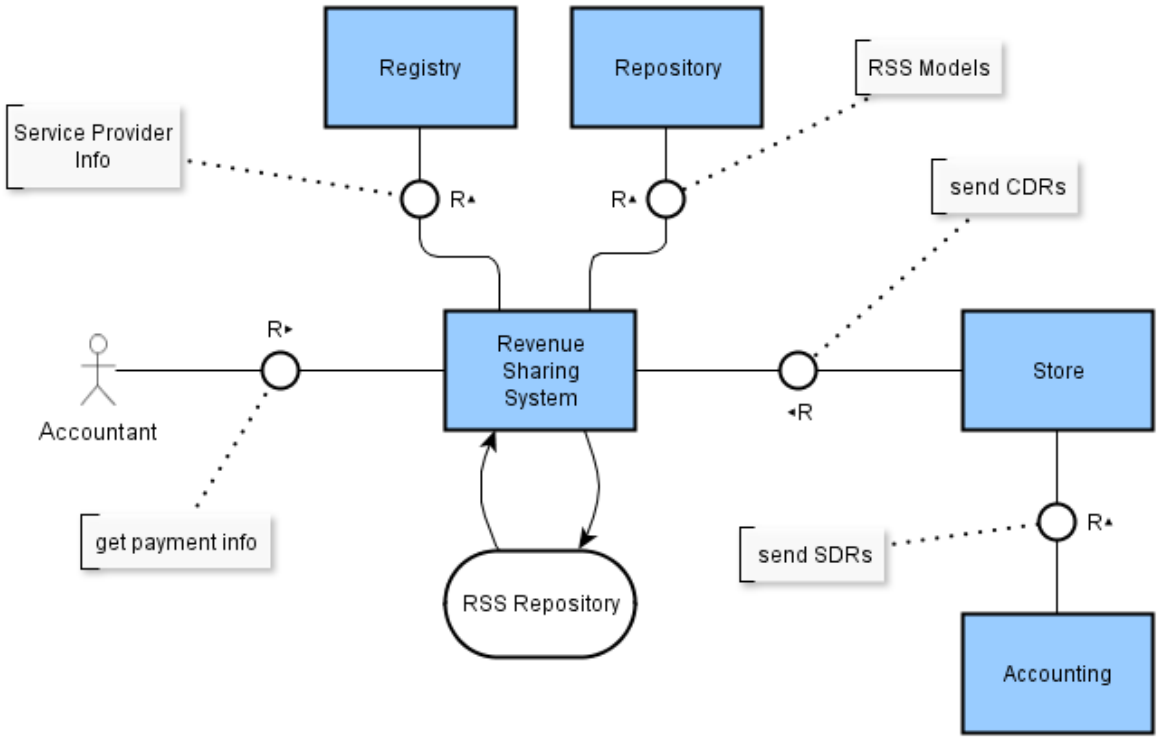
21.5.1.4 *Payment information*

As a result of the settlement process, the RSS GE computes the payments which must be done to each Service Provider. Payment information is aggregated, in a given payment period, per Service Provider, application and event so as to provide insight on the revenue sources. The payment file contains the following information for each Service Provider (one file per application and event combination):

- *Payment period*: Period used for settlement (typically one month).
- *Amount*: Money amount to be paid.
- *Tax information*: Taxes amount which must be included.
- *Currency*: Currency in which the amount must be paid.
- *Application Id*: Application or service which is being charged.
- *Event Id*: Event that is being used for charging (subscription , pay per use, etc.).
- *Payment method*: Information corresponding to the specified payment method.
    - *Credit card*. Parameters required:
        - *Card number*
        - *Card name*
        - *Security code*
        - *Description*
        - *Expiration date*
        - *Credit card provider* (VISA, MasterCard, etc.).
    - *Paypal*. Parameters required:
        - *Email address*
    - *Bank account*. Parameters required:
        - *Account number*
        - *Account name*
        - *Description*
        - *Swift code* (US accounts)
        - *IBAN* (UE accounts)
        - *Bank office address* (UE accounts).

21.6 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.



The main interactions between RSS and other GEs are as follows:

- 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.
- Repository GE: revenue sharing models, created by the BE&BM 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.
- 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.

21.7 Main Interactions

21.7.1 Receiving CDRs

In order to calculate revenue shares, RSS must be fed with CDRs from the Store GE using the following operation:

- *ReceiveCDRs*
- *Parameters:*
  - *CRDList*. Each CDR must include the parameters described in:
    - http://forge.fi-ware.eu/plugins/mediawiki/wiki/fiware/index.php?title=FIWARE.ArchitectureDescription.Apps.RSS#CDRs

21.7.2 User Management

RSS GE will get information about its users (basically administrators) from the IDMaaS GE. This information should include a user identification, role and other relevant parameters. Besides, the RSS GE relies on the IDMaaS GE for the authentication and authorization of users accessing the RSS GE.

21.7.3 Service Providers management

The RSS GE will read information about Service Providers from the Registry GE.

21.7.4 RSS Models management

The RSS GE will read information about RSS models created by the BE&BM GE from the Service Repository GE.

21.7.5 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.

21.8 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.FIWARE.OpenSpecification.Details.Apps.RSS

21.9 Re-utilised Technologies/Specifications

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

- W3C WS-*.

21.10 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.

22 FIWARE OpenSpecification Apps RSSRest

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

22.1 Introduction to the *RSS* API

22.1.1 RSS API Core

The RSS GE API is a RESTful, resource-oriented API accessed via HTTP that uses XML representation for information interchange.
The RSS GE APIs allows other components to send charging information to the RSS GE.

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 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-*.

22.1.3 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

22.1.4 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.

22.1.5 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.

22.2 General *RSS* API Information

22.2.1 Resources Summary

22.2.2 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).

22.2.3 Representation Format

The *RSS* 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).

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

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.

22.2.6 Links and References

22.2.6.1 *Web citizen*

The RSS GE is relying on Web principles:

- URI to identify resources
- consistent URI structure based on REST style protocol

22.2.7 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.

22.3 API Operations

22.3.1 Processing RSS Information

22.3.1.1 *Creating RSS entries from CDRs*

Verb	URI	Description
POST	/rss/cdrs	Process one or more CDRs resources received

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>
```

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.

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.

23 FIWARE OpenSpecification Apps RSS RSS-Models

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

23.1.1.1 *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 cobimations 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.

23.1.1.2 *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>
```

24 FI-WARE Open Specifications Legal Notice

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

24.1.1.1 *General Information*

"FI-WARE Partners" refer to Parties of the FI-WARE Project in accordance with the terms of the FI-WARE Consortium Agreement"

24.1.1.2 *Use Of Specification - Terms, Conditions & Notices*

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