SMART-FI

# Exploiting Aggregated Open Data from Smart Cities for the Future Internet Society

# D2.4: Architecture and design of the SMART-FI platform

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| Abstract | This document describes the final architecture, which will integrate the requirements, functionalities and the developed services, and align a common platform for the integration of the FIWARE architecture. |
| Keywords | Architecture, design, data normalization, data analytics, service orchestration |
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# Document Description

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# Table of Contents


Table of Contents ........ 3
Table of Figures ........ 3
Table of Tables ........ 3
Terms and abbreviations ........ 4
Executive Summary ........ 5
1 Introduction ........ 6
2 SMART-FI Architecture ........ 6
2.1 Functionalities or facilities ........ 6
2.2 Final Architecture ........ 7
3 Mapping with Use Cases ........ 10
4 Conclusions ........ 11
5 References ........ 12
Annex I: Glossary Terms used in SMART-FI ........ 12


# Table of Figures


FIGURE 1. SMART-FI PLATFORM ARCHITECTURE. ........ 8
FIGURE 2. DATA NORMALIZATION PROCESS ........ 10
FIGURE 3. DATA ANALYTICS MICROSERVICES. ........ 12
FIGURE 4. DATA ANALYTICS MICROSERVICES. ........ 14


# Table of Tables


TABLE 1. SMART-FI FACILITIES MATCHING WITH THE USE CASES ........ 16


  

# Terms and abbreviations

| | |
|---|---|
| WP | Work Package |
| MX | Month X |
| DX | Deliverable X |
| UC | Use Case |
| APP | Application |
| IoT | Internet of Things |
| IT | Information Technology |
| MiDAS | Micro Data Analytic Services |
| ESB | Enterprise Service Bus |
| EU | European Union |
| GE | Generic Enablers |
| QoS | Quality of Services |
| SLA | Service Level Agreement |
| URI | Uniform Resource Identifier |
| COSMOS | FIWARE Generic Enabler |
| IDM | FIWARE Generic Enabler |

# Executive Summary

In this document, we modify the intermediate architecture proposed in the previous deliverable, D2.2. Considering the requirements has not changed as regards the first version presented in D2.1, the main changes in this document is the perspective of how the layers contained the components implemented in SMART-FI are connected. This means after some discussions, we determine a flow of interactions between the components that is the one presented here.

Then, the final architecture is based on the functionalities and the developed services, and align a common platform for the integration of the FIWARE architecture.

Therefore, it contains the architecture and design for the SMART-FI platform, as outcome from Task 2.4, and connecting all the functionalities and tools developed in WP3, WP4 and WP5.

This architecture will provide a common framework that allows the integration of different services in a uniform manner.

As mentioned in D2.2, the aim is to integrate different heterogeneous services into a unified and homogeneous platform, allowing for a sustainable and exploitable environment. Hence, it is the glue that integrates all the components with the FIWARE platform and provides useful solution to the case studies and the stakeholders (application developers, service providers, data system administrators, citizens and municipalities).

# 1 Introduction

This document presents the SMART-FI final architecture, by describing the main components and functionalities of the platform. The architecture which will integrate the requirements, functionalities and developed services, and will combine with the FIWARE architecture. Since the requirements have not changed as regards the first version presented in D2.1 [1], the modifications in D2.4 versus D2.2 [5] are minimum, mainly based in the flow of interaction between the components that constitute the SMART-FI ecosystem.

In Section 2, we describe the SMART-FI final architecture, firstly the approach and facilities, and secondly the platform architecture itself. In Section 3, we present a final mapping between the functionalities developed in SMART-FI and the ones used in the use cases. Finally, we conclude the document in Section 4.

# 2 SMART-FI Architecture

In this section, we describe the final architecture and design of the SMART-FI platform, considering we will continue working of the technical aspects and possible modifications will be included in a final document to obtain the final architecture.

## 2.1 Functionalities or facilities

As detailed in D2.2, the SMART-FI approach is expected to help deploying and interconnecting services using real data from diverse sources, mainly from public administrations, but also from other third-party services or devices. The aim is to provide services on top of FIWARE, a standard open IoT platform recognized at EU level, that facilitates the development of smart applications and with an environment where cities can publish their open data.

Therefore, SMART-FI main goal is to provide a novel Smart City platform and a set of facilities to deploy and interoperate services by exploiting aggregated open data from smart cities.

The project will provide methodologies to homogenize heterogeneous open data and data services, perform analysis and aggregation of data analytics services to predict patterns and make recommendations, as well as to facilitate services deployment.

In this sense, the three main components with the corresponding functionalities in the SMART-FI platform are the following (more details about the components and functionalities/facilities can be found in Deliverables D2.1 [1] and D2.2 [5], since the main internal functions have not been modified):

1. **Data normalization in Smart Cities.**
   Functionality: Homogenization of heterogeneous open data and data services.
2. **Data analytics microservices for Smart Cities.**
   Functionality: Aggregation and development of data analytics services for predictions & recommendations.
3. **Services orchestration in Smart Cities.**
   Functionality: Development of methodologies to deploy and interoperate services.

## 2.2 Final Architecture

In this section, we present SMART-FI platform final architecture.

The main objective of the SMART-FI platform is to allow horizontal integration of open city data and data analytics services by providing a set of generic component and mechanism that will enable development of higher-level, added-value Smart city applications and services.

SMART-FI is focused to provide functionality to different stakeholders, considering the following ones:

- Application developers
- Service providers
- Data system administrators
- Citizens
- Municipalities

Figure 1 shows the SMART-FI platform architecture overview. The SMART-FI platform follows a layered architecture with the main layers or levels including: i) infrastructure level, ii) platform/component level, and iii) application level. This supposes the main change as regards the intermediate architecture presented in D2.2 (check [5] for more details). Basically, in the intermediate one, we were considering the layers were specified by the components themselves or the functionalities. But after some discussions, we decided to present a structure based on levels related to infrastructure, platform and application.

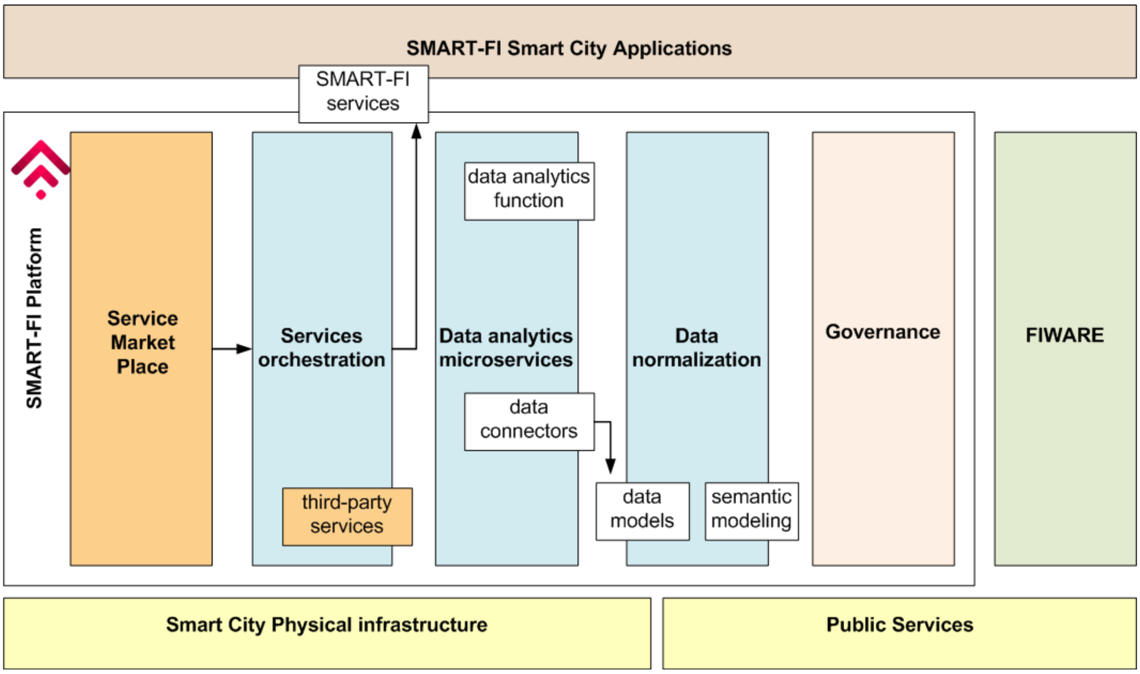


**Figure 1. SMART-FI Platform Architecture.**

At the infrastructure level will be performed the connection and use of physical devices and public services. The platform or component level mainly presents the three components or functionalities developing a set of methodologies and tools to be used in the application scope for smart cities. Specifically, the components, connected between them are the one listed previously in Section 2.1: 1) data normalization, 2) data analytics microservices, and 3) service orchestration.

In addition, the platform level contains the service market place that could be used for the composition with the SMART-FI services. The idea behind of this is to create composed services (also we are checking the possibility to use third-party services at the service orchestration scope). Also, it contains the Governance, used to coordinate the different functionalities.

On the other hand, the application level is focused on the generation of the Smart City application, considering among others CityGO, or other application or pilots to validate the platform.

Last, the connection with FIWARE ecosystem, what is integrated with SMART-FI in both infrastructure and platform levels. In this sense, SMART-FI is aligned with FIWARE.

In the next, we give more details about the linked open data integration performed in SMART-FI, as well as the RDF-based access, and Apache Jena.

  

## Linked Open Data Integration in SMART-FI

SMART-FI use a set of methodologies and tools to serve platform users SPARQL endpoints in order to access linked data stream via HTTP protocol. By using SMART-FI methodologies for Linked Open Data Integration, platform users will be able to integrate and transform data from various data sources like spreadsheets, CSV and XML files, JSON and Web APIs to Relational Database and publish it as linked data.

SMART-FI platforms users transform heterogeneous data by modeling it according to **SMART-FI Data Models guidelines** and mapping of data to ontology classes and then uses the ontology to propose a model that links these classes. Once the model is complete, users can publish the integrated data as RDF via HTTP by using suggested tools in platform. The main proposed and used tools and platforms to do this process are **D2RQ Platform** and **Apache Jena**.

## D2RQ Platform

The D2RQ Platform is a system for accessing relational databases as virtual, read-only RDF graphs. It offers RDF-based access to the content of relational databases without having to replicate it into an RDF store. Using D2RQ user are able to:

- query a non-RDF database using SPARQL
- access the content of the database as Linked Data over the Web
- create custom dumps of the database in RDF formats for loading into an RDF store
- access information in a non-RDF database using the Apache Jena API

The `dump-rdf` tool in D2RQ Platform uses D2RQ to **dump the contents of the whole database into a single RDF file**. This can be done with or without a D2RQ mapping file. If a mapping file is specified, then the tool will use it to translate the database contents to RDF. If no mapping file is specified, then the tool will use the default mapping of `generate-mapping` for the translation.

## Apache Jena

Apache Jena is a free and open source Java framework (collection of tools and Java libraries) to simplify the development of Semantic Web and Linked Data applications.

**Fuseki** tool in Apache Jena Platform provides REST-style interaction with RDF data. It is a SPARQL server that provides REST-style SPARQL HTTP Update, SPARQL Query, and SPARQL Update using the SPARQL protocol over HTTP.

The **D2RQ Engine** can be used as a component in **Apache Jena** to access a virtual RDF view on data in relational databases.

Detailed instructions on how to enable abovementioned tools and frameworks to work together are available in WP3 deliverables and SMART-FI GitHub repository.

# 3 Mapping with Use Cases

Next, we present a table to determine the contribution we expect from the SMART-FI tools to the development of the different use cases to validate the proposal, with the explanation connected with deliverable D6.2 Pilot implementation plan [4]. The functionalities offered by the Use Cases are characterized by grades in a 1 to 5 scale (1 = less important to 5 = very important) concerning the level of the importance of the development of the functionalities.

| SMART-FI basic Facilities / Functionalities | Malaga Use Case Transport | Malatya Use Case Governance | Karlshamn Use Case 1 Transport | Karlshamn Use Case 2 Energy |
|---|---|---|---|---|
| ***Data normalization:*** Homogenization of heterogeneous open data and data services. | **[Grade=4]**<br>-<br>Bus locations from Malaga Municipality as open data<br>-<br>Parking area information from Malaga Municipality as open data<br>- Bicycle stations data from Malaga Municipality as open data<br>-<br>Browse transportation options (real time and static) for Malaga city | **[Grade=4]**<br>-<br>POI browsing<br>-<br>Search for governance services<br>-<br>Gathering feedback data from users | **[Grade=4]**<br>-<br>Bus locations from Blekingetrafiken as open data<br>-<br>Static data from Blekingetrafiken as open data<br>-<br>Publish bus data from Blekingetrafken<br>-<br>Publish static data from Blekingetrafiken<br>-<br>Classify data from Blekingetrafiken<br>-<br>Bus locations on a map, web<br>-<br>Bus locations on a map, mobile app | **[Grade=3]**<br>-<br>Energy consumption as open data via Raybased<br>-<br>Static data as open data via Raybased<br>-<br>Publish real time building data from Raybased<br>-<br>Publish static building data from Raybased<br>-<br>Classify data from Raybased |
| ***Data analytics:*** Aggregation and | **[Grade=4]**<br>- | **[Grade=3]**<br>- | **[Grade=4]**<br>- | **[Grade=2]**<br>- |

| | | | | |
|---|---|---|---|---|
| development of data analytics services for predictions & recommendations. | Check weather forecast<br>-<br>Provide recommendations to the citizens<br>-<br>Provide stats graphs in web dashboard | Evaluate feedbacks<br>-<br>Recommend services for users<br>- | Bus flow assistance<br>-<br>Bus arrival prediction<br>-<br>Bus departure assistance | Energy consumption as open data via Raybased?<br>-<br>Building control as open interface via Raybased?<br>-<br>Visualization of energy consumtion, web<br>-<br>Workplace Assistant<br>-<br>Building alarms |
| ***Services orchestration:*** Development of methodologies to deploy and interoperate services. | **[Grade=3]**<br>-<br>Browse transportation options (real time and static) for Malaga city<br>-<br>Provide cultural events information | **[Grade=3]**<br>-<br>Share user feedbacks to other users<br>-<br>Open Data integration and distribution<br>-<br>Third party contributions to city services | **[Grade=3]**<br>-<br>Mashup for Blekingetrafiken<br>-<br>Bus departure assistance | **[Grade=3]**<br>-<br>Publish building control interface to Raybased installation<br>-<br>Visualization of energy consumtion, web<br>-<br>Workplace Assistant<br>-<br>Visualization of energy consumption, mobile app |

**Table 1. SMART-FI facilities matching with the Use Cases.**

# 4 Conclusions

This document describes the final architecture and design of the SMART-FI platform. Thus, the platform provides the architecture, which will integrate the requirements, functionalities and the developed services, and align a common platform for the integration of the FIWARE architecture. This supposes a modification of the previous architecture presented in D2.2.

  

# 5 References


- [1] SMART-FI Consortium. Deliverable 2.1: Requirements for the SMART-FI platform v1.
- [2] FIWARE Smart Cities. https://www.fiware.org/tag/smart-cities/
- [3] FIWARE Genering Enablers. https://catalogue.fiware.org/enablers
- [4] SMART-FI Consortium. Deliverable 6.2: Pilot implementation plan.
- FIWARE Consortium. Lambda Architecture
- http://lambda-architecture.net/}} https://catalogue.fiware.org/enablers
- [5] SMART-FI Consortium. Deliverable 2.2: Architecture and design of the SMART-FI platform.


## Annex I: Glossary Terms used in SMART-FI

https://docs.google.com/document/d/1nTYBqkbW5BYtpGw8C-KVKZ6YH3WZVxhL6R9Rl05kwPE/edit

  