BUILDING SMART CITIES TOGETHER

SHARINGCITIES

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D4.4 Report of Urban Sharing Platform Operation

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Executive Summary

This Report of Urban Sharing Platform (USP) Operation details the operational state of the USP up to month 24 of the Sharing Cities project. At this point the operational activity has been broadly consistent across the 3 core cities with initial implementations of platform components in each city, ready for the (logical) connection of the devices provided by WP3. In most cases some initial test device deployments have been made and data captured by the respective USP. Details of these connections and tests are provided in each cities section. Over the next 12 months the connection of devices will ramp up as they are built out by WP3 and integrated into the USP.

Of particular note from the first 24 months are:

- **London City DataStore** – Work on this has largely completed and the LondonCity Datastore has been live since November 2017.

- **London Royal Borough of Greenwich** – NEC has replaced Concirrus as the local USP partner. This was due to Concirrus withdrawing from the project. The impact of this change has been minimal to the project as NEC were already working with the Royal Borough of Greenwich and the modular nature of the USP architecture enabled efficient replacement of technical components, which was the intention of its design.

- **Lisbon** – The municipality has procured a City Operations Centre (COI) which will be provided by NEC utilising its CCOC platform. The COI will merge with the USP and the USP design will be updated to reflect this in 2018.

- **Milan** – Has delivered its USP to plan without some of the changes experienced by London & Lisbon and this good progress is set to continue in 2018.

Both the Royal Borough of Greenwich and Lisbon have chosen to work with the NEC CCOC platform and integrate this with the USP. The inclusion of NEC was entirely independent by the two cities; in Greenwich an existing NEC relationship was utilised when Concirrus chose to leave Sharing Cities and in Lisbon a City Operations Centre (COI) was procured. In balance the impact on Sharing Cities and WP4 is likely to be positive as the similar components will enable efficiencies and potentially create more opportunities to share knowledge and technology. The integration of the NEC components into the USP is being co-ordinating between the cities and it is expected that ease of accommodating such technical changes validates both the USP Reference Architecture and the EIP Urban Platforms architecture on which it is based.

Table of Contents

List of Figures

1 USP Operational Summary

The goal of this deliverable is to provide a progress report on the status of the Urban Sharing Platform (USP) development in each of the core cities of the Sharing Cities project. In this initial version of the report (M24), the focus is on the realisation plan and the design and build progress to date which is the respective USP city pilots for London, Lisbon and Milan.

Each of the three core cities is starting from different points but all are working towards the common USP reference model described in deliverable D4.2. Each city will manage its own platform hosted in the cloud or on premise, building on previous and planned local investment and the local investments scheduled during the Sharing Cities time period. All cities are exchanging knowledge with each other regarding the realisation of the USP, in order to maximize synergies and identify further opportunities of collaboration and reuse.

Interdependencies between WP4 and other WPs have been considered, discussed and addressed throughout the development of the city USPs through dedicated meetings, both at local and at global level (e.g., all of the latest WP4 global design workshops included a session about analysis of interdependencies and planning of related actions). Requirements stemming from national and European regulations regarding data privacy, security, confidentiality etc. are being addressed through specific data privacy impact assessments both at local and at project level (see, e.g., the GDPR workshops organized by the project).

1.1 Data Management & Security

Data management & Security are a serious consideration for WP4, especially with the new GDPR regulations. Data management & Security requirements stemming from national and European regulations regarding data privacy, security, confidentiality etc. are being addressed through specific data privacy impact assessments both at local and at project level through a series of GDP workshops.

SharingCities organised two workshops to address GDPR compliance on March 7th and 8th in London and on July 5th and 6th 2017 in Milan. Antonio Kung from Trialog, chair of the EIP-SCC initiative citizen approach to data: privacy-by-design was invited to act as a workshop facilitator.

The first workshop in London included managers and data protection officer representatives of the Greater London Authority, Royal Borough of Greenwich, and the cities of Lisbon and Milan. The workshop focused on understanding privacy compliance and the impact on the project use cases. Application use cases from London, Milan, Lisbon were discussed, and privacy compliance was analysed. The workshop concluded for the need to carry out common privacy impact assessment practice in a subsequent workshop.

The second workshop in Milan included 34 attendees with managers, data protection officers and suppliers of applications representatives of Milan, Lisbon, GLA, RB Greenwich, and Burgas. A privacy impact assessment exercise was carried out. The workshop provided architecture and design input for privacy preservation in four applications:

- building retrofit (Milan),
- bike sharing scheme (Lisbon),
- smart energy management system (Greenwich),
- and lamppost (Milan).

The workshop also provided insight on privacy impact assessment processes:

- the need for a common list of risks,
- the need for guidelines to assess a given level of risk,
- the necessity to integrate alternate design approaches when data subject consent is not provided,
- and the need for a data collection strategy when multiple applications are anticipated.

1.1.1 Ensuring GDPR Compliance

SharingCities is the first H2020 smart and cities communities project taking consortium level action to build a common understanding on how to ensure GDPR compliance. It has identified two recommendations:

- It is recommended to create of a body of knowledge and of common practices on GDPR compliance. Many issues and resulting measures identified in the workshop are truly common to all smart city projects. Initiatives such as EIP-SCC and associated support action projects could be of help.
- It is recommended to implement specific support measures that will ensure GDPR compliance of major innovation initiatives such as smart cities. They should be discussed and agreed by policy makers at the city level, at the data protection authority level, and at the European Commission level.

SharingCities supported the EIP summit with a breakfast briefing in October 2017. The breakfast was attended by Nathan Pierce, Programme Co-ordinator, Piero Pelizzaro for Milan and Antonio Kung as our GDPR expert.

In January 2018 UrbanDNA and Trialog were asked to provide technical training for Eurocities members at a workshop in Brussels. Representatives of over 15 cities went through 4 uses cases (smart heating, non-motorised traffic monitoring, health systems and managing GDPR) provided by the Royal Borough of Greenwich (SharingCities partner), Eindhoven, Espoo and Barcelona to test model Privacy Impact Assessments. The workshop will be followed up by a new GDPR support group for the cities.

1.2 Acronyms

API	Application Programming Interface
BEMS	Building Energy Management System
BI	Business Intelligence

EIP	European Innovation Partnership
EMS	Energy Management System
ESB	Enterprise Service Bus
EV	Electric Vehicle
H2020	Horizon 2020
IoT	Internet of Things
IT	Information Technology
KPI	Key Performance Indicator
MQTT	Message Queuing Telemetry Transport
REST	Representational State Transfer
SaaS	Software as a Service
SAML	Security Assertion Markup Language
SCC	Smart Cities and Communities
SEMS	Sustainable Energy Management System
SOAP	Simple Object Access Protocol
SSO	Single Sign-On
UC	Use Case
UML	Unified Modelling Language
USP	Urban Sharing Platform
WP	Work Package

1.3 References and Supporting Documentation

The following references and supporting documentation are appropriate for this document.

- Sharing Cities: H2020-SCC-2015 SHAR-LLM Proposal, final version.

- Sharing Cities: D4.2 Urban Sharing Platform Reference Model, R01.

2 USP City Operations

This section provides an update of the operations from each city.

2.1 London Royal Borough of Greenwich Operations

As in Lisbon and Milan the operation and evolution of the USP for London- Greenwich has followed an incremental and iterative approach. During the first two project years (M1-M24) the following has been achieved towards the operation of a USP in Greenwich:

- Year 1- Local activities during the first year of the project were mainly focused on defining the scope of the USP, i.e., how Greenwich planned to implement the USP reference model defined at project level, as described in D4.2. This resulted, at the end of M12 in a first version of the Greenwich USP architecture.
- Year 2- During the second year of the project the architecture of the Greenwich USP was further refined and components identified according to the reference architecture established in D4.2. This architecture and its components was subject to further change as one of the project partners- Concirrus withdrew from the programme, such changes are described in section 2.1.1. Additional outputs during the second year of the programme have been the development of documentation and an approach to support the integration of data sources and devices with the platform; and extensive work to map out the data and data flows and elements of other work packages that the USP would be expected to interact with in Greenwich and thus the expected functionality and capability the USP should provide.
- Year 3- the next steps for the USP in Greenwich will be to realise the USP's functionality with the measures and use cases being deployed in Greenwich, encouraging data sources to be integrated in to the USP as they come online and for users to shape and begin utilising the USP.

2.1.1 Greenwich USP design

The Greenwich USP architecture is aligned with the common USP reference model, and is based on the NEC Cloud City Operation Centre (CCOC).

It was previously the intention, as is described in D4.2 submitted in M12, that the Greenwich USP would be based on two products- Concirrus Connect, and the NEC CCOC, Concirrus being a partner in the Sharing Cities programme. In this architecture, Concirrus Connect would act as the "sensing layer" to the whole platform subsequently streaming the received data to NEC CCOC.

However, as it became known that Concirrus intend to step back from the Sharing Cities programme this architecture was no longer feasible. As a result the Greenwich USP architecture needed to be updated to accommodate and another technical partner to fulfil Concirrus' role. The flexible and modular Sharing Cities architecture enabled the easy replacement of one technical component (Concirrus) with another (NEC).

The expectation is that the NEC Europe will be invited to join the Sharing Cities programme as a direct replacement for Concirrus. The Royal Borough of Greenwich has a long standing partnership with NEC Europe which relates to Greenwich Council's work on smart city innovation. This includes exploring how NEC's smart city management platform is used to enable Greenwich to visualise and analyse real-time and historical data from Internet of Things (IoT) sensors across the city, monitor key performance indicators (KPIs), and increase efficiencies in a wide range of public services. Since 2015 Greenwich and NEC have piloted the application of NEC's data platform approach in public service areas such as adult social care and fleet management.
NEC has already provided technical support to Greenwich on how data platforms could be utilised in the service areas covered in Sharing Cities, and specifically energy and transport. This has been vital in ensuring consistency with other smart city initiatives in Greenwich. As a consequence, NEC are very familiar with the Sharing Cities activities in Greenwich, and work closely with Work Package 4 on the development of an architecture for an urban sharing platform to ingest, analyse and visualise data on energy and transport systems.

Greenwich has therefore proposed a revised architecture of the USP, utilising NEC's capabilities in ingestion, translation and analysis of data. This revised architecture is shown in Figure 1 Overview Greenwich USP which depicts the components proposed to be used for each of the functionalities of the architecture. Further detail on the current Greenwich USP architecture and components is also provided in D4.2 (M24 Update).

It is proposed that all the data sources (sensors, external data sources, legacy systems, etc.) will be integrated with the Greenwich USP through the ingestion layer provided by the CCOC; which will also provide functionalities for the Interoperability, Sharing, Data and Supporting layers of the USP Reference Model.

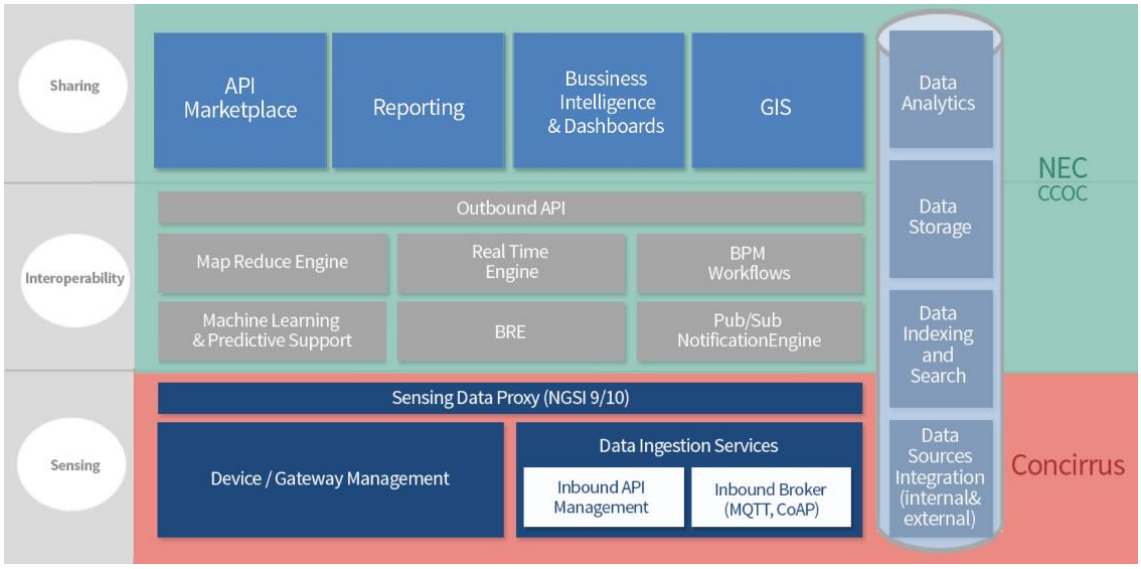


Figure 1 **Overview of Greenwich USP**

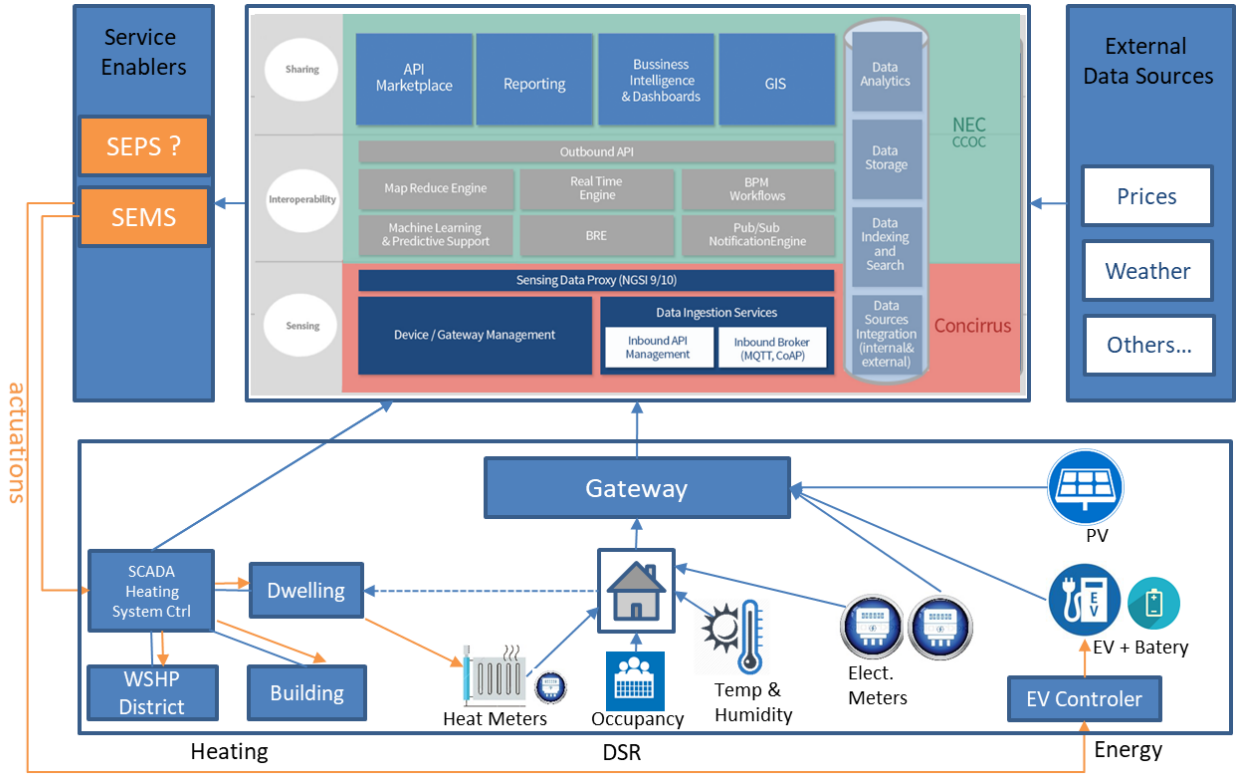


Figure 2. GREENWICH USP & INTERACTIONS

To further the development of the Greenwich USP towards operation, much work has been undertaken throughout year two to build an understanding of data flows to, through and from the USP, and of the USP's interactions with other work packages, especially WP3. Building this understanding was necessary in order to inform the USP's detailed design and development- to know what the USP is expected to deliver, its functionality, analysis it should undertake and visualization it should provide.

This process and its results are described in the following section '2.1.2. Mapping data and its use in the USP' and is structured as follows:

a) Mapping data the Sharing Cities programme will generate.
b) Where data will be coming from.
c) Data flow and use within the USP.
d) Data flows out of the USP.
e) Specialist Interactions.

2.1.2 Greenwich Data and Devices

a) Mapping data the Sharing Cities programme will generate.

Mapping the data being generated by the Sharing Cities programme in Greenwich was inherently linked to the measures and use cases deployed in Greenwich, and included considering in what unit and at what frequency the data would be generated. Once mapped at local level this was integrated with the wider Programme's process of developing and populating the Use Case Data Capture Table.

Figure 3 Snapshot of the Use Case Data Capture Table for Greenwich, shows the results of this data mapping exercise, it should be recognised that this captures solely the data rather than the flow of that data.

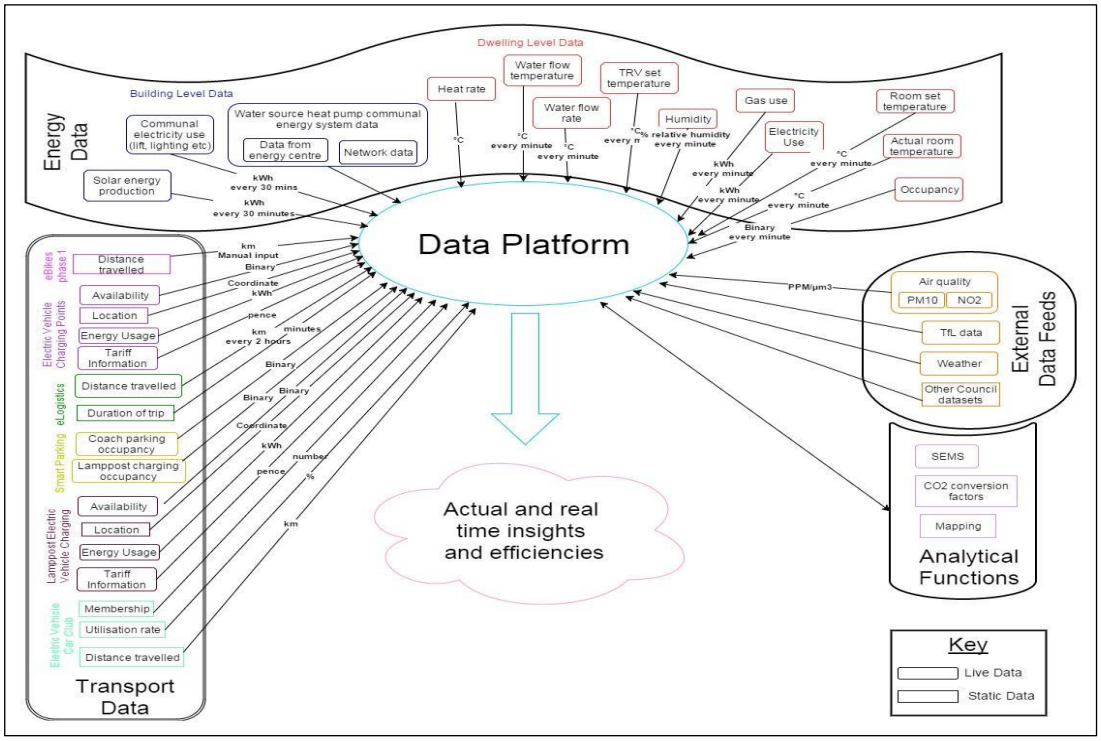


Figure 3 SNAPSHOT OF THE USE CASE DATA CAPTURE TABLE FOR GREENWICH.

b) Where data will be coming from.

This part of the process considered the devices, gateways and other platforms from which data will be derived, and had reference to how the USP would be ingesting data and whether any data translation and transformation would need to be enacted. This also included understanding the communication methods and formats being utilised. Again, this was integrated with the wider programme's process of developing and populating the Use Case Data Capture Table.

Determining where data would be coming from and in what format it would be delivered was a difficult process as in work package 3 the necessary procurement and implementation of devices had not yet reached a state where this information could be provided. However, this also offered an opportunity to influence procurement and device choice and dictate how devices/ data sources connected with the platform, and in what format.

Based on the proposed architecture and components of the USP it was determined that the integration and ingestion of data sources would be based on the FIWARE NGSI 9/10 protocol[1]. With this protocol being used to ingest the majority of data received from data sources in WP3 to NEC CCOC.

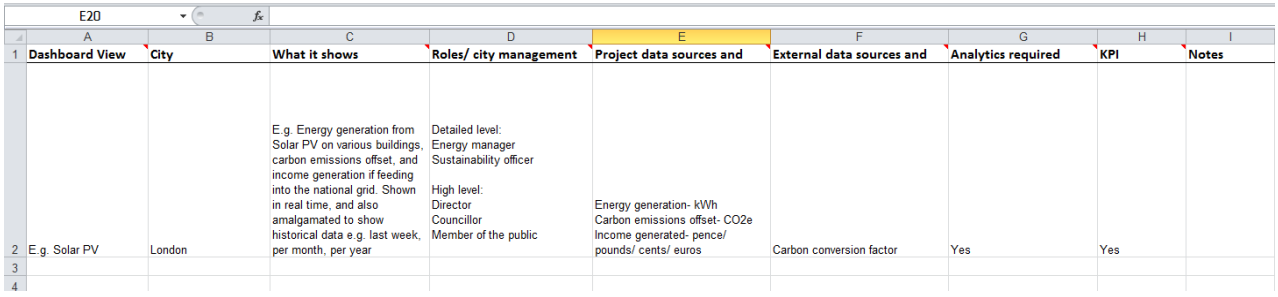
To this end requirements were created setting out how data sources and devices should connect with the Greenwich USP, putting the onus for such connection on the provider.

However, after interacting with project partners which were supplying devices and the market, it was established that although we may encourage the supplier to integrate with the Greenwich USP and utilise its integration approach and protocols, this was not always possible. This was especially the case when trialling data collection devices as companies were often reluctant to take on development costs to enable integration with the Greenwich USP for a trial. However, where possible Greenwich still intend to encourage, through the procurement process, suppliers of greater volumes to integrate with the Greenwich USP directly, supplying data in a dictated format.

c) Data flow and use within the USP.

To consider how data would need to flow and be manipulated within the USP, the end use of the USP needed to be considered, for example how a city manager would like to visualize and interact with data on a certain topic or measure, at what level of detail would then inform both how the USP would visualize this data and what would need to be performed on one or more data sets (i.e. analyses, KPI's, Business Intelligence) in order to meet that user need. A template was therefore created to define city manager end user visualization needs or 'dashboards'.

Figure 4 SNAPSHOT OF THE RESULTS OF THIS EXERCISE FOR GREENWICH.



	A	B	C	D	E	F	G	H	I
1	**Dashboard View**	**City**	**What it shows**	**Roles/ city management**	**Project data sources and**	**External data sources and**	**Analytics required**	**KPI**	**Notes**
2	E.g. Solar PV	London	E.g. Energy generation from Solar PV on various buildings, carbon emissions offset, and income generation if feeding into the national grid. Shown in real time, and also amalgamated to show historical data e.g. last week, per month, per year	Detailed level: Energy manager Sustainability officer High level: Director Councillor Member of the public	Energy generation- kWh Carbon emissions offset- CO_2e Income generated- pence/ pounds/ cents/ euros	Carbon conversion factor	Yes	Yes	
3									
4									

[1] https://www.fiware.org/

f) Data flows out of the USP. Where there may be a wish to share or publish data.

It became apparent from discussions with work package 3 that there may be instances whereby it would be useful for the city and its citizens to share data ingested and held in the USP with external parties. For example:

- Sharing data on parking space occupancy in coach parking bays with existing apps that are already regularly used by coach companies and drivers to identify parking spaces,
- Sharing data on parking space occupancy in parking bays that are co-located with an EV charge point with existing services providers and apps that are utilised by citizens wishing to access an EV charge point,
- Sharing and combining data with the London city data store to gain further insights and benefits.

g) Specialist Interactions.

This focussed on interactions between the USP and measures or areas of work package 3 where further and more specialist work had to be undertaken to integrate data and understand functions required of the USP. This mainly occurs for Greenwich in the interaction between the USP and work package 3.2- Sustainable Energy Management Systems. Much work has been undertaken during year 2 to understand how to bring this interaction to fruition in a way that will enable SEMs to function- being provided with an environment in which to operate, all the data it requires, and a USP functionality that can pass on instructions from SEMS to the relevant energy assets. The below figure 5. shows this interaction.

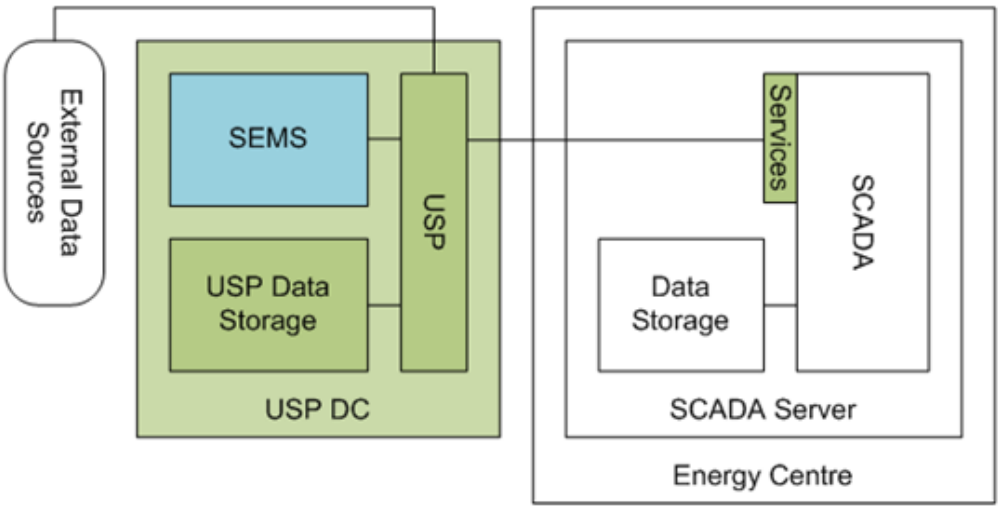


Figure 5 ***Architecture for SEMS and USP interaction, developed by Siemens UK and Greenwich.***

2.1.3 Greenwich USP Operational Status

The Greenwich USP has yet to integrate data from data sources and devices deployed as part of the Sharing Cities programme in Greenwich due to such data sources and devices not yet being deployed successfully. Some trials of dwelling level energy metering and monitoring devices have been conducted as part of work package 3.1 but integration with the USP was unable to take place due to communication issues experienced with these devices, namely the intermittent transfer of data via WIFI. This has provided much learning for the programme and will inform the wider procurement of in dwelling energy monitoring and metering devices and the communication methods they use.

Outside of the data sources and measures deployed in the Sharing Cities programme, Greenwich has successfully demonstrated an operational USP following the reference architecture of the Sharing Cities programme. This example has been realised in a faster timescale to the data sources and measures of Sharing Cities as the data collection devices and data systems to integrate with were already present.

This proof of concept USP has been realised for the Council's fleet management service area, and the following data sources have been successfully integrated into the USP, delivering an operational Sensing layer of the USP architecture:

- Real time data from telematics systems on board council fleet vehicles, which record data such as speed of the vehicle, location and running status
- Data from multiple Council legacy systems which include information on the fleet (type of vehicle, age, etc), usage of vehicles, instances of accidents, and repair and maintenance.
- Real time traffic information for Greenwich taken from open access API's
- Real time public transport information from Greenwich taken from multiple Transport for London open APIs
- Air Quality data taken from open access API's

Within the USP the above data sources have been manipulated and analysed, and modules realised to conduct business intelligence and attach KPI's. Processes and analysed data, as well as the results of KPI's and business intelligence have been visualized as part of the USP through tables, graphs and maps; demonstrating an operational Interoperability and Sharing layer of the USP.

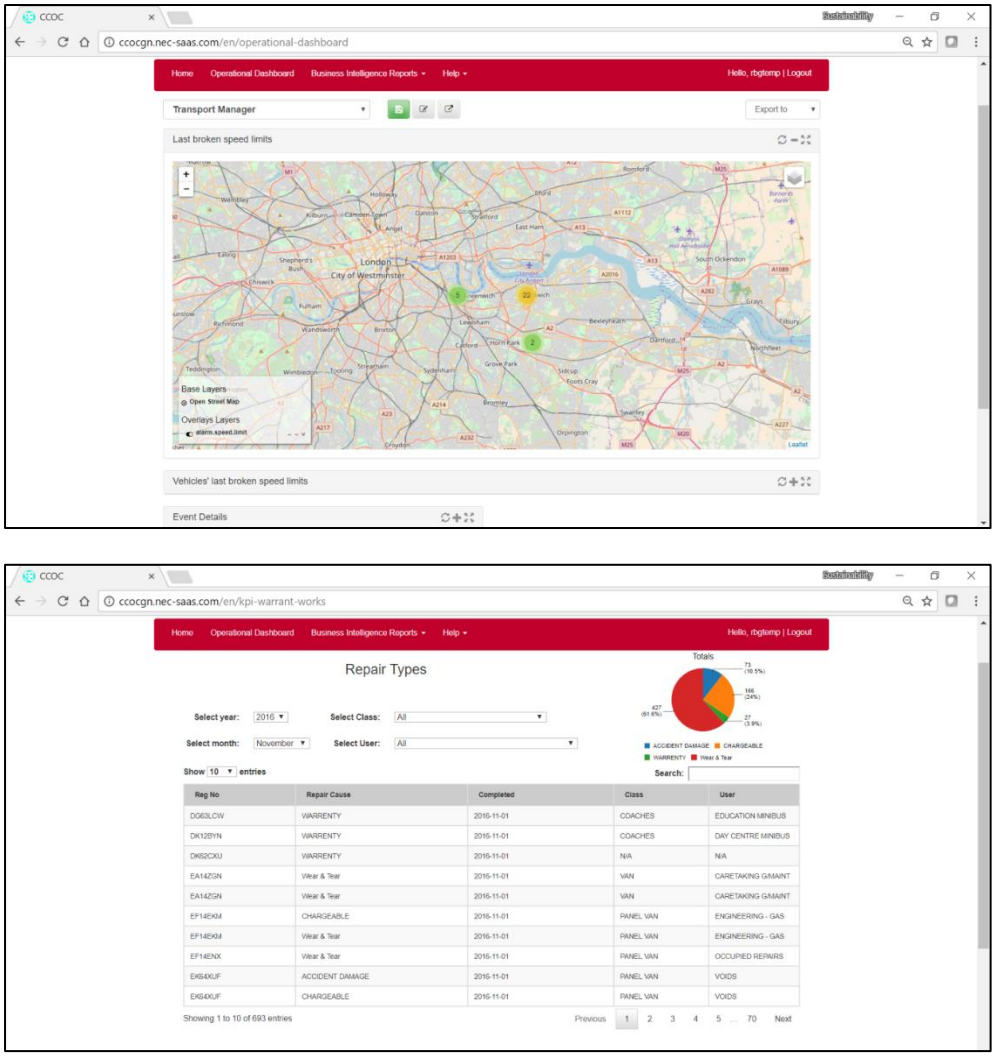


Figure 6 ***SCREENSHOTS OF AN OPERATIONAL PLATFORM IN GREENWICH USED FOR FLEET MANAGEMENT***

2.1.4 Greenwich Next steps

The next steps for Greenwich in order to realise an operational USP for the data sources and measures deployed in the Sharing Cities programme in Greenwich are as follows:

- Confirm a technical partner to carry out the role of Concirrus as it is their intention to withdraw from the programme
- Once the above is complete finalise the revised architecture and components of the Greenwich USP for Sharing Cities
- Integrate all relevant data from work package 3 into the Greenwich USP
- Ensure all external data sources required of work package 3 are integrated into the Greenwich USP

- Finalise the city manager end user needs to specify the visualization and analysis required within the Greenwich USP
- Establish an environment and finalise operational principles for a SEMS module within the Greenwich USP

2.2 London City DataStore

2.2.1 London City DataStore USP design

Led by the Greater London Authority(GLA) and MastodonC, the USP architecture, open standards and approach have been applied to develop an infrastructure for sharing metadata, data connections and actual datasets across London's public organisations.

The infrastructure is based on open source software, is open source itself (will be published and documented on GitHub) and is cloud hosted. A key philosophy is the use of APIs allowing it to be connected with any other platform that also uses open standards to present or request data.

All activity on the City DataStore is captured in a central events log, allowing data processes to be replicated if required, but also allowing for future machine learning algorithms be created based on user behaviour (such as searching patterns) and to develop small standards 'from the ground up' based on datasets that have been uploaded or linked to

2.2.2 London City DataStore Data and Devices

The API has been used to link to four networks of sensors in the Olympic Park (Weather, Bat monitoring, smart energy meters, geotagged tweets). However, it main use will be in supplying context data to the Greenwich USP and to SEMS (WP3) and in receiving aggregated data from these systems for use in city modelling and analytics.

2.2.3 London City DataStore USP Operational Status

The City DataStore is in full operation (i.e. it is in a production environment), the API is documented and there is a statement about the security arrangements available for users to view. There is also a chat-based support facility (run by MastodonC) and a short video for new users. There is a (manual) process for onboarding new users and assigning them to groups (data/metadata can be shared with a whole group, rather than having to tick a long list of potential users one at a time).

The City DataStore has an initial batch of 30 users in its first few weeks and is being used to store and share live data on live projects, including with researchers at the Alan Turing Institute and staff at the Olympic Park authority (LLDC).

There is still Sharing Cities funded development to take place in the next 12 months and we are working with MastodonC on the prioritised list of extra features.

In January 2018, the upload limit for a single file will increase to 5Tb. A search function (so that users can find their way directly to the dataset they want, rather than scrolling through a long list of files, which is how the system was launched). Collect + Share (this addresses the need to request data from multiple partners, ensure that they provide it against an agreed schema and see an overview of who has provided what)

Figure 7 London ***CITY DATASTORE LOGIN SCREEN***

Functions available at launch include

- upload files - owner chooses which other users/groups of users can see the metadata and/or the actual data
- standard metadata captured for entered for every dataset
- data packs (groups of datasets used on a project)

- API
- GLA login page, dataset logo
- 5Gb upload limit for a single file

The launch featured in the widely read London DataStore blog https://data.london.gov.uk/blog/city-datastore-better-data-sharing-for-impact-from-londons-data-ecosystem/

2.2.4 London DataStore Next steps

London WP4 still has a small amount of funding available which will be used during the lifetime of the Sharing Cities Programme to fund the development of additional features based on use cases and feedback from users. Based on our experience with the Open Data (CKAN) platform, there are pieces of development (or opportunities) that only become clear once the system as actually in regular use – and in fact 4 years after launch, we are still adding features or making bespoke connections to other open data stores.

Planned development over the coming 12 months:

- API will also be used to share data in both directions with the Greenwich USP.
- Search/filter for datasets
- URL as well as file upload
- CKAN harvesting (allows calling in of open data from London DataStore)
- Data packs (versioning for regularly updated datasets)
- Test against schema to ensure consistent data is uploaded
- Collect and share interface to manage data requests to multiple organisations
- Sub-set datasets and access via get request (for instance just data for a certain time period)

Additional funding sources include the Alan Turing Institute and other subscribers to the platform via MastodonC's subscriptions (mostly other local authorities).

2.3 Lisbon Operations

In Lisbon, to this date, the USP design and development has followed an iterative approach. In the first project year (M1-M12), the available resources for the USP have been identified and catalogued, and was translated into the first reference models for the USP, resulting in the first version of Lisbon´s USP architecture, aligned with the reference model defined at the global project level.

By year two (M12-M24), further iterations with Lisbon´s partners, resulted in further components being identified and catalogued. By the end of 2017, as a result of the implementation, by the Municipality of the NEC's platform – CCOC - that will support it´s City Operations Center (COI), and also the plans by the Municipality to

implement the SEPS (sustainable energy planning system) through the NEC platform, further revisions of the USP reference model are taking place and are expected to carry on until January 2018.

By the third year of the project, the final reference model of Lisbon´s USP will be achieved, integrating the latest developments and components, brought through the SEPS and SEMS implementations by the Municipality and EDP-D managed by the T3.2 local team. The realisation of the USP´s functionality covering the selected use cases and measures, will be achieved and the necessary data sources will be integrated. As data flows become available and integrated, the team that will develop the user dashboards and interfaces, will have the necessary resources to deploy the necessary apps and dashboards to the users.

2.3.1 Lisbon USP design

Currently Lisbon´s USP architecture is aligned with the common USP reference model, and is based on Altice Labs solutions.

As indicated in the last section of this document, with the deployment of the Integrated Operations Center Solution for Lisbon, and with its software platform (NEC CCOC) being made available to the Municipality, the Municipality took the decision to use it to achieve the SEPS T3.2 defined business requirements.

This has led to a discussion amongst the local partners on the previously defined role of the SEPS system on the global USP Architecture, that is still ongoing and expected to stabilize with a revised USP global architecture for Lisbon by the end of January 2018. This alignment between Lisbon´s USP and the NEC CCOC platform has also led to discussions on synergies and sharing of technical information between the Greenwich and Lisbon´s NEC CCOC teams concerning SEPS functionalities and design.

At this time, and still not reflecting the future scenario of SEPS deployment in Lisbon, the global USP Architecture that mirrors the developed work up-to-date is represented in the diagram bellow, providing a high-level view of the USP and its components:

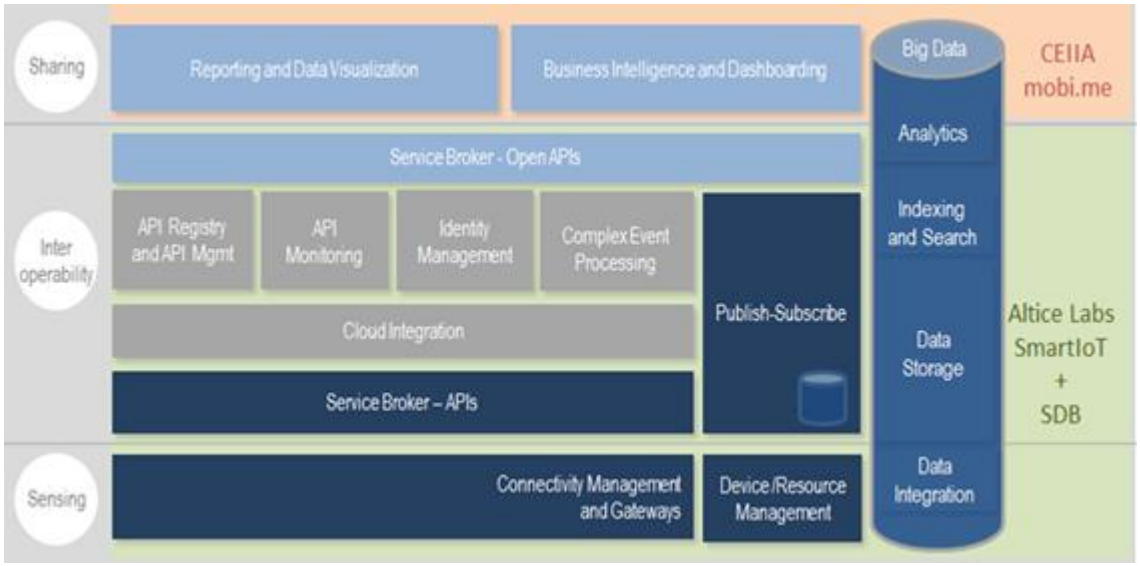


Figure 8 *Overview Lisbon USP*

Below, a high-level view of the USP and its components and its interactions with other WPs and data sources is presented:

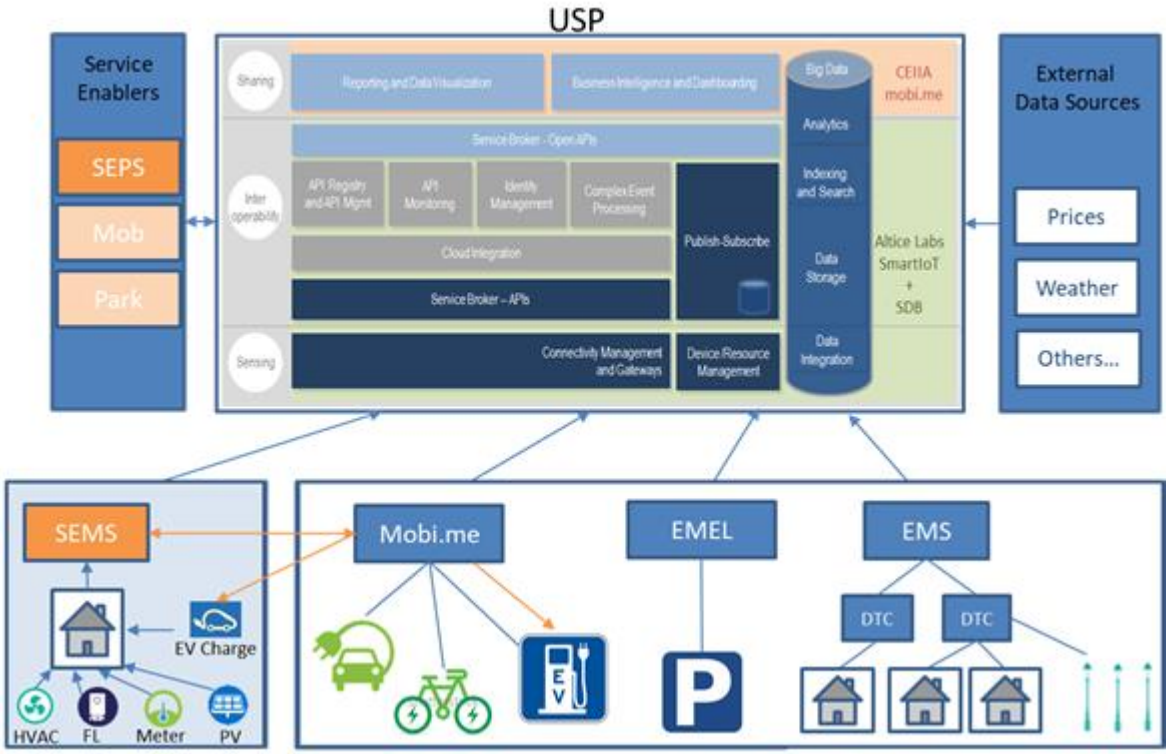


Figure 9 Lisbon´s USP & Interactions

2.3.2 Lisbon Data and Devices

In this section we provide a brief overview of the main IT solutions belonging to the WP3 local interventions which provide data to the USP and integrate with it, through their respective interfaces/APIs:

- Car/bike sharing operators' data, from the Municipality and EMEL, regarding vehicle position (i.e., geolocalization), vehicle status (free/busy/etc.) and status of the stations;
- Sensors providing environmental and energy data in the city and on selected buildings, provided by the Municipality and EDP-D, through SEPS and SEMS integration with the USP;
- EV charging station data, about charging points, geolocalization, data about e-vehicles being charged, provided by CEiiA;
- Smart Parking data, from EMEL;
- Municipality of Lisbon´s Operations Center (COI), relevant energy and mobility data;

2.3.3 Lisbon USP Operational Status

Lisbon´s USP has yet to integrate most of the selected data from data sources and devices deployed as part of the Sharing Cities programme. However, trials have been conducted as part of work package 3.1, 3.2 and 3.4, but integration with the USP was unable to fully take place, due to:

- integration issues experienced and discussions on data privacy;
- the level of granularity of data to be made available to the USP;
- the ongoing discussion on the revised scenario of integration of the SEPS and SEMS systems with the USP and NEC CCOC solution (COI);

This has provided valuable insights for the programme and will inform the wider procurement of smart city solutions for the city.

A proof of concept USP has been realised by Altice Labs, and the following data sources have been successfully integrated into the USP, delivering an operational Sensing layer of the USP architecture:

- Real time data from telematics systems on board council fleet vehicles, which record data such as speed of the vehicle, location and running status
- Smart Lamppost sensor data taken from open access API's developed with Lisboa E-Nova, regarding T3.4

2.3.4 Lisbon Next steps

The planned next steps for Lisbon regarding the USP are the following:

- Define the final scenario of SEPS and SEMS integration through the NEC CCOC solution with the USP;
- Finalise the revised architecture and components;
- Integrate all relevant data from work package 3 systems and devices;
- Ensure all external data sources required of work package 3, are integrated;
- Finalise the ongoing work regarding dashboards final user needs (city managers and citizen);
- Specify the visualization and analysis requirements;
- Set up and deploy an environment and finalise operational principles;

2.4 Milan Operations

The operation and evolution of the for the city of Milan follows an incremental and iterative approach. During the first two project years (M1-M24) the following iterations have been performed:

- Milan USP v1 (M12). Local activities during the first project year were mainly focused on defining the scope of the USP, i.e., how Milan planned to cover the USP reference model defined at project level, as described in D4.2. This activity mainly took into account IT components and infrastructures already in place (e.g., the Interoperability Platform of the Municipality of Milan, the Monet EMS solution, see Sect. 2.3.1.3.1) and related integration and configuration activities. The result at M12 was a core version of the USP, a proof of concept made of different operating components and capable of demonstrating basic API-based integration between the Monet EMS solution (which already acquired some data from test sensors of the smart district) and the Milan Interoperability Platform. More details about Milan USP v1 can be found in Sect. 2.4.1.
- Milan USP v2 (M18) and v3 (M24). During the second project year, the Milan USP began to take advantage of real data provided by some WP3 local interventions. API-based integration mechanisms between Monet EMS and the Interoperability Platform were updated and refined accordingly. In particular, an evolution of the defined interfaces and standards for collecting information from the field was defined in order to convey the payloads of the specific sensors and devices known so far. The Interoperability Platform of the Municipality was also enriched by means of new components supporting the publish-subscribe interaction pattern (i.e., the Message Broker) and the authentication and authorization mechanisms for users and applications (i.e., the Identity Server). Moreover, during the second project year various experimentations started to enrich the Milan USP with new components and features that are currently under evaluation, in particular as for data storage (thanks to the ongoing collaboration with the national Digital Transformation Team) and data visualisation (thanks to the integration into the USP of the geoportal of the Municipality). In general, the Milan USP always try to address needs and requirements stemming from other WP activities and related use cases, in particular as for actual data provision (WP3) and data usage (WP2 and WP8).

During the third project year the Milan USP could be possibly enriched by means of new components, if needed, but the main goal by M36 is to make it more extensively used by project end-users, thus enabling further refinement of USP features in order to better meet project and city needs.

2.4.1 Milan USP Design

The purpose of this section is to illustrate the IT solutions currently in place (or planned) in the city of Milan, which are relevant with respect to the realisation of the USP reference model and to the operation of the city USP.

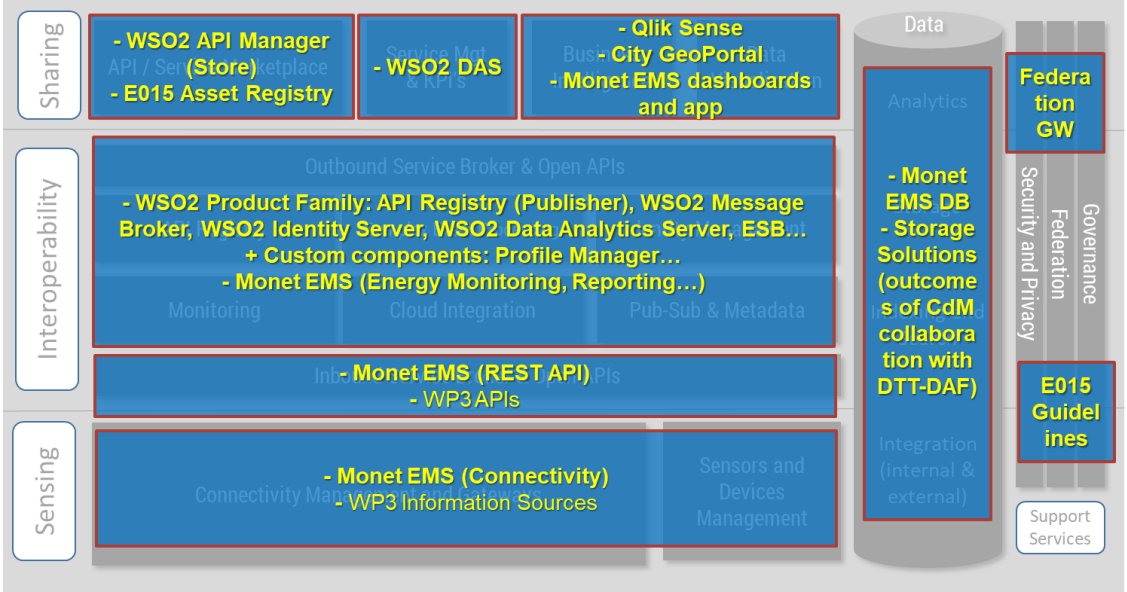


Figure 10 Overview of Milan USP

The following diagram provides a high-level view of the USP in Milan and its interactions with other WPs, data sources etc. Each USP component is described in more detail in the following sections. In order to support a more complete understanding of the overall USP UCs in Milan, the following sections include also some high-level information about the planned interventions related to field data sources (WP3) and end-users (WP2, WP8), so to recall a brief description of the project measures interacting with the WP4 USP.

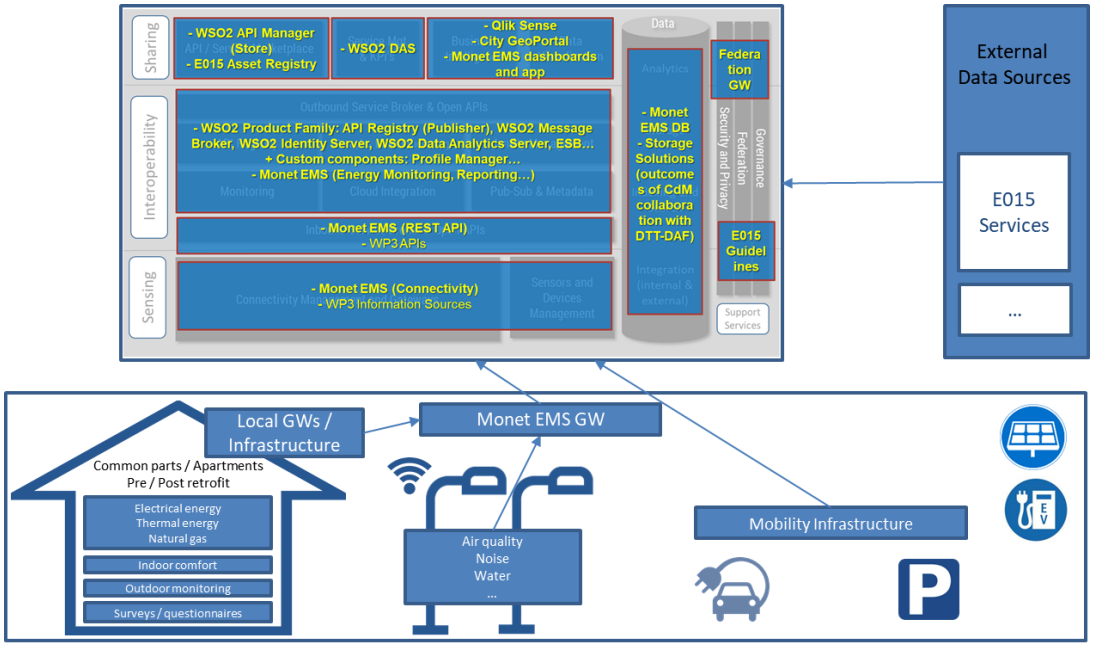


*Figure 11 **MILAN USP** AND INTERACTIONS*

2.4.1.1 USP END-USER APPLICATIONS

The purpose of this section is to briefly describe some of the different types of consumers that will access the Milan USP, i.e., in a broad sense the local or global end-user applications that are being or will be built by the project to support interventions in Milan's smart district. These applications mainly belong to the following WPs:

- WP2 "People": End-user applications supporting citizen engagement interventions and other initiatives mainly targeted to final users (e.g., the Digital Social Market, the Service Layer).
- WP3 "Place": End-user applications that are part of solutions built and deployed in the context of WP3 (e.g., car/bike sharing mobile apps).
- WP8 "Monitoring and Evaluation": Applications that implement the evaluation logic of the monitoring framework defined and built by WP8 by leveraging also data made available through the USP.

As described in D4.2, other end-user categories may stem from the relationship between the Milan USP and initiatives such as the E015 digital ecosystem (see Sect. 2.3.1.3.3).

2.4.2 Milan Data & Devices

The purpose of this section is to provide a brief, indicative description of the main IT solutions belonging to the WP3 local interventions which provide data to the USP and integrate with it:

- Sensors providing data about energy consumption and environmental comfort in apartments and buildings: such appliances and devices provide data that is conveyed to the USP thanks to the mediation and elaboration performed by the Monet EMS system (see Sect. 2.3.1.3.1).
- Car/bike sharing and logistics operators' platforms: These components represent the respective IT platforms of different operators, that will be able to provide information such as vehicle position (i.e., geolocalization), vehicle status (free/busy/etc.) etc. and in some case the status of the stations.
- PSS – Smart Parking System: A solution supporting mobility and parking management. This solution will be deployed in the cloud in order to provide information about the smart parking spots and sensors installed in the demonstrator area in Milan, in correspondence of e-vehicle charging stations. Information provided through a REST API include: parking areas (id, name, geolocation, status etc.), parking sensors (id, geolocation, status, setup date etc.) etc.
- EV charging station operator platform: This platform will be able to provide information about charging points (geolocalization, data about e-vehicles being charged).

These components are accessed by the USP through their respective interfaces/APIs.

2.4.3 Milan USP Operational Status

This section describes the ICT solutions constituting the Milan USP in the context of WP4 activities. As described in D4.2 and D4.3, the Milan USP is mainly the result of the integration, enhancement and evolution of:

- The Monet EMS solution by Siemens IT (see Sect. 2.3.1.3.1).
- The Interoperability Platform of the Municipality of Milan (see Sect. 2.3.1.3.2).
- The E015 digital ecosystem, an institutional initiative active in Italy since 2013 (see Sect. 2.3.1.3.3).

The following sections describe each component in more details.

2.4.3.1.1 MONET EMS

Monet (Mastering and Operate Next generation of Energy of Things) is a cloud platform by Siemens IT providing set of services for Energy Monitoring and Energy Management following the SaaS model. It is a solution for monitoring, controlling, and optimizing energy flows inside a specific site or location being a Smart Grid, a Micro Grid, a Smart City or part of it. This EMS solution is able to aggregate data from various sources (e.g., sensors, gateways, devices), process and visualize data. Monet services are accessible via a set of state-of-the-art Web applications. Monet HMI is designed as a dashboard/cockpit to provide to users high-level information through an intuitive user interface to supports business level decision. It supports MQTT devices and is able to adapt other communication protocols.

The following figure summarizes the logical architecture and main features of Monet.

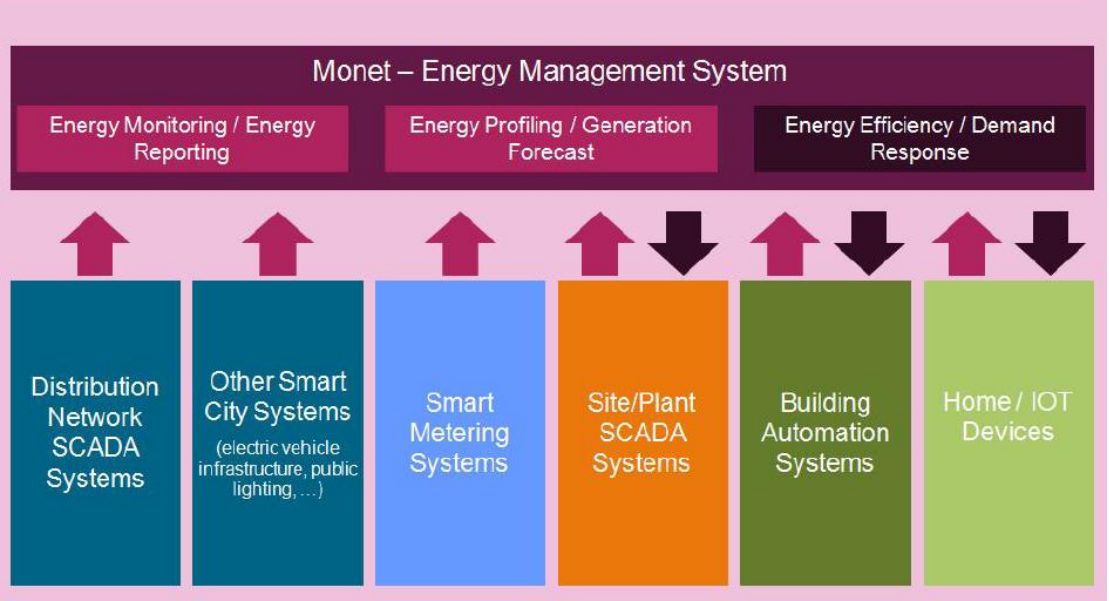


Figure 12 ***SIEMENS'S MONET EMS CONCEPT***

Monet EMS is already operational and supports the Milan USP. As soon as data from WP3 local interventions is becoming available, Monet collects and processes data mainly related to retrofit of private and public buildings in the "Porta Romana / Vettabbia" smart district.

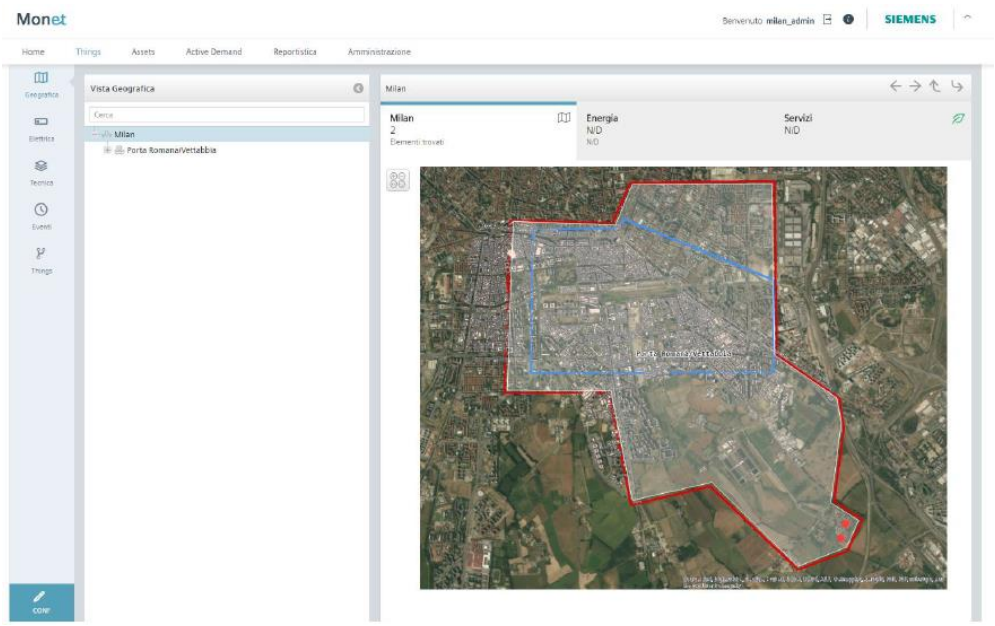


Figure 13 ***MONET FOR MILAN SMART DISTRICT – EXAMPLE OF DASHBOARD***

2.4.3.1.2 INTEROPERABILITY PLATFORM OF THE MUNICIPALITY OF MILAN

The Interoperability Platform of the Municipality of Milan is a set of components enabling, fostering and governing IT interoperability within the Administration and at city level. The platform is able to collect and process different kinds of information from different sources, internal and external. Internal information include, e.g.,

- Master data (e.g., toponymy, registries).
- Data specific to internal "vertical" applications.
- Citizens' opinions gathered through various communication channels.

Based on this data, the Interoperability Platform enables the realization and management of different kinds of APIs. The Interoperability Platform is currently mainly based on a set of selected open source components belonging to the WSO2 product suite, as described in the following sections.

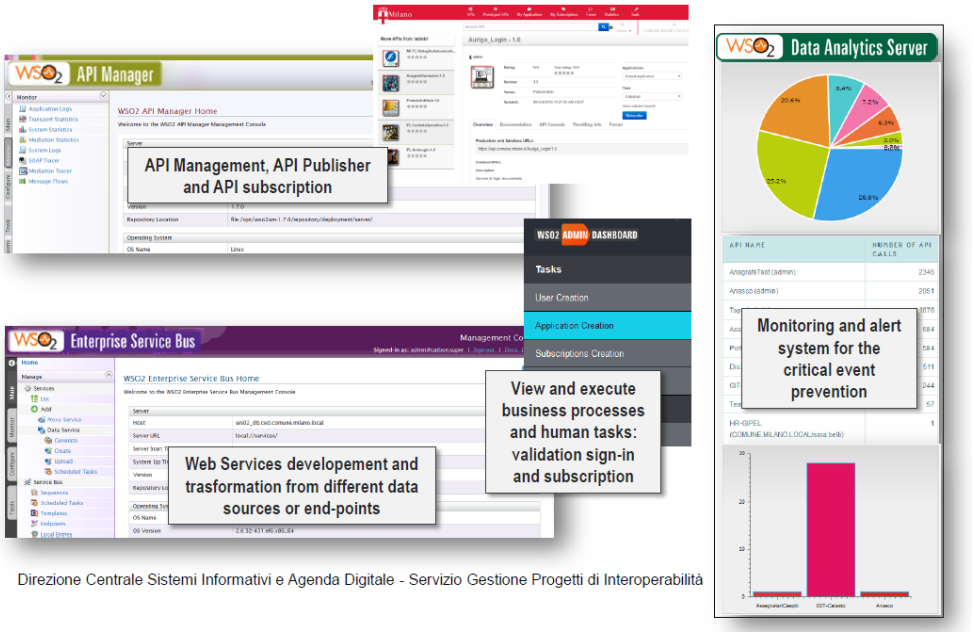
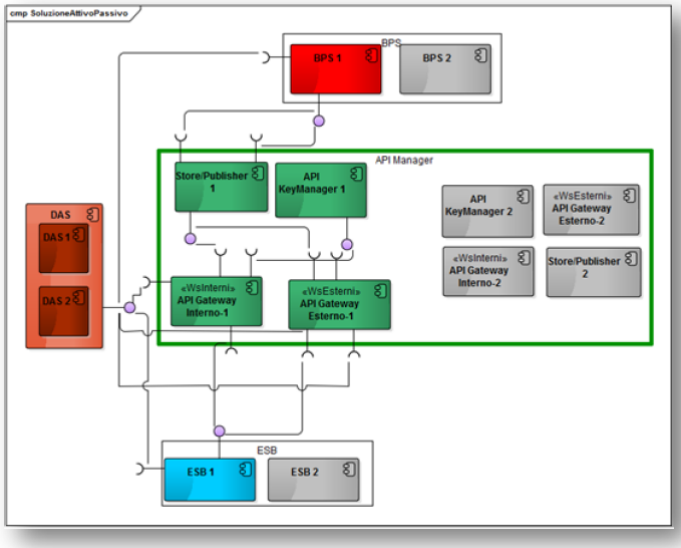


Figure 14 MAIN COMPONENTS AND FEATURES OF THE INTEROPERABILITY PLATFORM OF THE MUNICIPALITY OF MILAN

Current platform deployment (on premise, leveraging the IT infrastructure of the Municipality) adopts a failover solution in active-standby configuration.

Failover solution (active-stanby configuration with 8 istances x 500 transactions per second)



1. fault tolerant redundant environment F5 balancer based.

   Send String Example
   HEAD /services/Version HTTP/1.1\r\nHost: www.wso2cdm.local \r\n\r\n

2. WSO2 Technical Support 24x7x365 for every active istance

Component	N. Active	N. Standby
API Manager	4	3
DAS	2	0
ESB+DSS	1	1
BPS	1	1
	8	5

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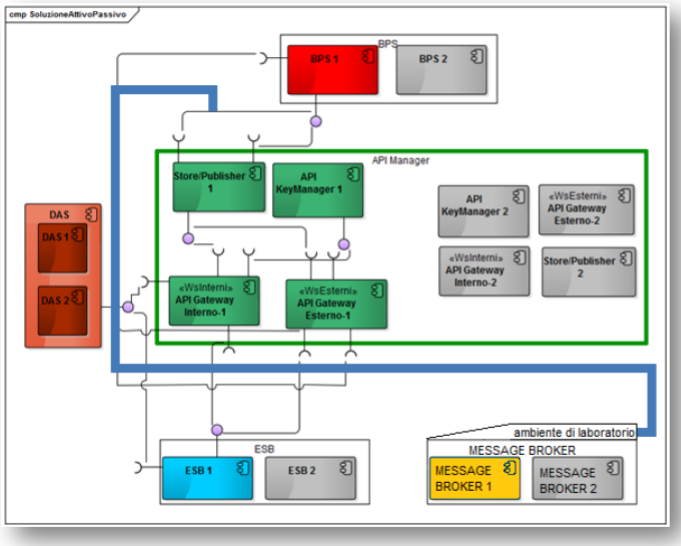
Figure 15 MILAN MUNICIPALITY INTEROPERABILITY PLATFORM – CURRENT PRODUCTION ENVIRONMENT

Failover solution (active-stanby configuration with 8 istances x 500 transactions per second)



Municipality is implementing production environment with Message Broker to support a Publish/Subscribe role for Sharing City USP and also for other applications.

2017
only DEVELOP enviroment

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Figure 16 MILAN MUNICIPALITY INTEROPERABILITY PLATFORM – TO-BE PRODUCTION ENVIRONMENT

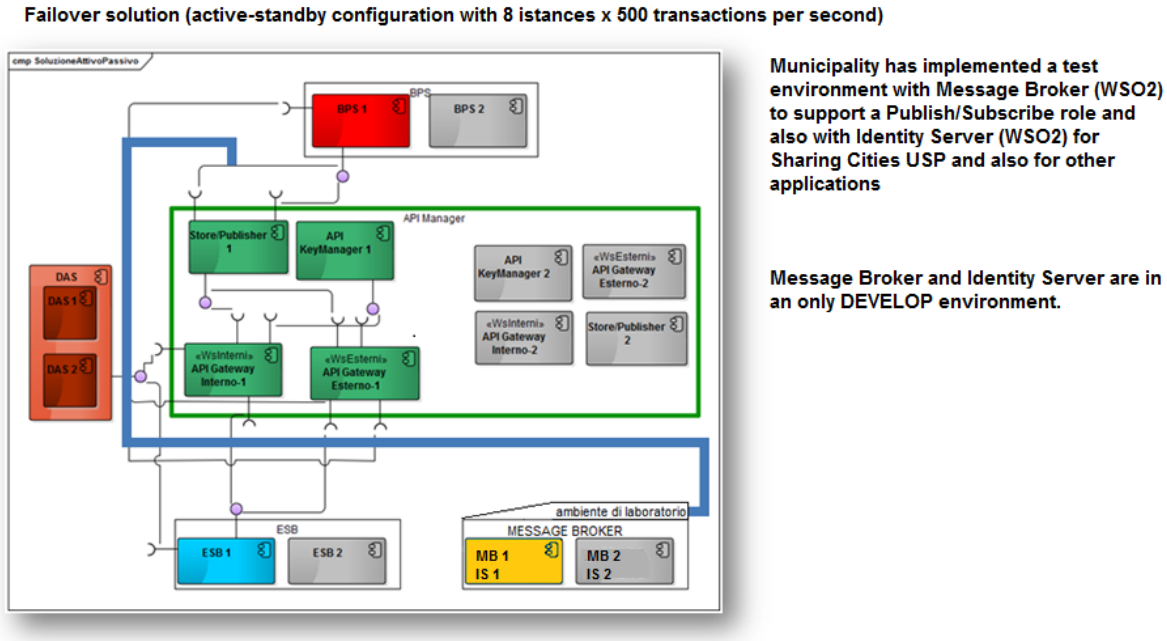

Figure 17. MILAN MUNICIPALITY INTEROPERABILITY PLATFORM –PRODUCTION ENVIRONMENT (WITH MESSAGE BROKER (MB1 AND MB2) AND IDENTITY SERVER (IS2 AND IS2) IN TEST ENVIRONMENT

2.4.3.1.2.1 WSO2 API MANAGER (PUBLISHER AND STORE)

This component enables management of API publication and API subscription. It is based on the WSO2 API Manager tool v1.10.0[2]. APIs can be published through the API Publisher v1.10.0 subcomponent in order to be made available via a self-provisioning Web portal (API Store v1.10.0 subcomponent). APIs can be used by the subscribers through the internal and the external Gateway, under defined security roles and policy. The key manager sub-component supports OAuth2 authentication. REST and SOAP APIs are available with a unique domain end-point. The end-point services can be developed by internal suppliers by means of ESB tools.

[2] https://docs.wso2.com/display/AM1100/WSO2+API+Manager+Documentation

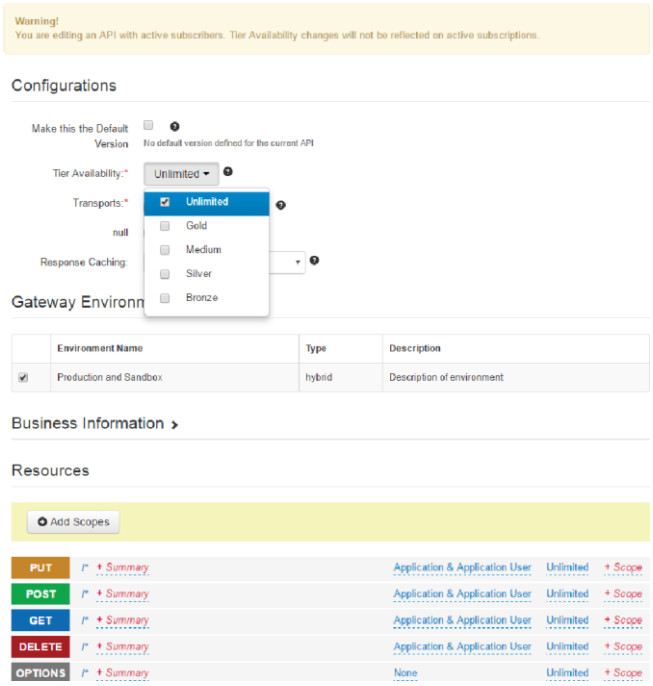

Figure 18 ***WSO2 API MANAGER, PUBLISHER – API CONFIGURATION EXAMPLE***

The API Manager is also able to provide statistics about API usage.

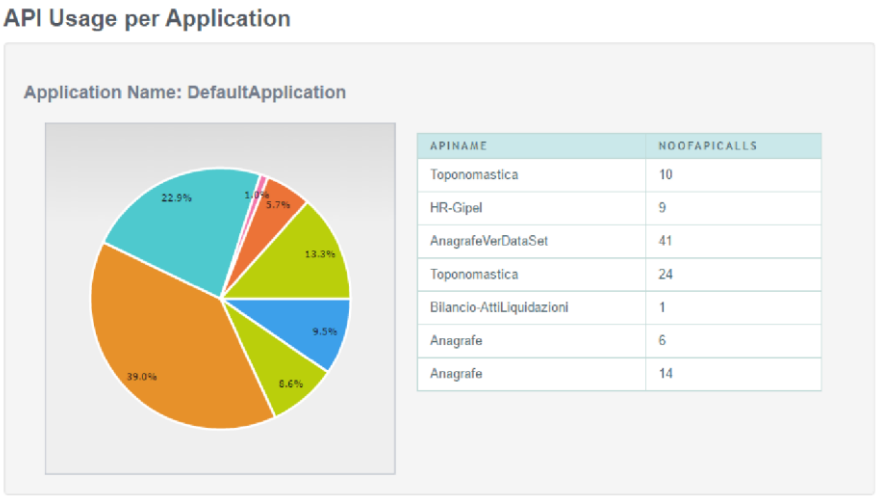

Figure 19 ***WSO2 API MANAGER – API USAGE STATISTICS EXAMPLE***

The API Console Manager v1.10.0 subcomponent enables advanced management of API users and roles, including visibility level on published APIs.

2.4.3.1.2.2 WSO2 Service Gateway

This component acts as an outbound gateway for fruition of external resources (e.g., external APIs). It relies on OAuth2 authentication. It is part of the family of WSO2 open source tools.

2.4.3.1.2.3 WSO2 Identity Server

This component is the identity server used by the other USP components (the API Manager, Store and Publisher in particular) for authenticating via OAuth2 service/API consumers. It is also used by external applications to authenticate the local Sharing Cities users and thus enable SSO to ensure a seamless user experiences. I.e., the component will be in charge of managing the identities and profiles of the users of the Sharing Cities local solutions. It is based on the WSO2 Identity Server tool v5.2.0[3]. Multiple authentication protocols are supported, including SAML and OpenID Connect.

2.4.3.1.2.4 WSO2 Business Process Server

This component supports the design and implementation of business processes related to communication management for service fruition (subscription, registration, update etc.). It is based on the WSO2 Business Process Server tool v3.5.1[4]. This component can manage and process every activity in which human interaction is needed, e.g., a validation step in a service subscription and registration workflow. It also manages the definition of the throttling tiers for usage of published APIs.

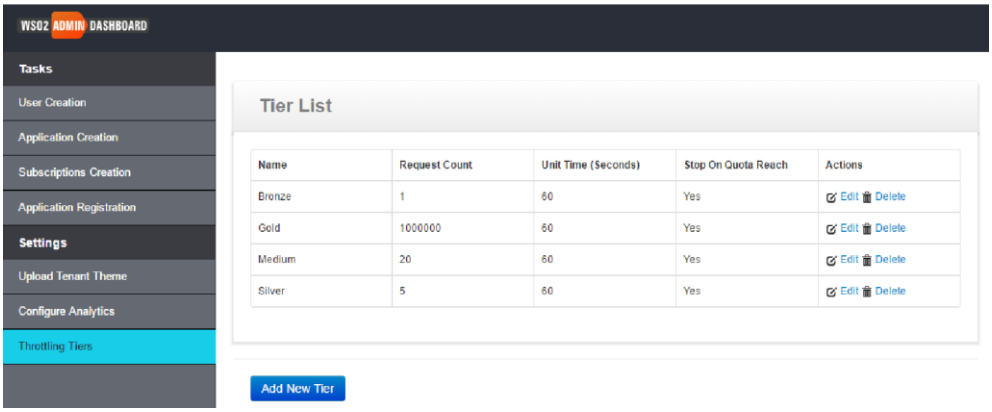

*Figure 20. **WSO2 Business Process Server – Settings Example***

[3] http://wso2.com/products/identity-server/
[4] http://wso2.com/products/business-process-server/

2.4.3.1.2.5 WSO2 Publish-Subscribe Message Broker

This component supports the publish-subscribe interaction paradigm. It will be based on the WSO2 Message Broker tool[5]. It will support connection with remote devices and sensors via the MQTT protocol.

2.4.3.1.2.6 WSO2 Data Analytics Server (Business Activity Monitoring)

This component enables monitoring of service behaviour and smart alerting in case of critical situations. It is based on the WSO2 Data Analytics Server tool v3.0.1[6]. It is currently installed on the same machine that manages the Business Analytics Monitoring server. It constitutes a console for the monitoring of each data transaction. This component analyses data in real time or in batch mode, and plays a fundamental role to control the status of the request load related to the machine request time. The Data Analytics Server is also necessary to locate errors and find the appropriate solutions.

The Data Analytics Server component is the most onerous component to run and maintain due to the resources and the production server support it requests. In fact, for each service request instance between two end-points, the component tracks all the communication status, producing a great quantity of data that can be used to analyse every possible bottleneck and every process problem.

2.4.3.1.2.7 WSO2 Enterprise Service Bus

This component enables the realization of advanced services by integrating different data sources exposed via APIs. It is based on the WSO2 Enterprise Service Bus tool[7].

2.4.3.1.2.8 Business Intelligence

The following components are currently available to the Municipality of Milan to support business intelligence and visualization features:

- SAS Visual Analytics.
- Qlik Sense Business Intelligence.
- SAS DataFlux.

All of these tools adopt a commercial license.

2.4.3.1.2.9 Geoportal

The geo portal of the Municipality of Milan[8] is the entry point for accessing a wide set of map-based city data. It supports cartographic visualization of data made available via REST/SOAP services. In order to be processed, data to be visualized on map should be annotated with proper metadata (guidelines are available).

[5] http://wso2.com/products/message-broker/
[6] https://docs.wso2.com/display/DAS301/WSO2+Data+Analytics+Server+Documentation
[7] http://wso2.com/products/enterprise-service-bus/
[8] https://geoportale.comune.milano.it

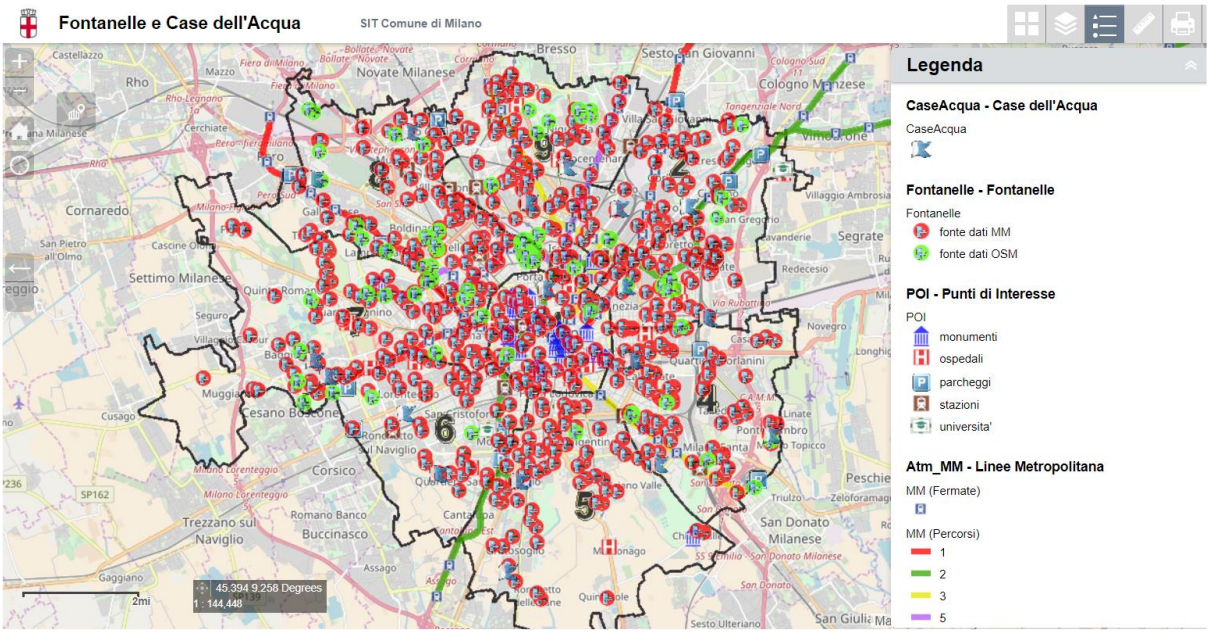

Figure 21 GEOPORTAL OF THE MUNICIPALITY OF MILAN

2.4.3.1.2.10 DATA STORAGE

This component is charge of storing part of the data ingested and managed by the USP. The Municipality of Milan started a collaboration activity with the national Digital Transformation Team – Data & Analytics Framework group[9]. The DAF group is developing data storage and data analytics/correlation solutions that will be shared with Italian local Public Authorities. The Municipality of Milan is collaborating with the DAF group in the design, configuration and test of such solutions. In particular, the Municipality provided examples of Sharing Cities datasets, and then will leverage such data with specific focus on data processing and elaboration in line with project use cases. This activity will lead to an enhanced USP better implementing the common Reference Model and addressing project needs.

2.4.3.1.3 E015 DIGITAL ECOSYSTEM

Service interoperability at regional/national level – and beyond – is achieved through the E015 digital ecosystem[10]. E015 is a multi-stakeholder digital ecosystem developed under the scientific coordination of Cefriel in order to exploit the Expo Milano 2015 event as a major opportunity to introduce disruptive innovations in all

[9] https://medium.com/team-per-la-trasformazione-digitale/public-administration-open-government-data-analytics-framework-27b7180cfb25

[10] http://www.e015.regione.lombardia.it/PE015/ (in Italian).

aspects of urban life: infrastructures, transportation, cultural and social life, accommodation, services and facilities etc. The ecosystem operates since 2013.

E015 contributes to the Milan USP in different ways, by sharing actual IT components (e.g., the asset registry) as well as technical and process guidelines for participating in the ecosystem.

2.4.3.1.3.1 E015 Asset Registry

The E015 Asset Registry is the main entry point of the E015 ecosystem. It provides the following features:

- Acts as the showcase Website of the ecosystem, providing all interested visitors with information about the goals and the current status of the Ecosystem initiative, advertising current results achieved in terms of active participants as well as number and kind of services, applications and glossaries published etc.
- Makes publicly available the process and technical guidelines of the ecosystem.
- Provides candidate participants with a Web form for submitting a membership request.
- Provides registered users with Web forms for submitting publication requests for new services, applications and glossaries.
- Supports participants and the Technical Management Boards with workflows and notification mechanisms for managing the different publication processes.
- Provides a Web interface for browsing the Ecosystem registry.

The E015 Asset Registry is composed of:

- The participant registry, listing all the subjects that joined the Ecosystem.
- The service registry, listing all the atomic or composed services published in the Ecosystem, with their respective descriptors.
- The application registry, listing all the end-user applications published in the Ecosystem, with their respective descriptors.
- The glossary registry, listing all the glossaries (data models, taxonomies, ontologies etc.) available in the ecosystem, with their respective documentation.

The Asset Registry also supports the creation of relationships between the instances of E015 entities, e.g.,

- Providers are linked to the services, applications and/or glossaries they published.
- Composed services are linked to the atomic services they use.
- Applications are linked to the services they use.
- Services are linked to the glossaries they use.

The E015 Asset Registry will be populated with a selection of Sharing Cities APIs and glossaries developed in the project. User of Sharing Cities solutions will be listed as application providers as well.

The E015 technical guidelines and best practices, publicly available on the ecosystem Web site, define different aspects of the E015 ecosystem operation, e.g.,

- Ecosystem roles and responsibilities.
- Processes and related activities: how to join E015, how to publish a service, an end-user application or a glossary.
- Technical guidelines, standards and best practices for realizing E015 services or end-user application (taking into account aspects such as security, interaction patterns, caching, exception handling versioning etc.).

2.4.3.1.3.2 FEDERATION GATEWAY

The Federation Gateway component will enable interoperability via E015 at international level, e.g., between the Lighthouse Cities, as well as the fellow/link cities. This component will design and implement standard approaches to make available APIs and services present in the USP of one city to the federated USPs of other cities.

2.4.4 Milan Next Steps

The Milan USP is currently composed of different already operating components (the Monet EMS and the Interoperability Platform of the Municipality of Milan in particular) and it is being configured to fully support city UCs. This USP realisation already implements API-based integration between the Monet EMS solution and the Interoperability Platform of the Municipality. In particular, the Monet solution already acquires, stores and elaborates actual data from test sensors deployed in the smart district of “Porta Romana / Vettabbia”. Data currently acquired by Monet EMS are energy data and environmental data, related to public locations, private and public buildings. Acquisition is based on different protocols, all data are stored and presented, in aggregated form or anonymous way to the Interoperability Platform via the Monet REST API. Thus such data is available as an API through the Interoperability Platform, taking advantage of the feature of the platform (M2M authentication, monitoring etc.), and is integrated in a simple dashboard based on Qlik Sense for demonstration purposes. Monet APIs currently integrated are:

- API to retrieve historical electrical data from a specific apartment in anonymous way.

Additional APIs will be added:

- API to retrieve environmental data from a public location.
- API to retrieve aggregated energy data from public and private building.

As soon as other WP3 data sources become available, they will be integrated to the USP in a seamless fashion, so to start populating an API-based ecosystem that enables the creation of advanced services for the end-users.

Moreover, the Milan USP will fully support authentication and authorization mechanisms based on standards such as OAuth2 and OpenId Connect, through specific components that are being refined and configured.

Finally, the Milan USP will support city dashboards – that are being designed as a joint cross-WP effort – through components and tools such as Qlik Sense and the GeoPortal of the Municipality.