



*"Linked Open Apps Ecosystem to open up innovation in smart cities"*

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### **Summary**

The success of the iCity project is strongly linked to its ability to identify, reach and engage the potential group of users of the iCity platform: developers, entrepreneurs, social innovators, SMEs, Big Companies etc. All of them will act as developers creating an ecosystem of services of public interest which takes advantage of the opened public infrastructures in the participant cities.

Success depends on the lessons learned during all this time since the beginning of the project until March 2015 and the ability to identify and interpret them.

And finally also depends on the ability to evolve and adapt the original platform design and concept to the identified needs and to the new and trending technologies.

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## ABBREVIATIONS AND ACRONYMS

Acronym	Description
App	Application
PU	Public
DoW	Document of Work
SMEs	Small and Medium Enterprises
API	Application Programming Interface
IoT	Internet of Things
NoE	Net of Everything
W3C	World Wide Web Consortium
SOA	Service Oriented Architecture
RETE	Retevision
IMI	Instituto Municipal de Informatica

# 1 Introduction

## 1.1 Resume

iCity Project main goal is to take functionalities of cities' information systems and make them available so third parties can use them. Of course, one of the most important functionalities to open is the access to data, which is nothing new indeed. Open data portals have existed for quite a while now and the 'read data' functions are widely spread worldwide.

As a result, iCity is not adding anything new to open data standards and policies. It would not make sense to try to modify an existing de facto standard.

On the other hand, cities are not worried about where their 'open data' go. As a matter of fact, if they are worried about something, it is about why their 'open data' is not being used as much as they would like.

Therefore, how can iCity help cities to have their 'open data' more used? How can iCity make 'open data' more interesting to developers? The answer is related to the combination of data from different cities, and also to the combination of that old 'read data' functions with other brand new functions like 'insert complaint', which classic open data portals cannot provide.

This document should clarify this answer, and we believe the best way to do so is to review the iCity Platform architecture. Not the current architecture, which has been widely described in deliverable 4.11, but the architecture we understand will be the logical evolution of the platform once the project is finished and iCity must become an operational –we should also call it 'commercial'– platform.

## 1.2 Scope

Since the beginning of this project the idea of the iCity Platform has evolved from a fairly vague concept that accumulated along the project itself and with the natural evolution of information systems seated in the market experiences and technological trends of the moment have shaped an objective model of what services of public interest platform should be.

So all this time we have seen how the needs of systems open to the public information have evolved as technology has invaded our quotidian lives, and how this has been shaping the characteristics of services of public interest.

The iCity Project is aimed at fostering the development of services of public interest to build 'Smart Cities' in the urban space through third parties (developers, small and medium-sized enterprises, entrepreneurs...)

Therefore, if the form and nature of services has evolved significantly is logical that the design of the iCity Platform should be reviewed to ensure that it is able to support the implementation of these new public interest services.

The scope of this document is to define the functional architecture for the future platform. These involves identifying each block of functionalities and describe it without going into the design of possible technical implementations.

### 1.3 Contents

Below is a guide to the contents of this document:

- **The evolution.** Presents all aspects, considerations and trends that have marked the evolution of information systems throughout the life of iCity Project, and as they all have contributed to the new design for the iCity Platform.
- **Functional architecture for new platform.** Presents a detailed description for the new design for the iCity Platform.

## 2 The evolution

As already mentioned, the technological evolution, the experiences along the own iCity Project and associated lessons learned, and new needs of citizens have changed the topology of services of public interest, and this is what has made evolve while the iCity Platform concept.

We can identify different kinds of evolutions:

1. Normalization and standardization in the mechanisms to offer open data to citizenship.
2. Interactivity for services available for citizenship.
3. The need, and the value, for unstructured social data collectors provided by citizenship smart devices.

### 2.1 Normalization and standardization of open data

The tendency of the public administrations to provide information to citizens has been consolidated and in recent years, even to be an instrument of government to implement its policies and a mechanism associated with complying with such laws.

Access to public administrations data ensures transparency to governments because citizens have access to data coming directly from official sources. Efficiency and equality of opportunity is promoted as citizens and businesses can create services that meet their needs in collaboration with the public administrations and everyone can access data on equal terms.

In parallel, open data portals have been consolidating and standardizing and W3C finally created a set of best practices. W3C has done a publishing guide with tips on how to publish data owned by governments. The guidelines for the publication of data, both technical and planning have been used in the preparation of many open data catalogs. Also there are other initiatives that create good practice manuals or awareness about open data such as those provided by the Sunlight Foundation or the Open Knowledge Foundation.

Additionally, some countries are developing their own regulations in reference to the portals open data. For instance, in Spain, the “UNE 178301 Smart Cities. Open Data”, is the first standard that establishes a set of requirements for reusing Open Data processed or held by the public sector in the scope of smart cities.

### 2.2 Interactivity for services available for citizenship

Open data is a powerful feature providing data sets of information available in the city. The evolution of the Open Data will be based on read/write functionalities.

In the future, public administrations will stop publishing any set of specific data through an Ms Excel or similar basic formats. Any data will be published through a set of functions that can extract the exact specific data needed to develop a service or to make a simple query. For example, through the call of a function will be possible to obtain the nearest 10 cycle's stations nearest to the customer and then download all this data through a CSV file.

Therefore, it will not take longer until the data will be, not only, read data but also read write data, allowing 3<sup>rd</sup> parties to interact with the city data through API's queries.

### 2.3 The need for unstructured social data collectors

Over time the smart devices are increasingly prevalent in our society, and citizens generate more and more diverse information that can be of great interest. For instance, the mere presence of our smartphones in the different rooms of a building can be vital information to those responsible for the queuing of a given establishment, as could be for example the case of a museum.

Another important aspect is that smart devices can also generate highly relevant information from sensors that embody.

And last but not least, the vast information generated by social networks can be a key contribution to the design and implementation of services of public interest for both private entities and public administrations. Technology trends underline the importance of data, and in particular the importance of data generated by citizens. The new *data science* is a new doctrine that will allow us to draw aside the true value information and secondly predict future events.

In a general sense, we can resume the evolution of the information systems related to the current iCity Platform in the next figure:

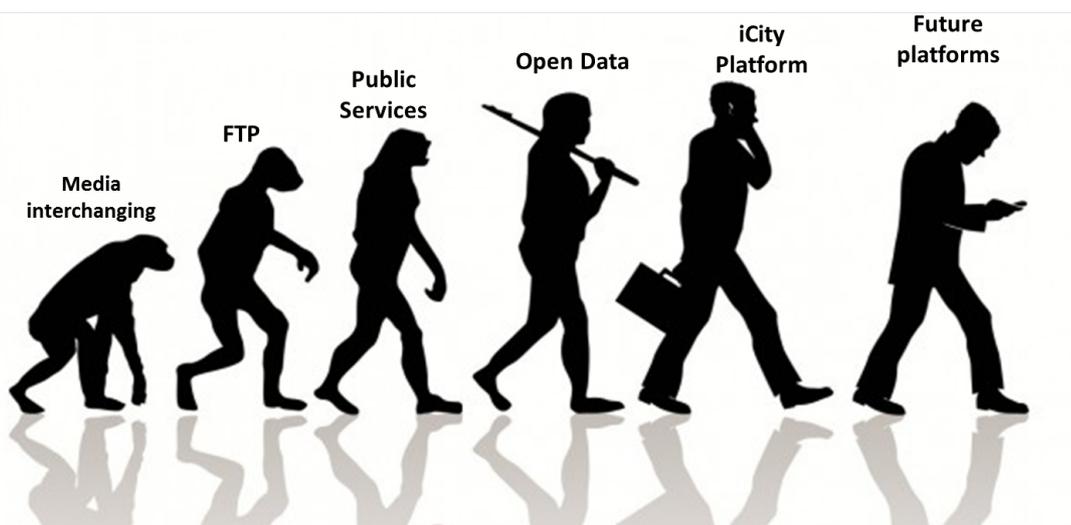


Figure 1 Information systems evolution

### 3 Functional architecture for new platform

#### 3.1 Overview

In this chapter we'll present a platform overview where we'll describe how it interacts with external agents. Then an overview of the platform and the agents with whom it interacts presents.

Next figure presents a complete vision for the platform overview:

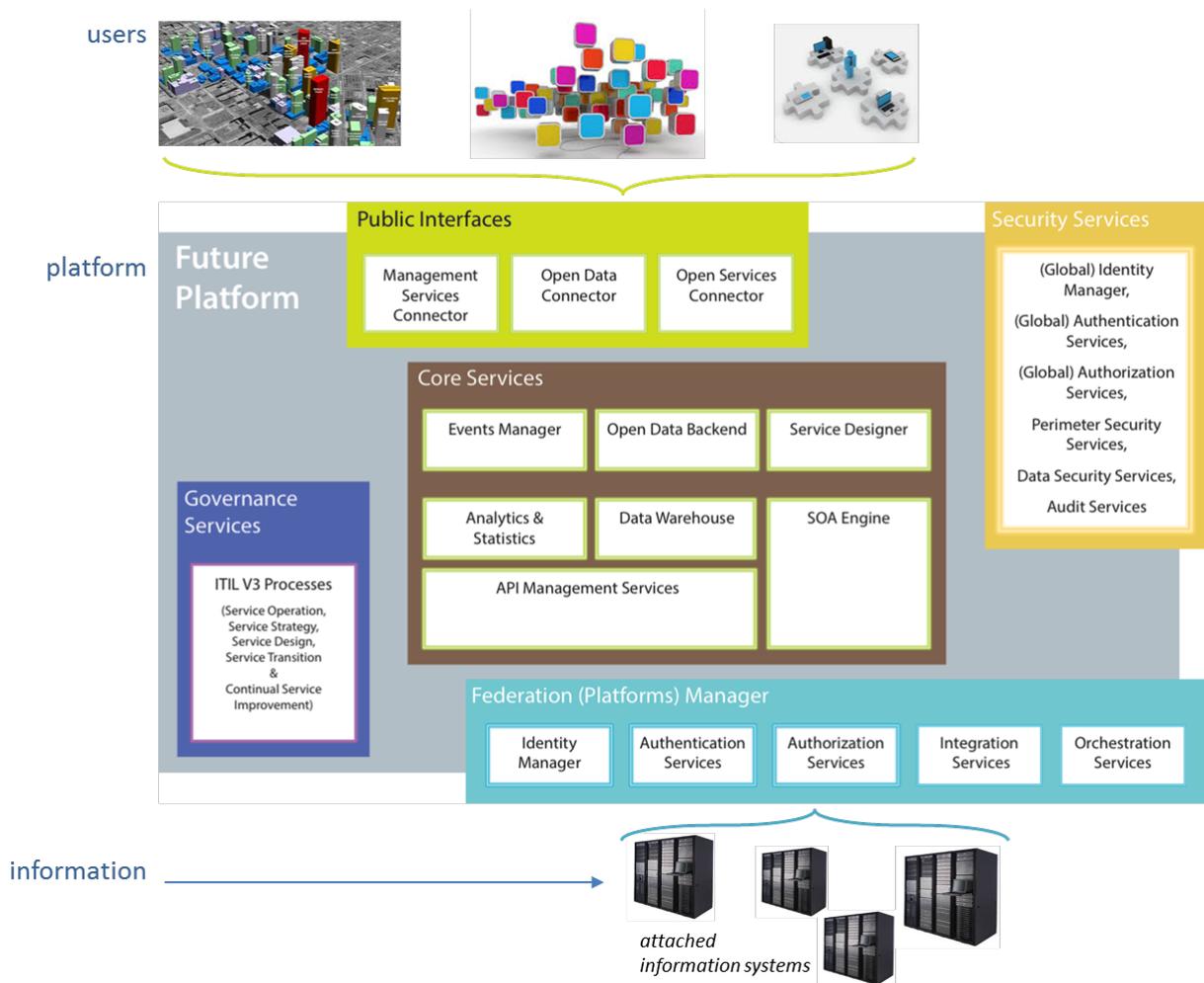


Figure 2 Entire Platform overview

From now, and in order to respect the nomenclature established in the above picture, we will refer to the platform we are defining as Future Platform.

As shown in this figure, there are two types of elements outside the platform. On one side, the *information* that is collected from different information systems attached to the Future Platform and on the other side the *users* of this information.

In a general way, *information* means any information source but in the scope of this document we will assume that *information* will be gathered from a set of information systems owned by public administrations or private companies that share its data with the Future Platform.

On the other side, we have the *users*, and they can act as a:

- Service of public interest for citizenship.
- Applications for citizenship, mainly mobile applications.
- Persons that directly interact, with different purposes, with the Future Platform. For instance:
  - Exploring and consuming open data.
  - Using desktop apps that use services based on the Future Platform.
  - Providing directly data collected by smart devices as a way to contribute to community. Especial purpose mobile applications will be required at this time.
  - Providing indirectly data collected by connectors to public social networks.

Let us consider that providing information to Future Platform from people's smart devices or collect public information from social networks is treat as a conventional information system attached to Future Platform. Here are some reasons for this consideration:

1. This kind of information is generated directly by people as a text, image or audio. Or is generated by sensors connected to smart devices that are monitoring some behavior state, for instance, health parameters.
2. Information source cannot be managed as a standard information system. There is no capacity management, request management, security plan... and so on.
3. The smart devices that usually generates this kind of information are the same smart devices that consume apps and services of public interest offered by the Future Platform.

## 3.2 Public Interfaces

These are the only entry points, the only interfaces for users to access to all available information from the attached information systems.

Next figure presents Public Interfaces structure:



Figure 3 Public Interfaces overview

Public Interfaces can be read and/or write depending on each case as shown in the following table:

Interface	Read	Write	Subscription
Management Services Connector	Yes	Yes	Yes
Open Data Connector	Yes	No	Yes
Open Services Connector	Yes	Yes	Yes

Table 1 Public Interfaces read, write and subscription capabilities

As you can notice, there is a subscription mode available mode for all connectors as there is always the read capability for them. Subscription is a more efficient way to manage the read operations and this will be a key feature for all connectors.

**ISSUE TO BE ANALYZED:** we are aware that the use of common and extensive usage API's for the messaging systems is a key feature for the Future Platform implementation success, but it's not in the scope of this document define which API's must be used.

Subscription events will be generated from all the information available on the Future Platform, which is obtained both services attached as internal data storage (the Data Warehouse module) when available.

Users may subscribe to Future Platform public events through API calls (these are not considered as write operations). These events will be always associated to Future Platform services and will implement a way for final users to receive notifications.

Then the various modules that are part of Core Services detailed.

**3.2.1 Management Services Connector**

This module will be responsible for providing the features needed to manage the services offered to final users. So, this Management Services are intended to be used by the service managers (as a role) responsible for services consumed by final users through the Public Interfaces. This role can be implemented by specific and

dedicated people or directly by final users. It depends on the nature and business model of each service.

It is not the intent of this document exhaustively detailing all Management Services, but rather give a few examples to allow an accurate understanding of the concept. And then a few examples are provided:

- Turn on or off the final services (the ones offered to final users through the Public Interfaces).
- Change services' conditions: availability, continuity, accounting plans, pricing terms...
- Manage services' security: block users, restrict channels by device (desktop, smartphones, tablets, laptops...)
- Monitoring consumption, service conditions, service incidents...
- Receive alerts based on the operation, use, consumption and conditions of final services.

### **3.2.2 Open Data Connector**

This module will be responsible for delivering to final users all Future Platform features related to open data technology. This module can operate in three different ways:

1. Providing to final users an entire open data site.
2. Redirecting all requests from users to an external open data portal.
3. Offering an API for managing open data requests and redirect them to an external open data backend.

In all cases the related Core Service, the Open Data Backend must exist and its features will depend on the operating way of its associated connector.

**ISSUE TO BE ANALYZED:** This document will not describe nor discuss the detailed set of functionalities that an open data site must provide, but it's interesting to note that this features should comply with the current laws and regulations of each country open data regulations.. For instance, in Spain, open data sites must meet the '*Norma Técnica de Interoperabilidad de Reutilización de Recursos de Información (Ley 37/2007)*' which is intended to facilitate and ensure the reuse process of public information from public administrations, ensuring the persistence of information, using formats and the terms and conditions of appropriate use.

### 3.2.3 Open Services Connector

This module will manage the user's interactions with the Future Platform in order to attend queries for the open services.

The main component will be a queries manager that will attend, process and serve all queries related to the open services. This component will use the core service Service Oriented Architecture (SOA) Engine to invoke the backend service associated to each external query.

The SOA Engine will invoke and control the execution of all internal services and functions in order to serve the users' queries. These internal services process all data available in Future Platform, not only the data provided from the attached information systems through the Federation Manager. It means that will use data from any module from the Core Services, and therefore, from the internal Data Warehouse. This feature gives Future Platform a powerful way to create new services. From this point of view, we can classify Open Services in next groups:

1. **Basic Services.** These correspond to services offered to final users that match directly, in 1:1 relation, with services offered from the attached information systems through the Federation Manager. There is always a set of functionalities added by the Future Platform that consist in data normalization, API translation... and obviously all security concerns (authentication, authorization...).
2. **Value added services.** These are the services resulting from the combination of all the information available on the Future Platform, and so can become one of the key factors for the success of it.

**ISSUE TO BE ANALYZED:** The legal issues related with the usage and possession of data from different sources may become extremely complex. Approach to deal with this issues may be the exclusive usage of public or free data, giving absolutely the Future Platform all rights to data.

### 3.3 Governance Services

This set of services is designed for the control, management and internal administration of the entire Future Platform. As shown in the full Future Platform overview, Governance Services are fully internal. They have no interaction with users nor attached information systems.

Next figure presents Governance Services structure:



*Figure 4 Platform Governance Services overview*

### **3.3.1 ITIL V3 Processes**

These services had been fully analyzed, defined, developed and deployed in many IT organizations, and we can say with guarantees and without doubt that Governance Services must match with ITIL v3 methodology. It's not in the scope of this document to neither explain nor describe ITIL processes.

Although, considering this direct match with ITIL, is important to briefly discuss some of the features or services inside this section.

#### **3.3.1.1 Access Services**

These services are internal to the Future Platform and will manage the connectivity between the Public Interfaces and the Core Services, and also between the Core Services and the Federation Manager, the module intended to govern all attached Information Systems.

This will allow to manage the availability and the level of access (for instance read, write, read and write...) of the internal services both to Public Interfaces modules to Federation Manager. Managing the Future Platform implies manage the level of access to the Core Services and therefore manage the visibility between services.

The Access Services also have the task of regulating the channels through which the services offered to end users are provided. For instance, maybe services that only can operate, have sense or are intended to be consumed by mobile devices. There is a wide range of possibilities and possible configurations, and this module must present sufficient flexibility to manage all.

### 3.3.1.2 Accounting Services

These services are internal to the Future Platform and will regulate the access between services in order to accomplish with the accounting plans of each one of them.

The Accounting Services include a broad set of functions; all of them intended to manage the accounting system of each piece of the Future Platform and the interactions between them.

**ISSUE TO BE ANALYZED:** will be necessary to identify the most popular and useful accounting models for information systems and the way to interconnect them to find an approach to the mechanisms to control the whole accounting.

The scope of these services is very wide and must be able to solve situations such as:

#### 3.3.1.2.1 Situation one

There is an attached information system that offers a service, service AS1, that accepts only a restricted number of queries by day, and when this limit is exceeded the responses present a large delay that makes user experience very poor.

Also, there are two open services, OS1 and OS2, that use AS1. OS1 is totally free and OS2 has a price for each query.

How should a global accounting system manage the priority and the access for OS1 and OS2 requests?

#### 3.3.1.2.2 Situation two

This is a more complex situation where there is:

- An attached information system that offers a service, service AS1, that accepts only a restricted number of queries by day, and when this number is exceeded a fee must be paid.
- There are some free open data record sets that invoke functionalities embedded in the Open Data Backend that use AS1
- There is a service related to the Open Services Connector called OS1 that invokes AS1. And OS1 has its own accounting system, for instance, based on the number of requests per week and divided, for pricing purposes, into sections.

The questions are: how can a global accounting system manage the accounting between internal or integrated services and how can a global accounting access to a concurrent service, considering that there are accounting systems, totally free, based on days and based on weeks.

As shown in these two examples the accounting can become a very complex issue due to the reuse and complexity of the services offered by the attached information systems through the Federation Manager.

### **3.3.1.3 Pricing Services**

These services must meet the goal on assigning the correct price for any service that interacts with the Future Platform, as for example: for services offered by the attached information services and accessed through the Federation Manager, and for services provided to users through the Public Interfaces.

Pricing Services are supposed to be at least as complex Accounting Services, and probably can be even more complex in many cases.

**ISSUE TO BE ANALYZED:** will be necessary to define a business model to apply to the Future Platform. First of all can determine the main purpose for the Future Platform, and then set the main objectives. It's a business and also a political issue due to the fact that is very important to decide who will govern the contents, it means data and services offered. Once defined the business model, and then the model of exploitation, it will be possible to determine more accurately a possible casuistry to which the task of designing accounting systems and pricing will face. Until then, the best approach is present a generic set of services for pricing and accounting able to support any future kind of implementation.

### **3.3.1.4 Capacity Services**

In the scope of this document capacity means the concept described in the ITIL methodology and related to a technical feature for the information systems.

These services are designed for manage the capacity of the services offered through the Public Interfaces. The services offered by the attached information services will be managed directly by its owners.

Managing the services offered to users implies managing the capacity of the internal services, the services that belong to the Core Services.

For example, the capacity of services provided to users by the Open Data Connector determines the capacity of the Open Data Backend services, and so in the opposite direction.

**ISSUE TO BE ANALYZED:** will be necessary to study the latest technics and mechanisms related to adaptive or elastic capacity management. This concept become a trend in last years due to the standardization of cloud services, and cloud services with variable capacity and automatic capacity management depending on the system load but always operating under a controlled parameters' range. These kind of systems, in the case of cloud services, are also known as elastic cloud services, and one of the most used is the Azure Platform from Microsoft.

### 3.3.1.5 Availability Services

In the scope of this document availability means the concept described in the ITIL methodology and related to a technical feature for the information systems. The same conclusions described in the previous point and related to Capacity Services apply for Availability Services.

### 3.3.1.6 Monitoring Services

These set of services are key services to guarantee the service level agreements. They have the objective of identifying every time the status of the services in all its dimensions.

Monitoring Services must continuously check:

- The status for the lowest and more technical services. Normally internal services.
- The status for the highest level services, which are the business services, the ones offered for the Future Platform users. This implies monitoring all technical systems and services and apply the right rules to obtain the status of the services from the users' point of view.
  - When more complex are the internal services configurations and combinations more complex becomes the high level monitoring tasks.

## 3.4 Federation Manager

This is the Future Platform's piece that manage all services available in the attached information systems and offer them to Core Services modules as a unique, comprehensive and single pack or catalogue of services.

Next figure presents Federation Manager structure:



*Figure 5 Federation Manager overview*

Then the various modules that are part of Federation Manager detailed.

### 3.4.1 Identity Manager

This module is responsible for performing identity management within the set of services offered by the information systems attached to the Future Platform. Identity Manager always works in coordination with the Global Identity Manager, which is in

charge of translating and adapting the identities of final users access to Future Platform into the identities Federation Manager needs in order to invoke the services provided by the information systems.

### **3.4.2 Authentication Services**

These sets of services manage the authentication mechanism needed to use and apply the identities through the services offered by the attached information systems.

Authentication Services must be aligned with the current and widely accepted standards for information services. From a functional point of view, the Future Platform must support at least the management of user-level authentication, and also the application and service levels.

From a technical point of view the management of authentication through multiple systems and services must support at least next mechanisms:

- Single sign on.
- Identity federation.

It's important to notice that the identities and mechanisms used by these services inside the Federation Manager must not meet de same identities and mechanisms applied to final users for the usage of services delivered through the Public Interfaces' connectors.

Final users for authentication mechanisms are managed by Security Services using the Global Authentication Services, which adapt and convert final users' authentications mechanisms in order to be used by the Federation Manager, specifically by its Authentication Services.

The scope for Global Authentication Services is the entire Future Platform. They manage the authentication mechanisms through any module except for the services directly provided by the attached information systems, where the authentication mechanisms are managed by the Federation Manager's Authentication Services.

### **3.4.3 Authorization Services**

These services must provide a comprehensive set of functionalities to manage the different kind of permissions, operating levels and available features for each identity across the services provided through the attached information systems and managed by the Federation Manager.

As happens with Authentication Services, Authorization Services only operates in the Federation Manager's scope, but the Global Authorization Services work through the entire Future Platform, especially the Core Services.

Also, the Global Authorization Services must convert and adapt the final users' authorization levels to Federation Manager's Authorization Services.

### 3.4.4 Integration Services

This group of services has a purely technical nature and it aims to integrate the messaging associated with the different services provided by the attached information services under a single standard thus enabling interoperability between them.

Integration Services must solve problems like:

- Work with different GET methods implementations: xml, JSON...
- Work with different charsets.
- Deal with different kind of API architecture like REST, SOAP...
- Normalize low level information structure: the number of digits to code integers, the number of digits to code decimals, or percentages... regardless of its units and the presentation formatting, and so on.

They are not intended to solve data management as formatting, deal with different metric systems, conversions into different nomenclatures and so on. The API Management Services as a part of Core Services will treat these issues.

The Integration Services may work at a low level information management ensuring that data can be safely further processed by Core Services.

It is not the intention of this document raise or resolve all technical problems that must be confronted, but determining the overall mission of the Integration Services, which is adapt the Future Platform to the various information systems attached to it, and make their integration as easy as possible for its owners. The purpose is then to minimize the impact in the information systems when attached and thereby improving the Future Platform's engagement capacity.

**ISSUE TO BE ANALYZED:** In a hypothetical scenario with many suppliers, interfaces, API's, messaging systems and technologies, the Integration Services can be extremely complex and may consider a new approach to these issues. This new approach is to establish a set of standards that any information system should comply with before to be glued to the Future Platform. Adopting an approach or another depends again on the business model and exploitation model established for the Future Platform.

### 3.4.5 Orchestration Services

This is probably one of the most complex group of services to be developed. The objective is to offer the services from the different information systems attached to Future Platform in a centralized and homogeneous way, as if it were a single platform.

Orchestration Services use the rest of modules in Federation Manager , adding some key functionalities like routing.

**ISSUE TO BE ANALYZED:** will be necessary to conduct a detailed analysis of the federation of services and technology platforms, cloud platforms, since it is one of the latest market trends and currently being explored and which are not yet set targets or objective models. It can be understood as the evolution of the traditional federated database but extended to cloud services provided by cloud platforms. This is the reason why additional services like, authentication, authorization, integration and orchestration services are also needed.

### 3.5 Security Services

These set of services are intended to manage security concerning the users' activity within the Future Platform.



*Figure 6 Security Services overview*

Then the various modules that are part of Security Services detailed.

#### 3.5.1 Global Identity Manager

There are, at least, two types or groups of identities managed within the Future Platform:

- The identities associated with the services offered to users through the Public Interfaces' connectors.
- The identities that internally the Future Platform uses to access to services offered by the attached information systems.

- The Identity Manager module works with this set of identities and manages them to access properly to its internal services.

The Global Identity Manager works with the first group, adapting and transforming the upcoming identities from final users to internal Future Platform services and modules, especially the Core Services and including the Federation Manager. The second group is managed by the Federation Manager, especially by its Identity Manager module.

For instance, imagine an internal service of the Federation Manager, a service offered by a concrete attached information system, can be accessed using two or three identities, and the Future Platform must use the right identity each time depending on the service invoked by users through the Public Interfaces in order to accomplish with the established rules for accounting, pricing and contract plans. The Global Identity Manager is the responsible for managing and determining which identity to use in each case.

There are several ways to tackle identity management across multiple services. Future Platform may implement any of it because initially no restrictions or technological limitation are identified,.

### **3.5.2 Global Authentication Services**

This module manages the authentication processes for all users that interact with the Future Platform through the Public Interfaces.

This module is called Global because it is responsible for the management and propagation of users' authentication through the entire Future Platform, especially the internal Core Services and up to the Federation Manager, where authentication must get transformed to be consistent with the services offered by systems information attached to the platform.

The Global Authentication Manager may become increasingly hard to design and implement as the catalog of Core Services is growing in number and complexity, and also as accounting and pricing mechanisms become also more and more complex.

In summary, Global Authentication Services (from Security Services) and Authentication Services (from Federation Manager) have the same functions but work with a different scope.

**ISSUE TO BE ANALYZED:** will be necessary to analyze the Future Platform objectives, business model and operation model in order to establish a set of realistic scenarios for the authentication tasks through the whole Platform. It would be advisable to establish the global authentication model based on known and widely implemented mechanisms as Single Sign On or Identity Federation.

### 3.5.3 Global Authorization Services

This module manages the authorization level for all Future Platform services' consumers, the final users, and it will work accordingly with the Global Authentication Manager.

As happens with Global Authentication Services, Global Authorization Services (from Security Services) and Authorization Services (from Federation Manager) have the same functions but work with a different scope.

### 3.5.4 Perimeter Security Services

The set of services are related to the Future Platform perimeter security and includes all security configuration implemented with firewalls, gateways, etc..

### 3.5.5 Data Security Services

This set of services consists on the set of rules, policies and politics involved in the access to information managed by the Future Platform.

We are accustomed to security as a key element in the design and implementation of IT services, nowadays evolved to cloud services, but increasingly is stronger a parallel dimension of security that focuses on data.

As time passes data are emerging as an increasingly critical asset, and therefore it requires further management, control and security. The question is no longer *¿Which applications are accessing my database?* But now the question is *¿Who is accessing this concrete set of data?* and consequently, *¿How can I manage the access, correct use and security each set of data in my information systems?*

**ISSUE TO BE ANALYZED:** will be necessary to analyze the systems, politics, mechanisms, associated to data security. Nowadays it is an emerging trend that walks hand data management. Only most modern and complete information have this kind of security. They correspond to very expensive technologies and implementations, available only in critical environments.

### 3.5.6 Audit Services

These services aim to conduct a forensic analysis of access to services and data to exploit this information and draw conclusions.

Two levels or types of audits are identified. There are:

- a) IT services audits. These are the well-known policies, audits and controls associated to ISO/IEC 27002 2005, BS 25777:2008, BS 25999-2:2007...
- b) Data audits. These audits are not as well implemented as IT services audits as they are associated with very critical information systems and there are no

many tools on the market. Usually these kind of audits are implemented programmatically as custom solutions for each information system.

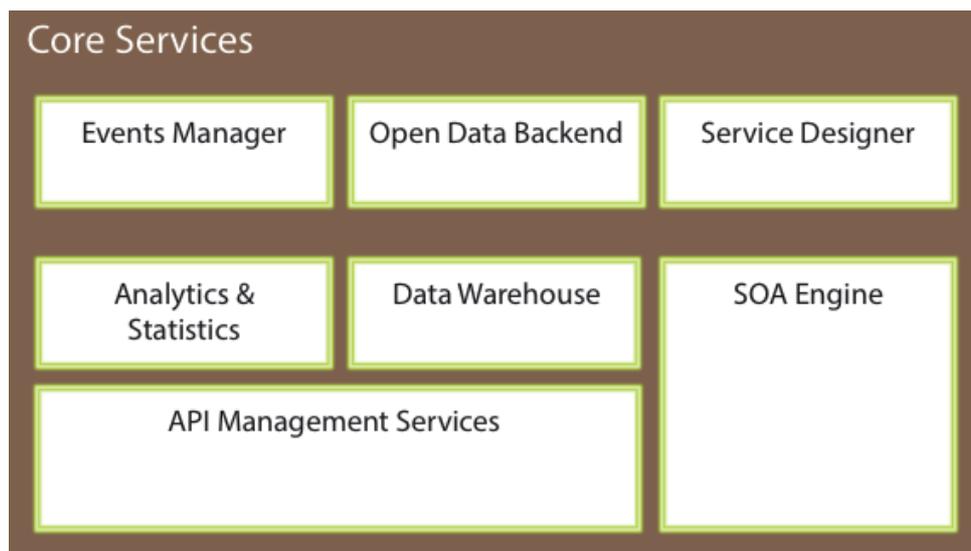
### 3.6 Core Services

These services are the Future Platform's heart and its mission is to compose the services to be offered to users through the Public Interfaces from the services offered by information systems attached to the platform.

Core Services do not work directly with the services offered by information systems attached to Future Platform but interact with the Federation Manager, which is connected within a homogeneous, simple and compact catalog.

In addition, Core Services do not manage the accounting and pricing, since they are managed by Governance Services. And finally, Core Services do not implement authentication, authorization nor security functions since they belong to Security Services.

Next figure presents Core Services structure:



*Figure 7 Core Services overview*

Then the various modules that are part of Core Services detailed.

#### 3.6.1 Events Manager

This module is responsible for implementing the algorithms and functions necessary for the generation of all notifications parametrized on the Future Platform and that will be sent to final users through the Public Interfaces connectors through the subscription mechanisms.

### 3.6.2 Open Data Backend

This module must fulfill all the functions of a backend component in an architecture of an information system that implements an open data site. In Future Platform case these functions will vary depending on the Open Data Connector usage. Then, we'll describe the functions of this core service in each case:

1. When Open Data Connector provides to final users an entire open data site, then the Open Data Backend must implement all functions that a common open data site implements. Then, the public interface connector will resend all site queries to its related core module, while the Security Services and Governance services will manage and rule all activity managed through Public Interface connectors.
2. When Open Data Connector redirects all requests from users to an external open data portal, then the Open Data Backend implements this redirection through the use of corresponding services offered by the Federation Manager, while the Security Services and Governance services will manage and rule all activity managed through Public Interface connectors.
3. When Open Data Connector offers only an API for managing open data specific requests, then the Open Data Backend works in a similar way that the previous case, it means processing low level queries based upon an open data API and using services from the attached information systems through the Federation Manager. And also, as in previous cases, while the Security Services and Governance services manage and rule all activity managed through Public Interface connectors.

### 3.6.3 Data Warehouse

This module is a classic data warehouse where store required information about the Future Platform operation and about the information processed by Public Interfaces modules and services offered by the attached information services.

This information can be used in several ways, but mainly in next ones:

- a) Analyze internal Future Platform activity in order to diagnose problems and improvements.
- b) Create accurate reports about data and services usage, trends, capacity, issues...
- c) Create new and additional services based on cross analysis of data managed by the Future Platform. The different kind of data managed by the Future Platform and gathered from the services from the attached information systems and the write public interfaces provided by users becomes a high valuable asset able to generate new services.

- Future Platform notifications will be sent to users through the API they are subscribed to, through the Public Interfaces connectors.

This module is not strictly necessary but it may be a key piece to offer new and high valuable additional services by analyzing and combining the data available across the Future Platforms. It will depend on the owners of the attached information systems, the Future Platform operation model and also on the business model.

### **3.6.4 Analytic and Statistics Services**

This module is a typical analytics and statistics software that manages data from the Data Warehouse. In fact, this module can be implemented from any existing market solution.

### **3.6.5 API Management Services**

This is also one of the key modules inside the Future Platform architecture. Its main goal is to manage the information gathered from services provided by the attached information services and structure it into common API's.

But this module has also other essential functions as follows:

- Translate information between API's structures.
- Implement Multilanguage management.
- Manage metrics conversions between systems and nomenclatures.
- Normalize data inside services' messages.
- Format data according with the rest of previous functions, it means, depending on language, metrics to use...

This module is very important also because one of the goals for the whole Future Platform is to normalize information offered to users using the most common, used and widely APIs for each kind of information.

**ISSUE TO BE ANALYZED:** will be necessary to analyze the treatment for multilanguage implementation. This is not an easy issue to resolve because there are many factors to consider:

- i. The information source, the system information source from which the information is extracted, it must be available for common European languages (English, French, Spanish).
- ii. The language of the user's device.
- iii. The language of the information served through the Public Interfaces.

- iv. The language the user wants to work with.

Something similar happens with the values of the magnitudes managed by the services. They vary depending on:

- i. The information source, it means, the system information source from which information is extracted. It must not be available for all languages.
- ii. The language of the user's device.
- iii. The geo-position of the elements described in the services.
- iv. The country to which the information system belongs to.
- v. The language of the user's device.

There are too many factors to consider and it looks like it will be difficult to find a solution compatible with all possible situations and that is accepted by most Future Platform users.

### **3.6.6 SOA Engine**

This module is a classic service oriented architecture that based on a Business Process Management (BPM) engine. There are different commercial solutions to implement this module.

The elements managed by the Service Oriented Architecture (SOA) Engine will be the services offered by the Federation Manager. This is the way for Core Services to work in a uniform way regardless to the topology of each one of the services offered by the attached information systems.

The SOA approach will allow an effective, structured and easy way to combine all services provided by the Federation Manager under a unique catalog and also combine them with the rest of Core Services in order to create new and high valuable additional services.

Although it's a well-known technology, it is not in the scope of this document to present a benchmark related with SOA technology.

### **3.6.7 Service Designere**

This module is the designer for the flows that SOA Engine will execute. Although it's a well-known technology, it is not in the scope of this document to present a benchmark related with Service designer technology.

## 4 Additional components

### 4.1 External components

The Future Platform design can be complemented with other components or modules external to it in order to enhance some features, especially features oriented to end users.

Some examples of this kind of complements may be:

A. Developers Portal.

- a. This portal should be a key resource for all developers interested in building applications or services based on Future Platform's Public Interfaces.
- b. It is important to engage the growing of a developers' community for creating frameworks, sample code and forums to provide assistance about the use of resources available from Future Platform.

B. Services and Applications Showcase.

- a. This site must be a place to dispose a full and extensive catalog for all assets offered by the Future Platform.

The Future Platform management and government authority must support this external initiatives as they are contributing to the quality of services delivered to end users.

### 4.2 Internal components

Future Platform can be also be complemented with other internal modules, especially to

#### 4.2.1 Multi Source Collector

This module acts as a hub for both structured and semi or completely unstructured information. Its nature is closely linked to the development of new technologies such as Internet of Things (IoT), NoE or stream processing data, technology paradigms commonly associated to big data systems' architecture.

So, the Multi Source Data Collector can:

1. Gather information from:
  - a. Social networks: Facebook, Twitter...

- b. Home automation systems.
  - c. Facility management services.
  - d. Public and private sensors networks.
  - e. Sensors in personal smart devices.
2. Digest data as an incipient data treatment in order to be ready to be processed by the rest of services of the Future Platform.
3. Store data as a valuable asset to be shared for the rest of services implemented by the Future Platform in order to enrich them or to create new and more valuable services as a result of treatment and or intersection of these data with the rest of available data.
  - a. In fact, the data will be stored on the internal Future Platform's Data Warehouse.
4. Real time stream processing the gathered data to generate also in real time valuable information for the Future Platform users, which can get this new and valuable information through the rest of modules in the Public Interfaces.
  - a. As an example we can consider some initiatives currently developed, as the one from the Seismological Society of America concerning the use of Twitter information, also known as tweets, to detect real earthquakes. Analyzing the frequency that some keywords, as 'quake' for instance', appears across all tweets someone can identify a real earthquake. In this example, developed five years ago, a kind of gather information piece was used to gather information and process it in real time in order to raise alerts to citizenship.

The real time information processing will be in fact implemented by a dedicated core service that will work closely with the Multi Source Collector. This core service is called Stream Processing Module.

This module, the Multi Source Data Collector can get the data in two ways:

1. Proactively gather public information, for instance, from social networks.
2. Reactively, through specific applications placed in users smart devices and developed to send data to this module. Data provided by sensors in smart devices, home automation services...

Thus, the operation of this module may be accompanied by the development of ad-hoc applications for users.

**ISSUE TO BE ANALYZED:** The storage of non-structured or semi-structured information may require the technology of Not only SQL (NoSQL) databases, especially if there is no stream processing functions capable to transform this kind of data on traditional structured information designed to be stored in a traditional DWH.

#### **4.2.2 Stream Processing Module**

As the Multi Source Collector module may be considered a new type of connector for the Public Interfaces, the Stream Processing Module would be its related module within the Core Services.

This module may be a real time information processor and also is a key piece inside the big data architecture. Its mission is to process information as this is coming to the platform and is essential when Future Platform has to process large volumes of data that cannot be stored or that must be analyzed in real time. This kind of data is usually known as streaming data.

Outputs from this module can be used to:

- Store valuable data in the Data Warehouse module to be used when needed by Open Services.
- Generate events to be notified to final users through API's, when they are subscribed.