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

D2.1: Requirements for the SMART-FI platform v1

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Terms and abbreviations

FIWARE	Middleware platform, driven by the European Union, for the development and global deployment of applications for Future Internet
SMART-FI	Provides services for smart city applications, creates business opportunities and improves public's quality of life using Open Data
USDL	Master schema constructed using semantic web technologies and linked data principles(Universal Service Description Language)
HADOOP	An open-source software framework used for distributed storage and processing of very large data sets
SPARQL	Semantic query language for databases, able to retrieve and manipulate data stored in Resource Description Framework (RDF) format
Enterprise Service Bus	Communication system between mutually interacting software applications in a service-oriented architecture (SOA
Generic Enabler(GE)	Software tools offered by FIWARE
CKAN	Open-source DMS (data management system) for powering data hubs and data portals
COSMOS	The code name for the Reference Implementation of the BigData Generic Enabler of FIWARE.
CYGNUS	Connector in charge of persisting certain sources of data in certain configured third-party storages, creating a historical view of such data.
ORION CONTEXT BROKER	The reference implementation of the Publish/Subscribe Context Broker GE.
MiDAS	(Multi-Attribute Indexing for Distributed Architecture Systems) MIDAS is an efficient method for indexing multi-attribute data
WP	Work Package
SMASSA	Municipal Society of Car Parks and Services
CartoDB	Software as a Service (SaaS) cloud computing platform that provides GIS and web mapping tools for display in a web browser.
MYSQL	Open-source relational database management

	system (RDBMS)

Executive Summary

In this document, we present a first version of the functional requirements of the SMART-FI platform and high level definition of the use cases to be implemented in WP6 (giving more details in Deliverable D6.1).

This deliverable is crucial in the context of the project, since it is related to the first task (T2.1 Core concepts and requirements) of WP2, which coordinates and synchronizes the different work packages in order to align objectives and common platform, avoid orphan requirements, identify limitations and achieve the objectives. In concrete, the main goal of the corresponding task, T2.1, is to collect and analyze the requirements of the case studies in order to align them with the design and development of WP3, WP4, and WP5. Also is necessary to analyze the requirements in the best way possible in order to provide the architecture, which integrates the requirements, functionalities and the developed services and tools, in the next task, T2.2, of WP2.

1 Introduction

This document supposes the starting point for creating a common understanding and it will provide a functional and technical specification, which is a formalization of the requirements elicitation for the case studies conducted by WP6 and aligned with the formalization of the technical and business requirements.

We will present the requirements collection for the 3 case studies and common understanding in order to achieve the objectives. This analysis of requirements is related to task T2.1 Core concepts and requirements, and has the input of the WP6 case studies provider by Malaga, Malatya and Karlshamn cities, providing the requirements based on these results; bearing in mind the integration with the FIWARE platform.

1.1 Structure of the Document

In Section 1 we present an introduction, describing the motivating scenarios with the corresponding stakeholders covered by our platform, as well as a high-level overview of the facilities or functionalities, and the added-value proposition. In Section 2, we will present the SMART-FI business goals and domain assumptions. Section 3 presents the requirements on open data, and Section 4 and 5 describe the initial functional and nonfunctional requirements for SMART-FI, respectively. Section 6 presents the domain description for each use case of our project, and in Section 7, we describe the ideas getting from the requirements to the exploitation plan. Then, Section 8 presents the conclusion and future work.
After this version, we will be working in the next months in a new version of the requirements (to be delivered on month M15) checking them together with our use cases.

1.2 Motivating Scenarios

Malaga Use Case
The use case scenario is for transportation diversity in the Malaga City where the user has a mobile device which monitors the GPS signal and will get information on certain routines for the user's itinerary. The "CityGO" application will be developed in the context of the project and will calculate the usual daily paths/itineraries and frequency (weekdays, hours, timing) and provides predictive information on this regular transportation habits.

Malatya Use Case
The use case scenario is based on governance services, integration and participation processes. The mobile application "MalatyaInsight" will aim to provide an open data portal based on SMART-FI and a mobile application that provides accurate and real information about several governance services, investment project and all important

facilities in Malatya, provides business industry data provided by the municipality for citizens enabling them to participate by providing comments, ratings, demand/complains related to the business and/or important places and getting personalized recommendations based on the time, location, their historical records, interested keywords for citizens and tourists in Malatya.

Karlshamn Use Cases

The first use case consists of a collection, analysis and presentation of data from traffic and other sources to enable new and improved services for the regional traffic network. This includes services for:

- Traffic and routing information for the traffic planner.
- Enhanced travel experience for the individual traveler.

- The second use case offers monitoring multisensory information for smart building management providing possibilities for the individual to automatically set different parameters in order to:
- Enable energy efficiency statistics and real time information for real estate owners.
- Provide possibilities for the individual to automatically set lightning, temperature and other parameters to fit the personal needs.

1.3 Actor Types / benefits and their Needs

The SMART-FI solution is for service developers and their users, all citizens, who can benefit from smart cities data, the SMART-FI approach will help deploy and interoperate services using open data. SMART-FI platform will provide tools to enable these smart city applications, creating business opportunities.

The platform will provide different benefits according to each profile as described below:

1.4 End users

1.4.1 For the cities, municipalities

For municipalities having a platform like SMART-FI could be an initial step in adopting a roadmap for implementing and offering these citizens' services in the cities. Also, allows them to really use the open data available, but (considering the end-user) hiding the technical complexities.

1.4.2 For the end users

Recently, the EU has been promoting the Smart City digital single market to have digital technologies to serve citizens with the goal to

have better public services, better use of resources and less impact on the environment.

With help of applications that will facilitate the daily life of citizens, SMART-FI will help to increase productivity.

Through applications that will be produced for the end users, it will be possible to collect information that can be used in city development processes.

1.4.3 Developers

The SMART-FI project will make it possible for third parties to create more innovative solutions by combining different data sets and data services provided through the SMART-FI platform. The use cases will provide new channels and open data portals to increase the type and diversity of the applications provided to citizens.

For University institutions

The use cases presented in our project are in line with the objectives and approach presented in the research interest of both Universities in the consortium, University of Málaga and Technical University of Wien.

For industrial partners

For industrial partners they could commercialize advanced services based on open data offered such as more complex analysis and elaborated, and personalized for cities. Also, could sell other services for institutions interested such as bicycle providers, electric car sharing among others.

1.5 High-level Overview of SMART-FI Functionalities

The main goal of the SMART-FI project is to provide a novel Smart City platform which will facilitate deploying, managing and interoperating Smart City services by exploiting aggregated open data from smart cities. SMART-FI uses smart cities data to provide services on top of FIWARE infrastructure. The main aim of the project and the proposed platform is to provide: i) methodologies to homogenize heterogeneous open data and data services, ii) perform analysis and aggregation of data analytics services to predict patterns and make recommendations, and iii) to facilitate services deployment.

To achieve this goal, technologies like Internet of Things, Services & Cloud Computing, Semantic-based Computing, and Big Data should be put together.

The main components (with corresponding subcomponents that will be detailed in next deliverables, specifically in D2.2) to be developed by the SMART-FI platform are the following:

1. **Data normalization in Smart Cities**
2. **Data analytics micro services for Smart Cities**
3. **Services orchestration in Smart Cities**

Based on the development over these three main components, the functionalities/facilities we will pretend to achieve with SMART-FI are the following:

1.5.1 Data normalization

Homogenization of heterogeneous open data and data services

- Linked Data technologies, and the Linked USDL language.
- Semantics to heterogeneous open data sets and data-as-a-services.
- Opening data
- Linked Sensor Data approaches will be considered to provide semantics to sensor data & real-time processing methods in Hadoop.
- Ontologies will be designed to describe the urban environment and its related data.

1.5.2 Data analytics micro services

Aggregation and development of data analytics services for predictions & recommendations

- Data processing frameworks, especially for streaming and batch analytics.
- Big Data Analytics techniques following sophisticated data processing, mining, filtering and aggregation methods.
- Streaming data processing (complex event processing) or batch processing based on workflows.
- Elastic micro services wrapping.

- Data analytics services directly consumed by citizens from SPARQL Endpoint or apps developed on top of them.

1.5.3 Service orchestration

Development of methodologies to deploy and interoperate services

- Service orchestration
- Service composition
- Automatic procedures and tools supplied by model-based software adaptation
- Lightweight model-based techniques to facilitate the interoperability among applications running.
- The integration through Enterprise Service Bus (ESB) component, by using a mediator between services, and a sequence (for holding the series of mediators).

1.6 SMART-FI Added-value Proposition

For all those who wish to improve their city and make it more closely to its citizens, SMART-FI offers a comprehensive platform that enables seamless integration and analytics of diverse city data turning it into disruptive innovation building blocks for the Smart City of the future.

Unlike other Smart City platforms, which are mainly intended to support specific domains, such as Smart Homes, Smart Health care, etc., SMART-FI offers a comprehensive and easily extendable platform, with a widespread of possible uses. To demonstrate its versatility SMART-FI is being applied to improve energy, transportation and e-Government domains in three different cities, across two continents

We provide an easy tool with the platform to host applications based on data from different sources. The platform is easy acceptable to use and maintain without deep technical knowledge and vast resources.

2 SMART-FI Business Goals and Domain Assumptions

Based on the actor needs and especially, the functionalities offered by SMART-FI platform, in the current section, we identify the business goals (Section 2.1), and the domain assumptions (Section 2.2) of SMART-FI platform. Then, in order to obtain a platform that accomplishes the Business Goals, we will identify (Sections 3 and 4) a finer-grained functional and nonfunctional requirements.

2.1 Business Goals

Table 1 Business goals table 1

Field	Description
Unique ID	BG01
Short name	*Data normalization*
Type	Business goal
Description	One of the main goals of the SMART-FI platform is to homogenize of heterogeneous open data and data services. Expected benefit: in order to address this facility, the platform will analyze and provide: Linked Data technologies, and the Linked USDL language, Semantics to heterogeneous open data sets and data-as-a-services and opening data, Linked Sensor Data approaches to provide semantics to sensor data & real-time processing methods in Hadoop, and Ontologies to describe the urban environment and its related data.
Supporting material	Internal facility

Table 2 Business goals table 2

Field	Description
Unique ID	BG02
Short name	*Data analytics*
Type	Business goal

Description	SMART-FI will support the development, deployment and runtime operation of data analytics services for predictions & recommendations. Expected benefit: in order to perform this facility, the platform will use and develop: data processing frameworks, Big Data Analytics techniques with data processing, mining, filtering and aggregation methods, Elastic micro services wrapping, and several pilot Data analytics services directly consumed by users from SPARQL Endpoint or apps developed on top of them.
Supporting material	Internal facility

Table 3 Business goals table 3

Field	Description
Unique ID	BG03
Short name	*Service orchestration*
Type	Business goal
Description	SMART-FI platform will support on the development of methodologies to deploy and interoperate services. Expected benefit: in order to address this facility, the main functionalities to get this facility, are the following: Service orchestration and composition, Automatic procedures and tools supplied by model-based software adaptation, Lightweight model-based techniques to facilitate the interoperability among applications running, and The integration through Enterprise Service Bus (ESB) component, by using a mediator between services, and a sequence (for holding the series of mediators).
Supporting material	Internal facility

2.2 Domain Assumptions

Except for the previously defined SMART-FI system requirements, we further make some assumption towards covering the required actor needs.

Table 4 Domains assumption table 1

Field	Description
Unique ID	DA1
Short name	*Open Data in FIWARE*
Type	Business goal
Description	We assume the data used by our platform is open data, in different formats supported by the FIWARE ecosystem.
Supporting material	--

Table 5 Domains assumption table 2

Field	Description
Unique ID	DA2
Short name	*Availability of FIWARE GE*
Type	Business goal
Description	We assume the FIWARE GE used for SMART-FI platform (CKAN, COSMOS, IDM, Cygnus and Orion Context Broker) will be available without any restriction to be exploited.
Supporting material	External tools or components

Table 6 Domains assumption table 3

Field	Description
Unique ID	DA3
Short name	*Security Assumption*
Type	Business goal
Description	We expect the data coming from cities maintain security and privacy politics.

Supporting material	--

Table 7 Domains assumption table 4

Field	Description
Unique ID	DA4
Short name	*Open Data in FIWARE*
Type	Business goal
Description	We assume the data used by our platform is open data, in different formats supported by the FIWARE ecosystem.
Supporting material	--

3 Requirements on SMART-FI Open Data

In this section, we present the main requirements at the open data level, considering the data is the important key in our platform. We relate these requirements with the business goals previously defined, and more details will be given in next sections, according the functional requirements in connection with each open data requirement.

Table 8 Open data requirements table 1

Field	Description
Unique ID	DR1
Short name	*Data extracting and storing*
Type	Data requirement
Description	The physical infrastructure or public services could include this kind of data. For Malaga, parking places, transportation routes, buses, parking, will be presented via services provided by Malaga Municipality. This data will be provided in a format that can be used by developers.

	This data is going to be stored in the FIWARE platform, Open Data portal
Business Goal	BG1

Table 9 Open data requirements table 2

Field	Description
Unique ID	DR2
Short name	*Data normalization (normalized data stream)*
Type	Data requirement
Description	The Data normalization (component) takes the real data coming from the physical part (open datasets, IoT, databases) that is going to be stored in FIWARE, and produce the normalized data. Incorporating data handling, processing, and presentation.
Business Goal	BG1

Table 10 Open data requirements table 3

Field	Description
Unique ID	DR3
Short name	*Data analytics (analytics data stream)*
Type	Data requirement
Description	Our platform will provide a novel model for real-time data analytics, which treats the data streams as first class citizens. In general, there is one-to-one mapping between MiDAS and data streams.
Business	BG2

Goal	

Table 11 Open data requirements table 4

Field	Description
Unique ID	DR4
Short name	*Data Stream and services*
Type	Data requirement
Description	SMART-FI platform provides methods and tools for deploying and integrating existing or new services and applications, for producing more advanced applications with the composition and orchestration of simpler ones (mashups of services). In order to provide assurance, SMART-FI also aims to create a marketplace that will be generated or enriched considering the Store in FIWARE and third-party applications giving value to the public data.
Business Goal	BG3

Table 12 Open data requirements table 5

Field	Description
Unique ID	DR5
Short name	*Data at Application level*
Type	Data requirement
Description	SMART-FI platform will exploit the normalized and analyzed data to be used in different applications. In the case of SMART-FI, we validate our platform in three different pilots: Malaga, Malatya and Karlshamn.
Business Goal	BG1, BG2, BG3

For Malaga City, parking places, transportation routes, buses, parking, will be presented via services provided by Malaga Municipality. This data will be provided in a data format that can be used by developers.

Sensors, parking info, bicycle and bus (route) information is being taken from official Malaga city web services.

These datasets are being published by these actors:

- Malaga City CKAN Portal
- Spanish Meteorological Agency
- EMT Malaga and SMASSA
- Portal Datos Abiertos(http://datosabiertos.malaga.eu/)

All the dynamic datasets are being exposed in these 2 platforms and is being updated for each specific time span.

One can list the details of the datasets that are being provided to the 3rd party application user:

- Parking places: Provide the free. occupied and total capacity of the parking place
- Bus routes: Provide the bus route, number, address and the line number of the bus for a specific station
- Bicycles: Provide the free. occupied and total capacity of the specific bicycle station
- Weather forecasts: Display the daily weather forecasts and provide the user the best route and transportation type information

CityGO application will keep the user itineraries anonymously for better recommendations and provide City a big dataset at the end which is entirely open. Application developers or City Hall officials can analyze this kind of data and come up with practical solutions, alternatives for the transportation case in Malaga.

Malatya Municipality and SAMPAS will provide data infrastructure and services required for SMART-FI.There are several open data sets prepared related to POI's, businesses retail products, comments for businesses, demands, complains to be published.

These datasets are being published by these actors:

- SMART-FI Data Management Platform
- Malatya Open Data Portal
- Malatya Insight Mobile Application for Citizens
- Spatial Citizen Insight Analysis Extension to existing GIS Infrastructure

By MalatyaInsight, citizens will be able to get accurate and real information about several governance services, investment project and all important facilities in Malatya, gets business industry data provided by the municipality and will be able to participate by providing comments, ratings, demand/complains related to the business and/or important place and gets personalized recommendation based on the time, location, their historical records, interested keywords using semantic search capabilities using their mobile phones and the web interface of the Malatya Open Data Portal.

Important places in Malatya

Important places in Malatya such as districts, touristic places, museums, hospitals, schools, pharmacies, religious facilities, recreation areas, parks, education zones, cultural zones, government buildings, transportation routes, accommodation, business districts etc. will be presented via services provided by Malatya Metropolitan Municipality. This data will be provided in a format that can be used by developers. Also real-time pharmacies on duty information for that day will be provided through data services. These data sets will be provided through existing GIS City Guide infrastructure. http://rehber.malatya.bel.tr:8080/EKentRehberi/

Retail industry information

For all business Services for all businesses in Malatya including retail products and services of these businesses (restaurants, shops, entertainment places, accommodation, etc.) will be provided. Users will be able to make selections amongst these businesses using provided services.

Information received from citizens /mobiles (scoring, comment, demand, complaint)

Inputs of users such as scorings, comments, and feedbacks for important places will be recorded via MalatyaInsight application in a way that is accessible to other users. In addition, complaints and demands of citizens will be reported to Municipality directly.

Historical real estate data and dynamic data from an advanced building automation system will be published for the purpose of analyzing, visualizing, and improving the conditions for reducing energy consumption, improve energy efficiency and increase cost savings. The system (Raybased, http://www.raybased.com/) makes it possible to monitor, control and optimize all electrical functions in a

building such as temperature, ventilation, and lighting and security systems.

Data will be taken from the Raybased Local Server via an open API. Sensors and devices will be read and updated.

The public transport company Blekingetrafiken (http://www.blekingetrafiken.se/) will make certain data available for the project like real time data from vehicles and timetables. The data set providing live data from the vehicles is taken from the Vehicle Tracking System (Consat). The other data sets, such as time tables, route information and so on, is taken from the Traffic Planning System (Rebus).

All the data will be provided in a format that can be used by developers.

4 SMART-FI Functional Requirements

In this section, we specify the requirements on the functionalities offered by the core SMART-FI components: Data normalization, data analytics and service orchestration. In other words, we specify the requirements on the required modus operandi for these components.

4.1 Real data – FIWARE

Table 13 Functional requirements table 1

Field	Description
Unique ID	FR-RD1
Short name	*Designing an Application*
Type	Functional requirement
Description	Malaga Use Case: – A calculation based on the daily itineraries and regular transportations habits provides predictive information on people's city journeys. – The user gets alerts with recommendations on what's the best itinerary based on real time information, such as weather conditions (e.g. if it will rain don't rent a bike), or choosing a bus, or using

	the car. Malatya Use Case : – Accessing open data for important places, projects and business directory. – Get information about governance services, investment projects, all important facilities (districts, touristic places, on duty pharmacies, museums, education zones, religious facilities, cultural zones, government building, health zones, transportation routes, accommodation, business districts and green areas). – Getting information about business (e.g. restaurants, shops, accommodation) – Providing feedbacks, comments, ratings and demands/complaints related with all location. – Getting personalized recommendations based on time, location, historical records and interested keywords. Karlshamn Use Case: – Traffic and routing information for the traffic planner. – Enhanced travel experience for the individual traveler. – Enable energy efficiency statistics and real time information for real estate owners. – Provide possibilities for the individual to automatically set lightning, temperature and other parameters to fit the personal needs.
Supporting material	-

Table 14 Functional requirements table 2

Field	Description
Unique ID	FR-RD2
Short name	*Recommendations*
Type	Functional requirement
Description	All 3 use cases provides recommendations based on the user inputs on a time span

	Malaga UC: Suggests user the optimum path and the transportation type based on the daily weather condition Malatya UC: Creates personalized recommendations based on time, location, historical records and interested keywords. Karlshamn UC: Traffic/route planning for a citizen and automatically taking care of the smart house applications
Supporting material	-Orion Context Broker, Cygnus, CKAN

Table 15 Functional requirements table 3

Field	Description
Unique ID	FR-RD3
Short name	*Handling Context Data in Orion Context Broker*
Type	Functional requirement
Description	Orion Context Broker (OCB) is responsible for managing flow of the homogenized data between Recommendation Engines and the CKAN/COSMOS platforms through Cygnus connector. OCB is responsible for exposing the latest data of an any entity that was registered before.
Supporting material	-Cygnus

Table 16 Functional requirements table 4

Field	Description
Unique ID	FR-RD4
Short name	*Big Data Analysis on COSMOS*
Type	Functional requirement

Description	COSMOS collects the same data with CKAN and saves in its internal Hadoop file system. By implementing a 3rd party application on COSMOS servers, it enables to build applications which are capable of analyzing big data that is populated by applications built for 3 use cases.
Supporting material	-

Table 17 Functional requirements table 5

Field	Description
Unique ID	FR-RD5
Short name	*Collecting information in CKAN portal*
Type	Functional requirement
Description	CKAN receives all the homogenized data through Cygnus and exposes these data with its internal API's for 3rd party developers CKAN is capable of visualizing these datasets through its portal
Supporting material	-CKAN

Table 18 Functional requirements table 6

Field	Description
Unique ID	FR-RD6
Short name	*Cygnus Gateway Application*
Type	Functional requirement
Description	Cygnus is the gateway component between Orion Context Broker and 3rd party applications like CKAN and HDFS platforms (COSMOS GE), CartoDB, MySQL etc.. It´s main role is to receive data from context broker and transmits them to the FIWARE platform

Supporting material	-Cygnus

Table 19 Functional requirements table 7

Field	Description
Unique ID	FR-RD7
Short name	*Real Time Data*
Type	Functional requirement
Description	The SMART-FI platform needs to work with the real time data that is going to be gathered, normalized, analyzed, composed and used by each smart city application. In our pilot validation, for example: - Tracking of vehicle location and gathering sensor data in smart houses (Karlshamn Use Case) - Taking the bicycle, bus and vehicle stations information (Malaga Use Case) - Important places information and integration with the e-government services (Malatya Use Case)
Supporting material	FIWARE Orion Context Broker

5 Data normalization

In order to efficiently create new public services, the vast city data sets should be homogenized and normalized to create urban ontologies where data services will based on. For this purpose, SMART-FI platform uses Linked Data technologies and the Linked USDL language, in order to give structure and semantics to urban environment and smart city related heterogeneous open data sets and data-as-a-services, generating SPARQL endpoints. This will enable the development of third-party applications taking advantage of data increasing their exploitation and advanced use by citizens.

Data Characterization provides a concise and succinct summarization of the given collection of data. Generally SMART-FI considers cities data streams including Open Data Portals, Open Data Sets and Services, Internet of Things (IoT) and sensor data sets and silos of

legacy databases as data input streams. The main components of the Data Normalization layer include: i) Data Handling, ii) Data Processing and iii) Data Presentation components.

Table 20 Functional requirements for data normalization table 1

Field	Description
Unique ID	FR – DN1
Short name	*Data handling*
Type	Functional requirement
Description	Data Handling layer will receive heterogeneous data sets via the Input Handler and apply pre-processing to produce a list of data sets with access rules and a schema. The data will reside in semantic data stores. During the data processing period, Metadata processing, SPARQL based Query processing and Linked Open and Linked Sensor Data processing techniques will be applied using several different Urban Ontologies to create Urban Environment Ontology.
Supporting material	

Table 21 Functional requirements for data normalization table 2

Field	Description
Unique ID	FR – DN2
Short name	*Data processing*
Type	Functional requirement
Description	Data processing layer will homogenize the data using urban ontology definitions and will provide a uniform data format. SMART-FI Data Normalization components will ease the discovery; the standards based normalized data sharing and reduce redundancy by also adding value to build ecosystems around cities data and contents. This component also includes Linked Data processing capabilities which are one of the best means for

	publishing and interlinking structured data for access by both humans and machines via the use of the RDF (Resource Description Framework) family of standards for data interchange and SPARQL for query. Here SPARQL- based solutions will be used to facilitate the discovery compared to conventional search mechanisms.
Supporting material	

Table 22 Functional requirements for data normalization table 3

Field	Description
Unique ID	FR – DN3
Short name	*Data presentation*
Type	Functional requirement
Description	Data Presentation layer will provide Data Services to both Analytics components and Service Orchestration components.
Supporting material	

Table 23 Functional requirements for data normalization table 4

Field	Description
Unique ID	FR – DN4
Short name	*Normalized data stream*
Type	Functional requirement
Description	Heterogeneous data sets will be managed in the Data normalization component. It generates data sets with access rules and a normalized schema, based on urban ontologies, which are stored in semantic data store. Next, these normalized data streams are used by the Data analytics micro services and Service orchestration components.

Supporting material	

5.1 Data analytics

Table 24 Functional requirements for data analytics table 1

Field	Description
Unique ID	FR-DA1
Short name	*Real time data analytics model*
Type	Functional requirement
Description	The SMART-FI platform needs to provide models and components that allow for developing and managing value-added data analytic services in Smart Cities. It will provide advanced models for programming generic, elastic data analytic services, in order to facilitate analyzing aggregated data for predictions and recommendations. The aforementioned data analytics models will enable novel paradigm for developing real-time data analytics services and Smart City applications, based on data streams as "first class citizens".
Supporting material	Data Handling, Normalized Data Streams

Table 25 Functional requirements for data analytics table 2

Field	Description
Unique ID	FR-DA2
Short name	*Batch analytics*
Type	Functional requirement
Description	The SMART-FI platform needs to support blending of the real-time (stream) data analytics with batch (offline) data processing. To this end, SMART-FI

	platform will implement supporting facilities, based on state-of-the-art data analytics Lambda architecture. These facilities need to incorporate batch processing techniques and frameworks such as MapReduce.
Supporting material	FIWARE components

Table 26 Functional requirements for data analytics table 3

Field	Description
Unique ID	FR-DA3
Short name	*Fusion & serving*
Type	Functional requirement
Description	In order to enable uniform and seamless interaction with data analytics services, the SMART-FI platform needs to provide fusion functions. Such functions will be used to complement the aforementioned services by facilitating combining partial aggregates (FR-DA2) with real-time delta views (FR-DA1) and serve the results proactively or on-demand, enabling push/pull based interaction.
Supporting material	

5.2 Service orchestration

Table 27 Functional requirements service orchestration table 1

Field	Description
Unique ID	FR- SO1
Short name	*Service handling*
Type	Functional requirement
Description	Service Handling is responsible for handling output

	data stream and services that may come from normalized data services or data analytic services. It comprises different characteristics of Service Discovery, Service Composition and Service Mashup delivery.
Supporting material	

Table 28 Functional requirements service orchestration table 2

Field	Description
Unique ID	FR- SO2
Short name	*Service management*
Type	Functional requirement
Description	Service Management is responsible for the mediation of services, business rules and Enterprise Service Bus (ESB) management. The Mediation Service is a middleware component responsible for providing interoperability among different communication protocols and among different data models.
Supporting material	

Table 29 Functional requirements service orchestration table 3

Field	Description
Unique ID	FR- SO3
Short name	*Service delivery*
Type	Functional requirement
Description	For the effective Service Delivery all services all combined in the Registry and Repository. Composed and integrated services are delivered to the application layer through the Marketplace component.

Supporting material	

Smart City application

Table 30 Functional requirements for application table 1

Field	Description
Unique ID	FR-SCA1
Short name	*Using normalized SMART-FI data*
Type	Functional requirement
Description	The SMART-FI platform must support or provide: - SMART-FI ontology - Open data from smart cities
Supporting material	FR-DN1-4

Table 31 Functional requirements for application table 2

Field	Description
Unique ID	FR-SCA2
Short name	*Using SMART-FI analytics*
Type	Functional requirement
Description	The SMART-FI platform must support or provide: - Creating, using and managing analytics services
Supporting material	

Table 32 Functional requirements for application table 3

Field	Description

Unique ID	FR-SCA3
Short name	*Using SMART-FI orchestration services*
Type	Functional requirement
Description	The SMART-FI platform must support or provide: - Deploying, managing and using services related to published open data from smart cities
Supporting material	FR-SO1-3

Table 33 Functional requirements for application table 4

Field	Description
Unique ID	FR-SCA4
Short name	*Managing SMART-FI applications*
Type	Functional requirement
Description	The SMART-FI platform must support or provide: - SMART-FI applications life cycle management (deploy, start, stop, update, delete) - Monitoring - Maintenance
Supporting material	

6 SMART-FI Non-Functional Requirements

In general as non-functional requirements, we need the SMART-FI platform covers:

- Technical
- Ease of use
- Support
- Maintainability

6.1 Technical

The platform and development environment needs to be competitive towards other possible solutions for the customer to build their applications. As we could expect a lot of live data, the platform need to support this in a stable and structured way. There should, when possible, be functions to validate the quality of the data in use.

6.2 Ease of use

Many of the possible customers are cities and municipalities without sufficient resources and competence to spend a lot of effort in building and maintaining an application. Porting or creating new applications must be simple with a clear process how to work.

6.3 Support

We need to be able to describe the level of support the project and its continuation is willing and capable to provide and at what cost.

6.4 Maintainability

In a public environment it is most certain the customer expect the platform to be stable and support for at least 5 years, possibly longer.

6.5 Malatya use case

Table 34 Non-functional requirements table 1

Field	Description
Unique ID	NFR1
Short name	*Look and feel*
Type	Non-Functional requirement
Description	For best usage of applications an understandable user interface with good looking is important. For this purpose visual design of applications must be attractive.
Supporting material	-

Table 35 Non-functional requirements table 2

Field	Description
Unique ID	NFR2
Short name	*Usability Requirements*
Type	Non-Functional requirement
Description	Usage of applications must be simple because users are citizens for this type of application. Easy usage of the applications can increase user count.
Supporting material	-

Table 36 Non-functional requirements table 3

Field	Description
Unique ID	NFR3
Short name	*Performance Requirements*
Type	Non-Functional requirement
Description	Applications will run over services with using GSM operator's internet services. This can affect application performance when getting data from servers. For increasing performance, services that provided for applications must be tiny data packets and this is the one side of performance issues. In the other hand client side application must be designed and developed for best performance.
Supporting material	-

Table 37 Non-functional requirements table 4

Field	Description

Unique ID	NFR4
Short name	*Operational Requirements*
Type	Non-Functional requirement
Description	Application functions must meet the operations for defined before pilot needs.
Supporting material	-

Table 38 Non-functional requirements table 5

Field	Description
Unique ID	NFR5
Short name	*Maintainability Requirements*
Type	Non-Functional requirement
Description	Maintain needs for applications and platforms developed for SMART-FI must be defined before production environment setup. There will be service providers, applications and virtual machines for running up provider which means maintainability must be defined for every environment separately.
Supporting material	-

Table 39 Non-functional requirements table 6

Field	Description
Unique ID	NFR6
Short name	*Security Requirements*

Type	Non-Functional requirement
Description	Data security must be ensured including both security of information and information systems. The platform must support secure encryption mechanism. In addition, personal data must be anonymized and encrypted in case of collection and processing of personal data.
Supporting material	-

Table 40 Non-functional requirements table 7

Field	Description
Unique ID	NFR7
Short name	*Legal requirements*
Type	Non-Functional requirement
Description	Regulations and directives on data security and protection of EU/other countries in which the platform is delivered must be taken into consideration while deploying services.
Supporting material	-

Table 41 Non-functional requirements table 8

Field	Description
Unique ID	NFR8
Short name	*Usability*
Type	Non-Functional requirement
Descriptio	The SMART-FI platform need to be:

n	- Easily understood - Supported by comprehensive, appropriate, well-structured user documentation - Straightforward to use - Easy to learn how to use its functions
Supporting material	-

Table 42 Non-functional requirements table 9

Field	Description
Unique ID	NFR9
Short name	*Sustainability and Maintainability*
Type	Non-Functional requirement
Description	- Project/software identity should be clear and unique - Easy to see who owns the project/software - Easy to understand how the platform is run and the development of the software managed - Evidence of current/future community - Easy to test - Evidence of current/future developer support - Easy to understand at the source level - Easy to contribute to - Evidence of current/future development and support
Supporting material	-

7 SMART-FI Domain Description

Domains of all the use cases

7.1 Transportation

The use case scenario is for **transportation diversity** in the Malaga City, that the terminal (a mobile device) which monitors the GPS signal and will get information on certain routines for the user's itinerary.

CityGO calculates the usual daily paths/itineraries and frequency (weekdays, hours, timing) and provides predictive information on this regular transportation habits.

What we understand for "transportation diversity" (also called as Option Value, Transport Choice or Balanced Transportation) refers to the quantity and quality of transport services available in a particular situation for example a particular location and time, taking into account a user's needs and abilities.

Moreover, it includes diversity of modes such as particularly modes suitable for being used by people who are physically, economically or socially disadvantaged, or including prices for example such as various vehicle and vehicle rental prices, and in the case of Malaga use case the services such as public transit, taxi, and delivery services.

The data information about itineraries is crossed with open data from the Malaga City, and/or from sensors or devices; therefore the application can know what the best transportation type option and at the same time is able to make recommendations.

7.2 Malatya focus

The aim of the use case is have a better understanding of citizens' needs and priorities while providing high quality, transparent and responsive services for citizens and an opportunity for developers to develop innovative applications.

The use case scenario is based on governance services, integration and participation processes. The mobile application "MalatyaInsight" will aim to provide an open data portal based on SMART-FI and a mobile application that provides accurate and real information about several governance services, investment project and all important facilities in Malatya, provides business industry data provided by the municipality for citizens enabling them to participate by providing comments, ratings, demand/complains related to the business and/or important places and getting personalized recommendations based on the time, location, their historical records, interested keywords for citizens and tourists in Malatya.

7.3 The Use Cases for Karlshamn: Energy and Public transport

The Karlshamn case study includes two use cases;

- the energy use case, based on data from a local installation of a new wireless system for advanced building automation on site at NetPort.
- the public transport use case, based on data provided by the public transport company Blekingetrafiken.
- One main objective of the Karlshamn use cases is to create an efficient process and strategy for small municipalities like Karlshamn to improve their ability to provide and expose open data to be used by smart services and applications.

7.4 Energy Use Case

The aim of the user case is to illustrate how publishing historical and dynamic open data from the real estate and the energy field makes it easier to analyze, visualize, and improve the conditions for reducing energy consumption, improve energy efficiency and increase cost savings. Information, such as temperature, motion, light, sound, etc. can be recorded by system sensors. The information can be coordinated and evaluated by the system, which then can be addressed in an intelligent, optimum manner; in terms of both economics and function. More efficient operation and preventive maintenance gives the right information to provide cost and energy savings actions.

In this scenario a new wireless system for advanced building automation will be installed and operated on site at NetPort.

7.5 Public transport Use Case

The aim of the use case is to improve the quality of public transport by providing real and accurate information to the citizens and increasing the quality of data to the public transport company to support their ability to improve their services. By combining new open data sets personalized services can be created based on real-time location of vehicles and citizens. Even problems related to delays and lack of information can be reduced. The citizens and public transport company will be able to know exactly where the busses are at any time.

8 From the Requirements to the Exploitation Plan

The platform needs to be flexible enough to allow changes when tested towards the real case implementation in the use cases.

A part of input to the exploitation plan is also to describe the platform from the perspectives mentioned in section 2; meaning technical, ease of use, support and maintainability.

To reach a level on the platform possible and compelling enough to use for cities and municipalities to consider in live applications we need to describe the alternatives for exploitation. Will we provide a "package" including documentation offered to anyone to use at own risk and effort or will we provide support from a post project competence resource. To what level will the platform be self-contained in structure and documentation?

We propose to homogenize heterogeneous open data and data services and give these a specific structure thought the application of semantic logic onto heterogeneous open data sets and data-as-a-services to solve current challenges that hinder city data analytics solutions due of the lack of common data formats.

Within the SMART-FI platform we propose to use certain methods to apply semantic classification for the open data that's offered by these three cities to capture, store, and process and analyze a large amount of open data the city, generated by several sources, to transform the data into useful knowledge through the application of data analytics services. Open data will be managed for providing outcomes for suggesting recommendations and predictions to citizens. Thus, the open data from Malaga, Karlshamn and Malatya will be processed, analyzed, ranked, filtered and be ready to be aggregated and will be changed and presented in a meaningful format to achieve specific business objectives: to allow citizens to know the availability and current service conditions of public transport, parking, energy usage or public services via smartphones and other mobile devices.

With the growing number of city sensors, cameras etc. the massive number of urban smart devices are constantly producing multiple data gathered by cities/municipalities a scalable infrastructure like SMART-FI is need it to make useful sense out of this data, transformed into real-time citizens benefits.

Cities need to manage volume, variety, velocity, and veracity of data in urban smart devices and SMART-FI offers the solution to this limitation.

Developers need to know how to use, deploy and interoperate services and citizens need to have better services, as there's an insufficient support to foster it, thus we propose a holistic ecosystem with the main aim of improving the management of urban problems and allowing the three cities to offer real-time solutions to their citizens for current urban challenges such as traffic, energy usage and community services, among others.

We aim to make the open data from smart cities ready to be used but hiding the technical complexities. The SMART-FI platform roadmap we propose is a robust platform ready to be integrated in urban ecosystem used by public administrations. Understanding that the full capabilities of these architectures will be reached in a near future, we propose our roadmap for smart cities. Benefits in the long term are ensured, as we propose to increase citizen engagement, increase citizen participation in decision making process within smart cities. Municipalities will provide better public services and all that together will foster strengthening the economic power of the city by fostering the development of new and innovative services and products to its citizens.

9 Conclusion

In this document we have described the first version of the requirements for SMART-FI platform, considering the functional and technical specification, and the integration with FIWARE. These requirements will be aligned with the three project use cases. To do this, we have presented the business goals and domains for the SMART-FI platform, the functional and non-functional requirements, and the domain descriptions according to the three pilots to be studied. Also, an explanation about how to achieve the exploitation plan from the requirements has been described. As aforementioned, this first version will be revised in the next months, according the coordination with the architecture.

10 References

- SMART-FI ERANET Proposal 2016.
- Project website: http://www.smart-fi.eu/
- SMART-FI: Exploiting Open IoT Data from Smart Cities in the Future Internet Society. Stefan Nastic, Javier Cubo, Malena Donato, Schahram Dustdar, Orjan Guthu. Mats Jonsson, Omer Ozdemir, Ernesto Pimentel, M. Serdar Yumlu, 2017. Springer Series, Internet of Things Technology, Communication and Computing.
- Rafael Achaerandio, Roberta Bigliani, José Curto, Gaia Gallotti, 2012. Smart Cities Analysis in Spain 2012, The Smart Journey. IDC Smart Cities Index Ranking http://www.portalidc.com/resources/white_papers/IDC_Smart_City_Analysis_Spain_EN.pdf
- Carlos Canal, Pascal Poizat, and Gwen Salaün, 2008. Model-based adaptation of behavioral mismatching components. IEEE Transactions on Software Engineering, 34(4):546–563, 2008.
- Comisión Europea, 2015. Una Estrategia para el Mercado Único Digital de Europa: http://eur-lex.europa.eu/legal-content/ES/TXT/HTML/?uri=CELEX:52015DC0192&from=ES https://ec.europa.eu/digital-single-market/en/smart-cities
- EU Internet Handbook – Keep it simple http://ec.europa.eu/ipg/content/tips/volume_en.htm
- SMART-FI Project Website http://www.smart-fi.eu/ (2016).
- VTPI, Online TDM Encyclopedia (2015), VTPI, retrieved June 14, 2016, chapters:
- "Transport Options" www.vtpi.org/tdm/tdm65.htm and http://www.vtpi.org/tca/tca0509.pdf
- "Transport Resilience" www.vtpi.org/tdm/tdm88.htm.
- "Basic Mobility and Accessibility" www.vtpi.org/tdm/tdm103.htm
- SmartCity World ExpoCongress (CityGO Demo)
    - https://www.fiware.org/2016/11/04/fiware-at-the-scewc-2016/
- SMART-FI ATOS Website
- http://es.atos.net/es-es/home/quienes-somos/filosofia-de-empresa-e-innovacion/research-and-innovation/noticias-de-innovacion/smart-fi.html