MAtchUP

D4.22: Urban platform adaptation specifications in Antalya – Final Version

WP 4, T 4.6

30th November, 2020 (M38)

Authors: M.Serdar Yümlü, Cenk Güreken, Eser Karakaya, Selçuk Ilıkcan(SAM)

MAtchUP - SCC-1-2016-2017

Innovation Action – GRANT AGREEMENT No. 774477

This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement N°774477

Technical References

Project Acronym	**MatchUP**
Project Title	MAximizing the UPscaling and replication potential of high level urban transformation strategies - MAtchUP
Project Coordinator	Ernesto Faubel Ayuntamiento de Valencia efaubel@valencia.es
Project Duration	1 October 2017 – 30 September 2022 (60 Months)

Deliverable No.	D4.22
Dissemination Level	CO[1]
Work Package	WP 4 - Demonstration in Antalya
Task	T 4.6 - Urban Platform developments
Lead beneficiary	15-SAM
Contributing beneficiary(ies)	14-ANT
Due date of deliverable	30 November 2020
Actual submission date	19 November 2020
Estimated person-month for deliverable	13 PM

[1] PU = Public
PP = Restricted to other programme participants (including the Commission Services)
RE = Restricted to a group specified by the consortium (including the Commission Services)
CO = Confidential, only for members of the consortium (including the Commission Services)

This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement N°774477

Version	Person	Partner	Date
1.0 Final (M24)	M.Serdar Yümlü, Eser Karakaya Cenk Güreken	SAM	24 September 2019
1.1	Cenk Güreken	SAM	26 August 2020
1.2	M. Serdar Yümlü Cenk Güreken Selçuk Ilıkcan Eser Karakaya	SAM	29 September 2020
1.3	M. Serdar Yümlü Serdar Serdaroğlu Caner Tosunoğlu İbrahim Acar	SAM	9 October 2020
1.4	Cenk Güreken M. Serdar Yümlü	SAM	12 October 2020
1.5	Pau Arce Vila	UPV	27 October 2020
1.6	M. Serdar Yümlü Cenk Güreken	SAM	09 November 2020

Disclaimer

The information reflects only the author's view and the Commission is not responsible for any use that may be made of the information it contains.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement N°774477

Table of Content

This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement N°774477

List of Tables

This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement N°774477

List of Figures

This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement N°774477

Abbreviations and Acronyms

Acronym	Description
API	Application Programming Interface
APP	Application
AUP	Antalya Urban Platform
BI	Business Intelligence
CKAN	Comprehensive Knowledge Archive Network
CoAP	Constrained Application Protocol
CSV	Comma-separated values
ETSI	European Telecommunications Standards Institute
FP	Frequent Pattern
GDPR	EU General Data Protection Regulation
HDFS	Hadoop Distributed File System
HTTP	HyperText Transfer Protocol
HUE	Hadoop User Experience
ICT	Information and Communications Technology
IDM	Identity Manager
IoT	Internet of Things
ISG	Industry Specification Group
ISO	International Organization for Standardization
JSON	JavaScript Object Notation
KNX	Konnex
KPI	Key Performance Indicator
LDAP	Lightweight Directory Access Protocol
LWM2M	Lightweight Machine to Machine
M2M	Machine to Machine
ML	Machine Learning
MQTT	Message Queuing Telemetry Transport
NGSI	Next Generation Service Interfaces
OMA	Open Mobile Alliance
PDF	Portable Document Format
RDD	Resilient Distributed Dataset
RDF	Resource Description Framework
REST	Representational State Transfer
SOA	Service – Oriented Architecture
SOAP	Simple Object Access Protocol
SQL	Structured Query Language
WMS	Warehouse Management System
WMS	Web Map Services
XLS	Microsoft Excel spreadsheet file

This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement N°774477

1 Abstract

This deliverable is part of Task 4.6. This task is in charge of developing a number of services to improve city operation, decision-making services and citizens' engagement to ensure the interaction between the city of Antalya and its citizens. All these developments follow the same principles: ensuring open data, interoperability through open APIs developments and assessing the evaluation process by considering the requirements of the Antalya monitoring plan outlined in Task 5.1.

This deliverable deals with the details regarding the current state of the Antalya's existing urban platform, specifically on the specifications of the adaptation of new MAtchUP services on top of the existing urban platform. In particular, description of the specifications that Antalya's platform needs to assure open data operability, open APIs and additional functionalities such as Big Data abilities.

On the third year of the project, Antalya open data platform developments are completed and the platform is ready for the beta test and release. This deliverable provides all relevant details about the Antalya urban platform esp. for the big data ingestion, processing and visualization components. These components play an important role for MAtchUP intervention implementations for the monitoring period. This deliverable also details the updates, improvements and planning for the project lifecycle and achievements during the 3rd period.

As far as the cities in the project share a similar objective, this deliverable D4.22, shares a common structure with the analogous deliverables of WP2, which is D2.22, and WP3, which is D3.22. Furthermore, this deliverable is an extension of the deliverable D4.21, presented in M24 as second version of the document. This final version is due on M38 and explains the new advances and services related to urban platform that have been achieved in addition to the previous improvements.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement N°774477

2 Introduction

2.1 Objective

The objective of this deliverable is to report the features and developments that have been completed of the Antalya Urban Platform.

In scope of the MAtchUP Project, the requirements of the Antalya's existing urban platform is being determined aligned with the designated interventions and objectives of the project. To this end, new services are being adapted to be successfully integrated into the urban platform. The interventions in each MAtchUP pillar namely ICT, Mobility, Energy and Social, are taken into consideration in both performing these interventions and determining the requirements. The integration strategies are denoted in detail through the dedicated Chapter 4. The related European reference architectures are also taken into consideration for a comparison.

The adaptation of the urban platform requires the consideration of the associated datasets to be integrated, implementation of a new open data portal that the Antalya did not have before MAtchUP, adding the big data functionalities, development of the new APIs and integration of the new IoT adaptors. In this deliverable, we present the existing components of the Antalya urban platform and give insight on the adaptation of the new modules related to the Open Data, Open APIs as well as the Big Data.

Section 4 provides a brief of the integration strategies that are applied throughout the MAtchUP Antalya platform developments and further detailed in D4.24.

Section 5 describes the open data adaptations step by step by defining the open data sources to be used, considering open data privacy and security measurements by Turkish and worldwide standards, and then dives into the Antalya Open Data Portal specifications and features. Lastly, the open data operability is explained.

Section 6 and 7 focuses on the open API adaptation strategies applied in Antalya followed by detailing the big data functionalities and how the big data is adapted into the developed platforms within the framework of Urban Platform architecture. In chapter 7, in addition to the big data analysis, the big data visualization and its benefits are also studied.

As the main goal of this deliverable, Antalya Urban Platform and MAtchUP adaptations over components are provided. Ultimately, the deliverable provides the architecture and specific components of the Antalya Urban Platform and concludes with the plan and future improvements expected during the implementation of the interventions and monitoring period.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement N°774477

2.2 Contribution of partners

Table 1 depicts the main contributions from participant partners in the development of this deliverable.

Participant short name	Contributions
SAM	Responsible for the deliverable
ANT	Hosts the Urban Platform and provides the data for Big data processes and Open Data Platform
UPV	Reviewer

Table 1 Contribution of partners

This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement N°774477

3 Requirements of the Urban Platform

In this section, each city urban platform is described. As far as this deliverable is about urban platform adaptation and specifications in Antalya, Antalya urban platform is explained in detail. For the other cities in the project, the reference to the deliverables regarding urban platform specifications is shown.

In this chapter, the planned and performed interventions have been described for the Antalya Urban Platform and modules in general, as well as the ones within the scope of Kepez Santral Smart City, along with their requirements.

3.1 Specifications of the Urban Platform

Urban data platforms integrate the large amount of data in cities, including energy, transport, social data, etc., and provide holistic view of the information with the aim of improvement and development of innovative smart city services.

In general, all urban platforms have common specifications because they have many components in common and share many elements. However, beyond these common assets, every urban platform also has its key differences that are reflected in extra specifications.

The following specifications belong to all three Urban Platforms as common:

- **IoT Devices** involve all sensors and devices that collect information from the city or the environment and are able to send that measurements to the urban platform.
- **IoT Device Gateway** act as a relay or translator in those cases when some IoT devices cannot send their information to the context broker directly, because a lack of direct connectivity or because they use incompatible transport protocols.
- **Big Data** refers to the distributed storage of a huge amount of data that can be accessed in a reliable way, but also it is related to functions and processes to analyse pieces of data as quick as possible, obtaining analytics, statistics or indicators.
- **Open (DATA) Portal** involves the publication of those data that can be considered of public interest, improving government transparency and making datasets available for citizens, entrepreneurs or third parties that can take advantage of these functions to improve the social and business network.
- **Context Broker** enables publication of context information by entities, referred as context producers, so that published context information becomes available to other entities, referred as context consumers or sinks, which are interested in processing the published context information.
- **Dashboards** are the easiest way of representing all the data stored and processed in the urban platform. Using panels and graphs, city administrators or citizens can keep up with anything that the city is monitoring. The use of maps is another way of showing georeferenced information, enhancing the comprehension of data.
- **Security** is an important piece of any urban platform, which may require mechanisms of authentication to ensure the correct operation of the platform.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement N°774477

3.2 City Urban Platform

In this section, each city urban platform is described. As this deliverable is about urban platform adaptation and specifications in Antalya, Antalya urban platform is explained in detail. For the other cities in the project, the reference to the deliverables regarding urban platform specifications are given below.

3.2.1 Valencia Urban Platform

The Valencia Urban platform is described in Deliverable 2.22.

3.2.2 Dresden Urban Platform

The Dresden Urban platform is described in Deliverable 3.22.

3.2.3 Antalya Urban Platform

Antalya Metropolitan Municipality provided a smart city vision to include several aspects for a safe, green and vibrant Antalya Smart City. This Smart City Framework given in Figure 1 provides the main aspects including policies, citizen centric approaches, business/economy, safety, sustainability and mobility features. Abovementioned urban platform components and ICT infrastructure play a crucial role in this picture.

With respect to this framework, the urban platform within MAtchUP becomes an additional layer to support this city wide initiative and with the demo district. All interventions related with MAtchUP are also depicted in the figure as yellow dots.

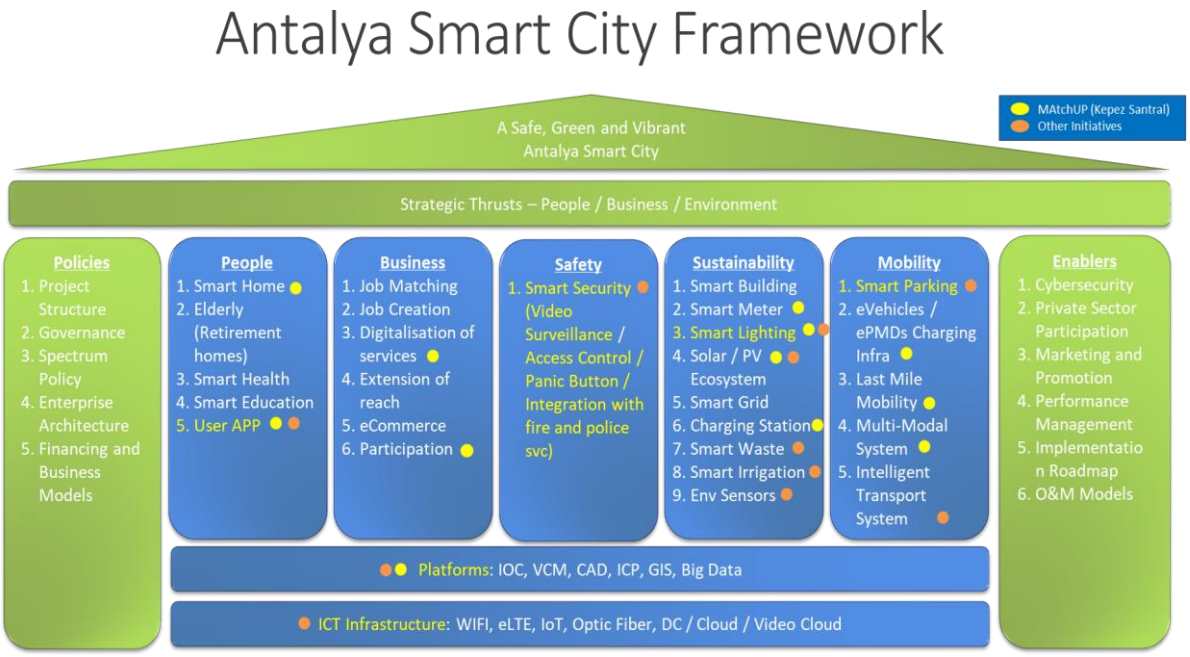

Figure 1 Antalya Smart City Framework

In order to support the motive of Antalya Smart City, one of the most important aspects is to integrate new urban platform initiatives. The following section describes the current ICT initiatives in Antalya.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement N°774477

Existing ICT Services in ANTALYA

The Municipality of Antalya, in line with its Digital Agenda, has developed a global ICT-Infrastructure in which many vertical services of the city are integrated. This Urban Platform of Antalya is in charge of gathering information from these municipal services and to provide information to make city decisions by elaborating a set of key indicators to support this process. Another objective of the platform is to offer data to the citizens and municipal managers to support all the necessary information to ease their daily life.

To enhance the interoperability capabilities and to ensure an appropriate scalability to ease the extension of this Urban Platform, Antalya Municipality has running its own data centers in its new building where they manage the following main solutions:

- Management Information Systems (MIS) including 30+ modules of tax management, accounting, HR, procurement, ticketing and other departmental requirements.
- Geographical Information Systems (GIS)
- Web GIS Servers serving 1:5.000 and 1:25.000 zoning plans and 1:100.000 landscaping plan
- 3rd Party Integrated Solutions
- e-Government Integrations
- e-Municipality
- Web Reporting on Departmental Activities & Yearly Performance Indicators
- Mobile Citizen Solutions
- MUBIM – Regional District Authorities Management Portal
- City Council Decision Portal
- Web Interfaces of Antalya
- E-Ticketing for Theatres
- Accessibility Portal for Antalya
- City Information System
- 360-degree Panoramic View Portal
- Smart Cities initiatives

Antalya e-Government Services (www.antalya.bel.tr)

- ATASEM Application and Other Services
- ATABEM Application and Other Services
- Wholesale Market Hall Application
- MUBİM Application, Requests and Complaints
- Fast Payment Application
- Municipal Debt Inquiry
- Purchase Requests Login Application
- Those Who Deceased Today
- Duty Pharmacies
- Application for Information
- Creating Wish, Request, Complaint

This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement N°774477

- Theatre E-Ticket Application
- E-signature Query and Verification
- Assembly and Council Decisions
- Wedding Reservation and Status Inquiry
- Creating E-Declaration
- SMS Debt Notification
- Tax Amnesty Control
- 1 / 25.000 Scale Master Development Plan Inquiry
- 1 / 100.000 Scale Environmental Plan Inquiry

e-Government Turkey Integrations

Turkey is conducting e-Government Turkey Integration processes throughout the nation including Pharmacies interrogation, Death Information Inquiry, Statement Information Inquiry, Information Application and Questionnaire, Registry Information Inquiry, Accrual Information Inquiry, Collection Information Inquiry, including a total of 7 e-service of citizens made available through e-Government Door (www.turkiye.gov.tr)

Antalya Metropolitan Municipality manages its own data center in their new building. Almost all the solutions are integrated, secured and controlled through the central data center which has disaster recovery and maintenance options. In more than 20+ different servers and storage units, Antalya manages more than 100 cores of CPU and around 500 GB of memory with terabytes of data. All modern data center management techniques are being used daily under the control of ICT team of Antalya. The typical diagram of server clusters (network components like firewall, gateways, switches, routers, etc., big data application servers), which some of them are used for MAtchUP, is provided in Figure 2.

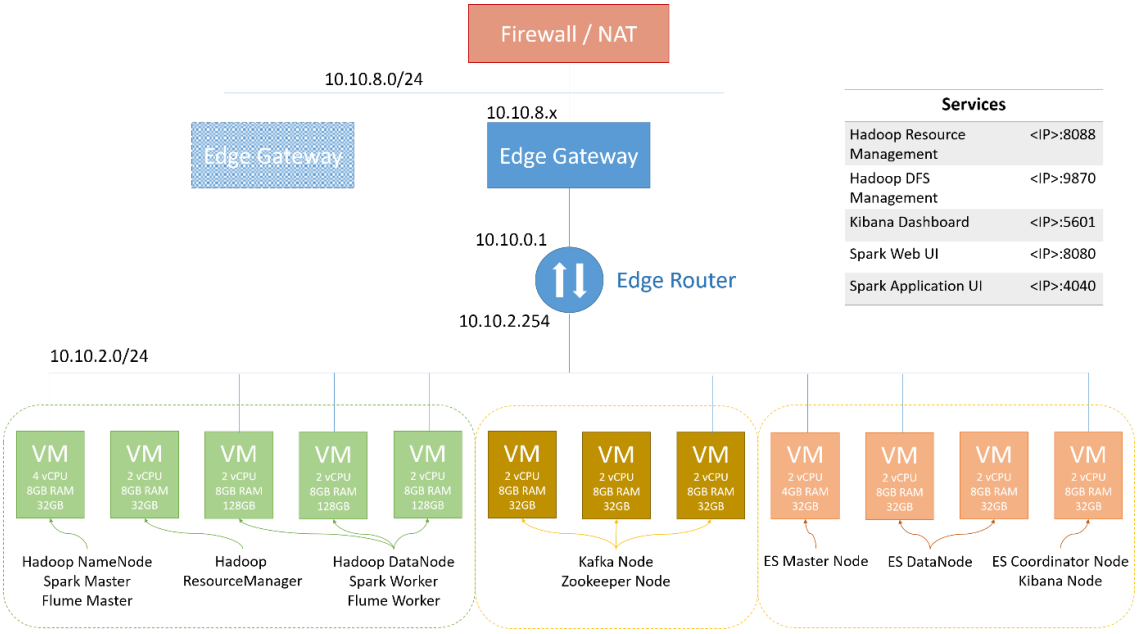

Figure 2 A group of Server Cluster from Antalya DC

This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement N°774477

Security/privacy is one of the main pillars of the Urban Platform, as sensitive data is managed. The security of the network infrastructure is ensured by various security components, including the multi-level firewall as well as the establishment of so-called demilitarized zones (DMZ), which ensure secure access by external users and, in particular, protects the internal network against unauthorized access. Another widely used secure access technology is Virtual Private Network (VPN). Also, several access control schemes and authorization techniques are applied to ensure authentication and authorization requirements for all sorts of solutions under Urban Platform.

The following vertical services are integrated and managed through this platform:

- Water Authority (ASAT)
- Traffic & Transport
- Administration
- Governance
- E-Government Integrations
- 3rd Party Integrations
- Energy in Municipal buildings
- Energy in Private Buildings
- Energy in industry
- Tenders
- Contracts
- Citizens' portal
- Geographical Information Systems
- Ticketing Systems (Theatres)

The following standards/technologies are used for the standardization of the services:

- **Authentication**: Authentication & Authorization are provided through LDAP and access control lists. Strong password protection, token management and single sign on are provided under the platform. For web services WS-Security standards are used.
- **APIs development**: Urban Platform is based on SOA architecture and Enterprise Service Bus is used to mediate and manage all web services. SOAP and REST based protocols are mainly used for service integration and APIs are provided in open specification for 3rd parties and e-Government services to be integrated.
- **IoT/M2M communications**: IoT and M2M communication is based on IoT data management component and international standards, like MQTT, are being used for communication protocols. For energy management; open source building energy management that supports protocols like Zigbee, HTTP/XML, Modbus. Also for home automation and domotics, KNX-based standards are followed.
- **Geo-Information**: Open Geospatial Consortium (OGC) based standards is used. WMS, WFS based services are provided through the central GIS application to provide geo-spatial data sets. The urban database is able to store geo-spatial data with inventory data sets together.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement N°774477

- **eGovernment data**: Turkey has several different e-Government services including e-Identity, Land & Registry, Cadastre, Address Management, e-Gov Portal, etc. All these services are connected to the Antalya Urban Platform and ICT solutions via international standards based web services including SOAP, REST, XML APIs and WS-Security standards.
- **KPIs calculations**: KPIs are defined through the business intelligence suite and these calculations are done based on the data marts. KPIs are defined according to departmental, high level and subject level expectations based on the strategic targets of the city.

New Kepez Santral Urban Transformation is one of the first implementations of smart districts with high performance district and building solutions. New Kepez Santral Smart District include several ICT initiatives including integrated smart lighting, smart mobility, metering and smart controls in residential units and smart environmental sensors. With respect to this, Integrated, Intelligent and Instrumented urban ICT platform is realized and integrated in New Kepez Santral Urban Transformation demo site with existing ICT infrastructure of Antalya Metropolitan Municipality.

The urban platform acts as the Open Data Gateway for all interventions and integrations between other ICT services of Antalya, 3rd parties and other e-government services. It also provides SOA based Open API developments regarding all open data sets, measurements, smart controls, domotics and several IoT and device integrations. Considering the big data is collected and analysed; the visualization techniques are adapted to provide insights to the policy makers using business intelligence capabilities. During the integration phase, IoT adaptors in residential units and the municipality building are integrated into the urban platform using the proprietary and common services provided by procured IoT device manufacturers. The main actions around ICT Urban Platform are be based on the following actions:

- New Open Data Gateway
- New Open API Developments
- Big Data Functionalities
- IoT Adaptors

These include real-time and batch context data integration, open data portal and open data management, evolution of city management dashboard, integration of data market & economy of data mechanisms, data services for public facilities (LFG station, solar plants, etc.), IoT devices and data acquisition systems integration for smart meters, smart controls, domotics for smart homes and buildings (calorimeters, wireless sensors, smart thermostatic switches, e.g.), public lighting sensors, charging stations, electric storage unit measurements, etc.

Antalya Urban Platform, shown in Figure 3, has several different components. The main objective of Antalya urban platform is to have an integrated, instrumented and intelligent platform according to the Smart City Framework provided in Figure 1.

In the integration part, the platform is integrated with existing utilities, e-Government services, municipal internal and external services, banks, solutions providers and telco operators. In the heart of the platform, there are lots of different sub components for IoT

This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement N°774477

management, integration service bus and visualizations. In addition, citizen centric solutions, such as open data and mobile apps, take an important role in the intelligence part of the platform. The instrumentation includes all sensor based integration through energy, mobility, ICT and social interventions/actions.

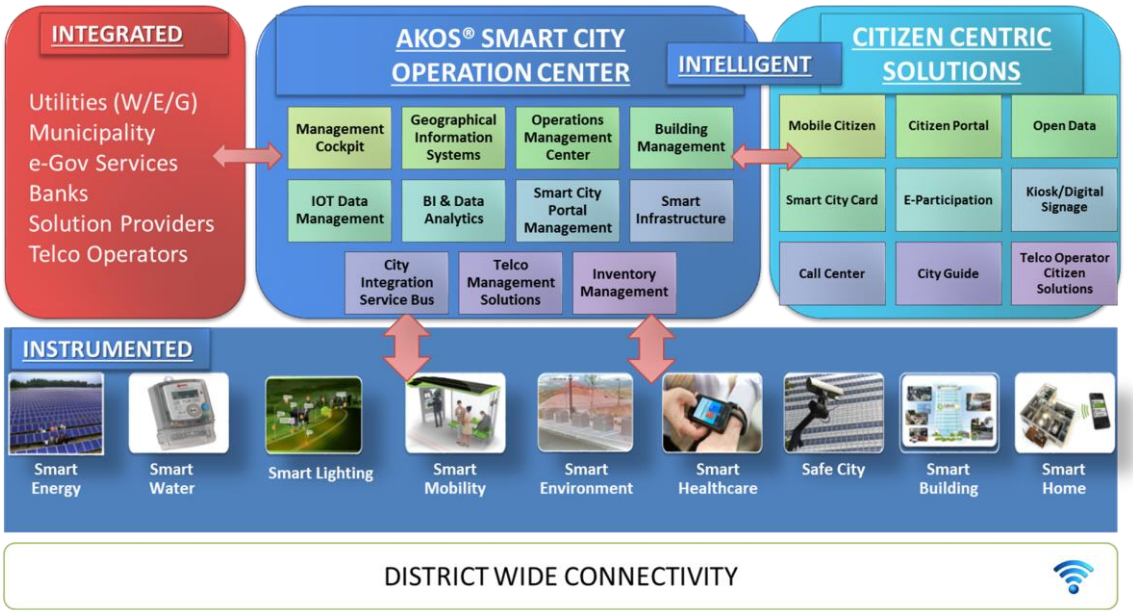

Figure 3 Antalya Urban Platform

New Open Data Gateway

One of the main ICT related actions is the establishment of a new open data gateway for Antalya (Action 39: “New open data gateway”). Within this task, considering all the developments to be implemented in MAtchUP actions in Antalya, the current existing Urban platform in Antalya is extended by integrating new data sources from the different data acquisition systems. Data from the energy and mobility domains is integrated in the vertical services of the Antalya Urban Platform. A new open gateway for the interconnection of these datasets following the open specification concept is implemented using the technologies defined below.

Another new functionality is the preparation of the platform to publish pre-processed, non-sensible and anonymized data (considering the privacy and security aspects). These open datasets are offered to citizens and third-party developers, in order to let entrepreneurs, start-ups and SMEs create new innovative services for Antalya on top of the Urban Platform. The common open specifications concept is used, ensuring that the data can be explored in a uniform and interoperable way in the three lighthouses, easing the replication in other cities.

In the platform, security access levels and control flow mechanisms are improved. As a final functionality of this open data gateway, the interoperability of the implemented Open APIs with other existing APIs developed are ensured by using standard mechanisms.

This project has received funding from the European Union’s Horizon 2020 research and innovation programme under Grant Agreement N°774477

New Open API developments

Following Open Data initiatives, Antalya Urban Platform are adapted and extended to provide all the developments to be implemented under the umbrella of MAtchUP as open APIs (including open SDKs) under Action 40: “New Open API developments”. These APIs are aimed at improving the collection, aggregation and analysis of functionalities. Open data is used, in line with Action 39. The result is that all new services are easily integrated in the Urban Platform, favouring that entrepreneurs, start-ups and SMEs to create a local business ecosystem in the city of Antalya around the Urban Platform, open data and open APIs concepts.

IoT Adaptors & APIs

New City APIs are mainly based on new IoT initiatives in the demo district. Action 42: “IoT adaptors” defines and implement all new IoT integrations and APIs. A set of IoT ad-hoc adaptors that allows the connection of several devices to the existing Urban Platform in Antalya exists. However, some developments in order to implement standard IoT device semantic languages (such as UL 2.0, Sensor ML) and transport protocols (like OMA LWM2M, COAP, MQTT, HTTP) are being implemented. All new IoT devices are to be integrated in Antalya Urban platform complies with this specification, again, complementing the Open Data and Open APIs and SDK concept described in Action 39 and Action 40.

All the items are visualized through the Urban Platform visualization and are going to be projected in the video wall in the main hall of the Municipality building Figure 4.

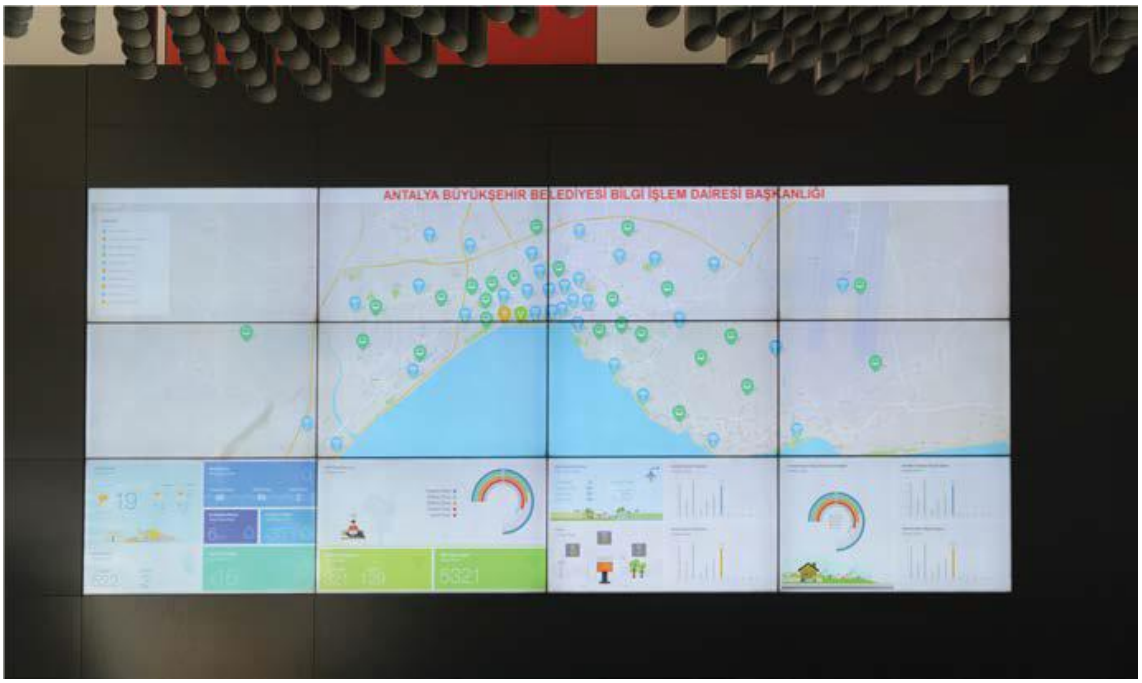

Figure 4 Antalya Videowall for Smart City Applications (Municipality Entrance)

This project has received funding from the European Union’s Horizon 2020 research and innovation programme under Grant Agreement N°774477

Reference architecture (FIWARE)

Within these components, Antalya is also considering to benefit from the FIWARE platform and components (see 3.3 Related Urban Platforms). FIWARE data models consists of twelve data models to answer different expectations of Smart City concept varying by the city elements where each one has a set of particular attributes and relationships. Based on these data models, Antalya Urban Platform generated the following data models for the Kepez Smart City district:

- Smart e-Car Charge Station
- Smart e-Scooter Charge Station
- Smart Public Lighting
- Smart Buildings
- Smart Solar Panels
- Smart Meters and Home Controls

The MQTT (Message Queuing Telemetry Transport) protocol is a widely used cross-machine message based protocol on the Internet. It is a client/server publish/subscribe messaging transport protocol designed to support messaging transport from remote locations/devices involving small code footprints (e.g. 8-bit, 256 KB ram controllers), low power, low bandwidth, high-cost connections, high latency, variable availability, and negotiated delivery guarantees. The MQTT protocol offers mechanisms for resource discovery, bi-directional communication, QoS level specification, and scalability.

MQTT is an extremely lightweight and reliable (over TCP) connectivity protocol designed for M2M communications and the IoT. Almost all IoT cloud platforms support the MQTT protocol.

The key element in MQTT protocol is the MQTT Broker. The main task of the MQTT Broker is to send messages that are received from publishers, to the subscribers. MQTT Broker uses topics as a channel. Publishers sends the data to topics and subscribers receives data from these topics. With these topics, publishers and subscribers do not need to know each other. This structure makes this protocol very scalable.

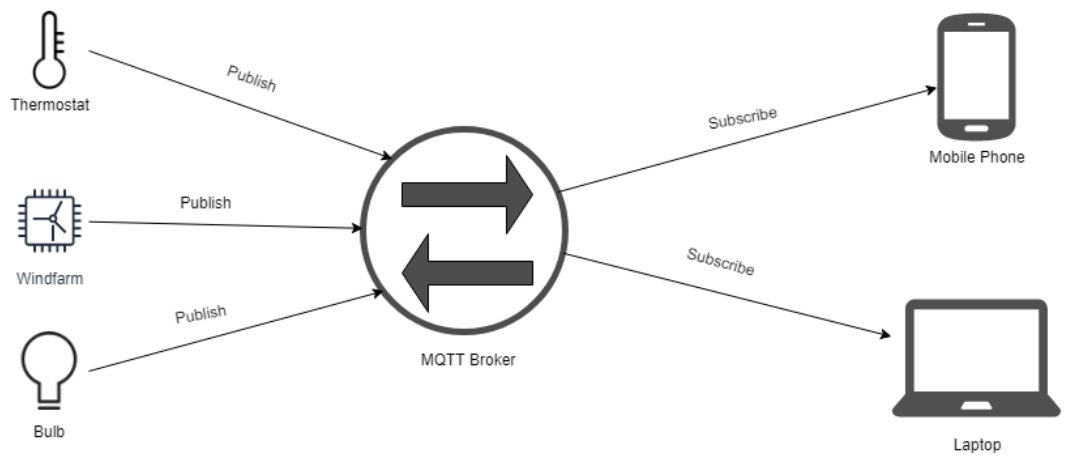

Figure 5 MQTT Broker Example Scenario

This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement N°774477

The MQTT Broker is a module that retrieves data from publishers and transmits this data to subscribers. Antalya Urban platform uses 'Mosquitto' as a broker in this architecture.

Mosquitto: Eclipse Mosquitto is an open source (EPL/EDL licensed) message broker that implements the MQTT protocol versions 5.0, 3.1.1 and 3.1. Mosquitto is lightweight and is suitable for use on all devices from low power single board computers to full servers. The MQTT protocol provides a lightweight method of carrying out messaging using a publish/subscribe model. This makes it suitable for Internet of Things messaging like in low power sensors or mobile devices such as phones, embedded computers or microcontrollers[2].

Using the MQTT architecture defined in Figure 5, clients can perform various types of actions:

- Update context information, e.g. send new temperature updates, the brightness level of an illuminator, or can inform the consumed electricity or the working hours.
- Be notified when there is a change in the context information (e.g. change the temperature value, notify on/off status, overheating, cut-offs).
- Ask about context information. The Context Broker stores context information that is being updated from the applications, so that queries are resolved based on this data.

In Antalya Urban platform several different components are used for managing and integrating certain sources of data in certain configured third-party storages, creating a historical view of such data, using CKAN as the open data portal, Hadoop for big data processing, Kafka for integration and service bus purposes, and Elasticsearch & Kibana for visualization purposes. These specific components and the general architecture is provided in detail in Big Data Analysis section.

3.3 Related European Urban Platforms

This section examines the other existing European Urban Platforms where various communication technologies are used to support smart city requirements and diverse IoT protocols but also security and privacy, service orchestration, etc. Several smart city and urban platforms are already being developed in different projects. The following platforms and standards used as European Urban platforms:

- ESPRESSO
- AIOTI
- OneM2M
- FIWARE
- Organicity
- Synchronicity

[2] https://mosquitto.org

This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement N°774477

Among these examples, the Antalya Urban Platform uses an integrated approach benefitting different platforms capabilities not only limited to FIWARE.

ESPRESSO

ESPRESSO[3] together with the CITYKeys[4] project focuses on the development of a conceptual Smart Cities Information Framework, with the scope of making standards and technologies for smart cities interoperable. In short, it helps cities better plan investment in Smart City projects – by way of setting up a KPIs and standardization roadmap. It aims to develop and validate a framework for performance indicators and data collection procedures, which will be used for the transparent monitoring of smart city solutions across European cities. The objective of ESPRESSO is to define an Urban Platform, based on open standards to achieve interoperability.

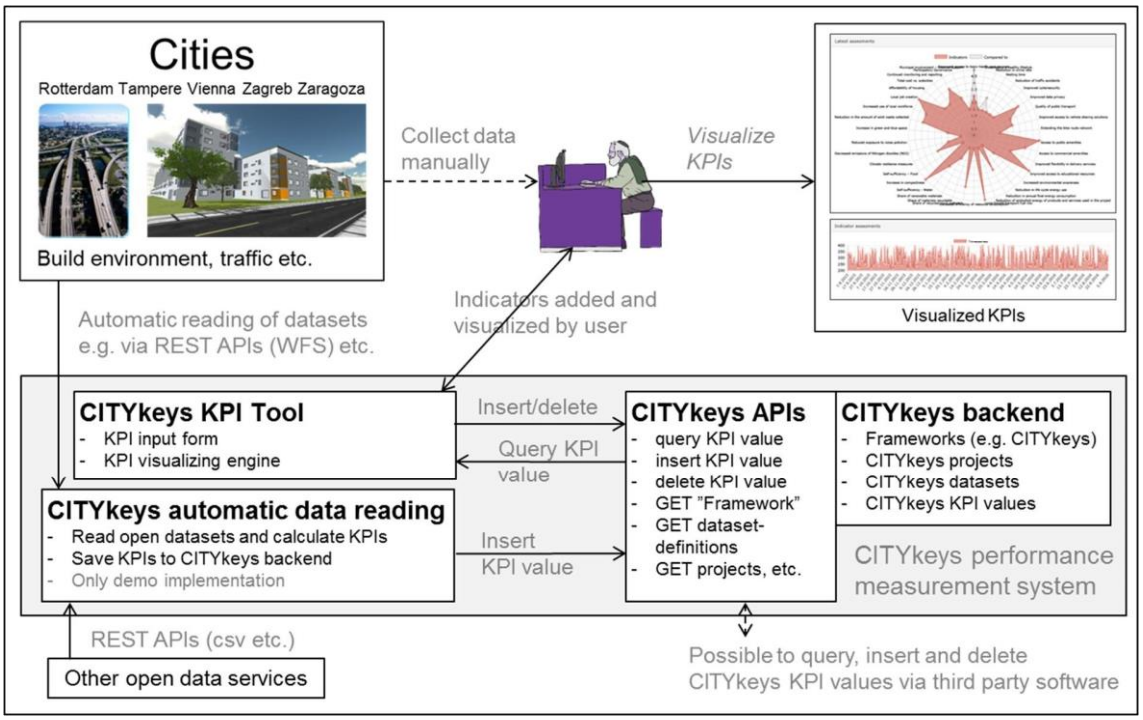

Figure 6 Overview of the CITYkeys KPI tool concept[5]

AIOTI

AIOTI aims to create and master sustainable innovative European IoT ecosystems in the global context to address the challenges of IoT technology and applications deployment.[6] It

[3] http://espresso.espresso-project.eu/project-2/the-espresso-project/

[4] http://www.citykeys-project.eu/citykeys/news/ESPRESSO-strengthens-collaboration-on-the-European-standardisation-for-smart-cities-WSWE-AU6KR9

[5] http://www.citykeys-project.eu/citykeys/resources/general/download/CITYkeys-D2-4-Report-on-the-case-studies-WSWE-AJENSL

[6] AIOTI - The Alliance for the Internet of Things Innovation [Online]. Available: https://aioti-space.org/.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement N°774477

has 4 general WGs (IoT research, Innovation Ecosystems, IoT standardisation and IoT policy), and 9 market specific WGs (Smart living environment for ageing well, smart farming and food security, wearables, smart cities, smart mobility, smart water management, smart manufacturing, smart energy and smart buildings and architecture).

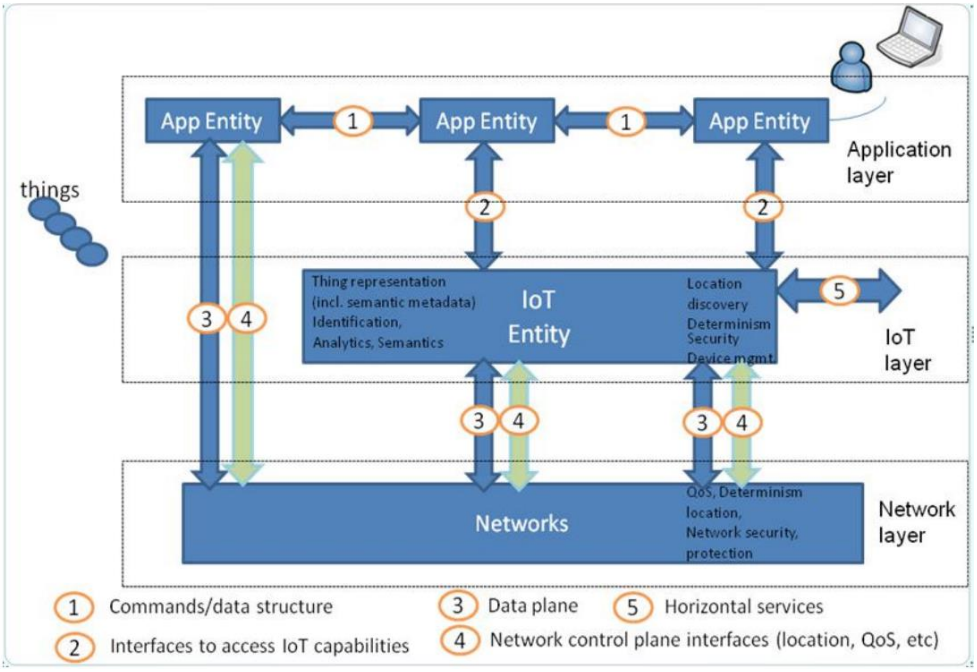

Figure 7 AIOTI HLA functional model[7]

The High Level Architecture functional model depicted in Figure 7 consists of Application layer, IoT layer, Network layer and a set of interfaces among the logical components.

OneM2M

The horizontal OneM2M platform provides common service functions of different domains so that application developers can focus on application logics since oneM2M provides common APIs. As shown in Figure 8, oneM2M can support a smart city system from the devices up to the applications in a holistic way. It can also build a smart city system together with other platforms (e.g. FIWARE, W3C). oneM2M protocols are bound to CoAP, HTTP, MQTT and WebSocket for protocols. The other IoT/M2M systems such as LwM2M, AllJoyn, OCF are interworked with oneM2M system as defined in the corresponding interworking specifications. oneM2M also provides generic interworking for legacy protocols such as ZigBee.

Antalya Urban Platform also uses some of these standards in its implementation such as MQTT, HTTP, e.g.

[7] AIOTI WG03 – IoT Standardisation, AIOTI High Level Architecture (HLA) Release 3.0, 2016.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement N°774477

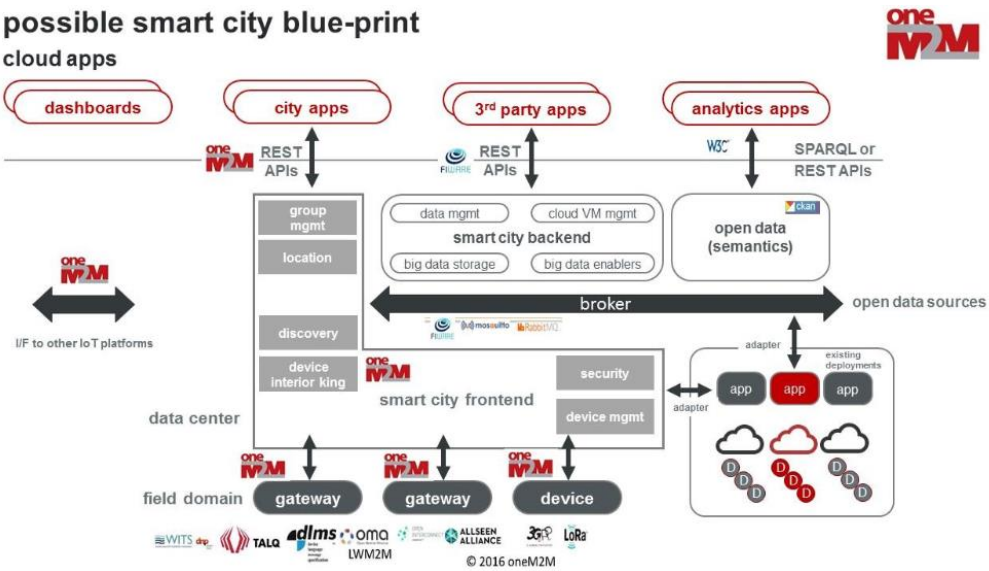

Figure 8 oneM2M possible smart city blue-print[8]

FIWARE

FIWARE is an open source platform intended to provide the software infrastructure needed to support smart applications in multiple sectors.[9] Specifically for the smart cities, it provides components allow acquiring and harmonizing data coming from different IoT devices or external systems. FIWARE Context Broker offers a modern REST API which allows applications and other services to manage, consume and subscribe to all the data generated by the city. Data is published to a data hub (context broker), which contains a uniform view, in real time, of the status of a city.

Around the context broker, different components can be plugged in. For instance, historical and big data can be generated, stored and later analysed, providing insights or predictions. FIWARE also enables the publication and monetization of the city data by integrating CKAN and different extensions. Those extensions enable the creation of a data marketplace by leveraging the TMForum[10] APIs.

Figure 9 provides a more detailed functional overview of a complete FIWARE architecture.

[8] oneM2M, oneM2M Smart Cities Done Smarter, 2017.

[9] FIWARE, [Online]. Available: https://www.fiware.org/.

[10] TM Forum, [Online]. Available: https://www.tmforum.org/.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement N°774477

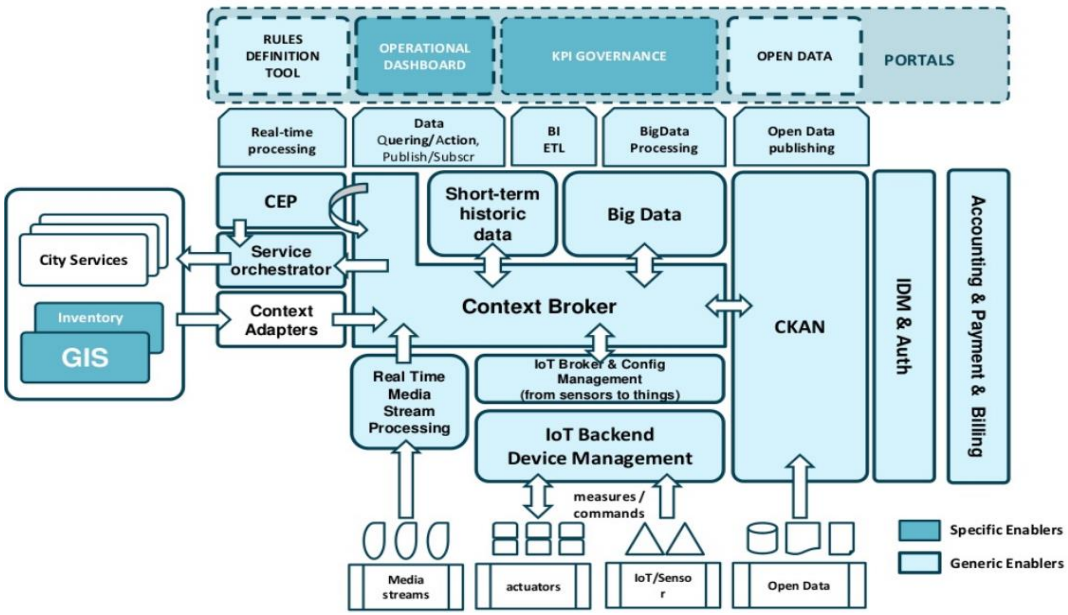

Figure 9 FIWARE Overall Architecture [11]

Within the platform multiple protocols are supported, particularly HTTP, MQTT, LWM2M or Sigfox. In addition, different representation formats for IoT data are supported, including Ultralight 2.0 or plain JSON. Developing new adapters for other protocols is quick and easy thanks to the programming library mentioned above.

Valencia VLCi platform is entirely based on FIWARE. On the Antalya Urban Platform (AUP), following the similar approach, the main standards and components used under FIWARE, including the CKAN open data portal and context broker applications. However, within AUP it is expanded to have specific architecture and components different from that provided in the FIWARE ecosystem.

OrganiCity

OrganiCity[12] aims to offer a multidisciplinary research facility on a city level for developers of urban services, urban data scientists, IoT solution developers, sociologists, economists, citizens, etc., allowing different facets of value creation for smarter cities and communities to be explored. Cities involved are Aarhus, London and Santander. These cities offer to their stakeholders a common *Experimentation as a Service* (EaaS) platform plus access to different sets of cities data, empowering them to be active in the development of solutions to tackle their local issues. Figure 10 depicts the basic structure of the OrganiCity facility architecture, separated into 3 different layers, known as tiers.

[11] FIWARE Managing context information at large scale, [Online]. Available: https://www.slideshare.net/FI-WARE/fiware-ngsi-managing-context-information-at-large-scale

[12] OrganiCity Project, [Online]. Available: http://organicity.eu/.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement N°774477

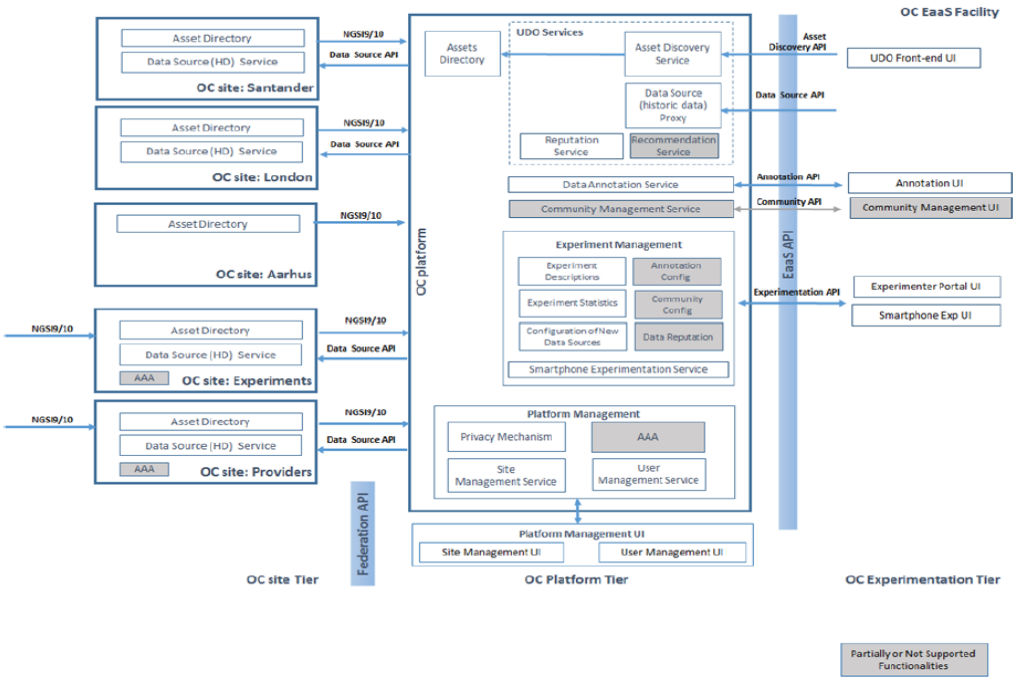

Figure 10 Simplified OrganiCity facility architecture

As shown in Figure 10, the communication between the Site Tier and the OC platform is based on NGSI9/10 and NGSIv2 interfaces, since the OC core platform is based on FIWARE Orion Context Broker (OCB).

SYNCHRONICITY

SynchroniCity[13] aims to design, implement and deploy an open digital single market for IoT-enabled urban services. European cities in SynchroniCity include Eindhoven, Milan, Antwerp, Helsinki, Porto, Santander, Carouge and Manchester.

Figure 11 shows the full stack of the SynchroniCity's reference architecture from sensors and data sources to end users (citizens). It is comprehensive of the baseline and city services layer on top of the SynchroniCity northbound interface.

[13] SynchroniCity Project, [Online]. Available: https://synchronicity-iot.eu/

This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement N°774477

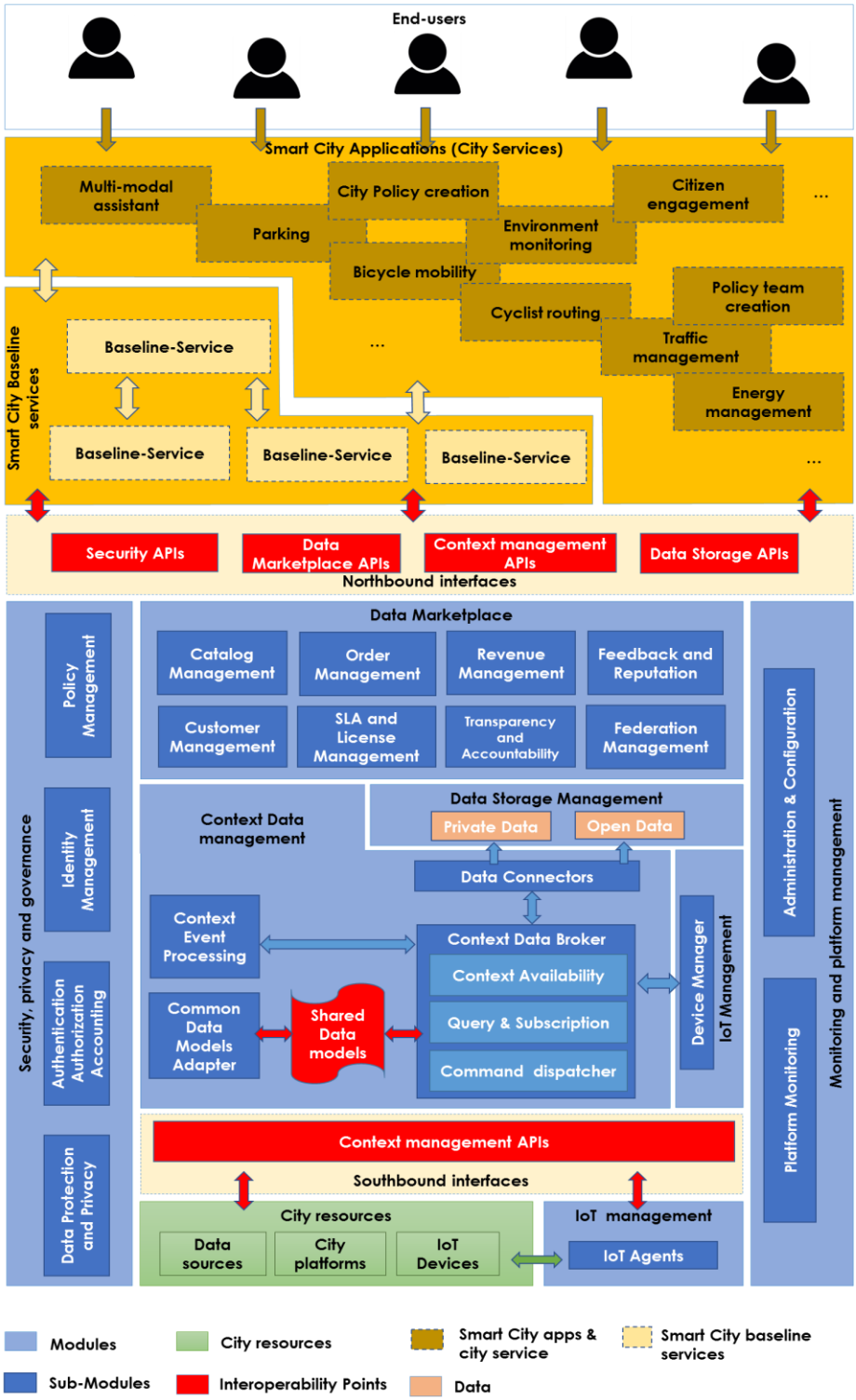

Figure 11 Full stack of the SynchroniCity Reference Architecture[14]

[14] SynchroniCity Project, [Online]. Available: https://synchronicity-iot.eu/

This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement N°774477

4 Integration strategies

The Integration strategies of Antalya Urban Platform consists of integration among urban platform components, integration with existing legacy systems and integration with datasets and sensors from interventions in the demo site. All these topics are addressed by SAM as the ICT responsible of the platform aligned with ICT teams of Valencia and Dresden. ICT thematic group is responsible to define all datasets, data catalogue, IoT integration and how to integrate all components in the urban platform and also for the integrations among lighthouse cities.

In order to carry out MAtchUP successfully, it is crucial to plan an integration strategy for the MAtchUP actions and to describe in detail how the data is gathered, transmitted and stored. In order to do so, describing specific and tailored data integration of the actions to be deployed in the Antalya city interventions is key. These integration strategies are further described and detailed in D4.24. Within the project, in addition to the technical actions there are also social/non-technical actions aiming to foster citizen participation and engagement. The results from these actions regarding citizen involvement are also integrated in the urban platform, using the generated KPIs of these interventions through the virtual tools provided in 4.26 and 4.27.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement N°774477

5 Open Data Adaptation

One of the notions of the modern smart cities is the possession of an open data portal which would majorly ensure the engagement of the citizens and businesses for new innovative opportunities. A vast set of urban data is increasingly being produced in the cities from various data acquisition sources (e.g. smart city sensors, city indicators, environmental sources, transportation flows, weather status) and made public by the local authorities. Increasingly, cities are building their own portals for which a set of certain processes and worldwide standards must be followed and fulfilled. In addition, the city requirements must be analysed for adapting the implementation in the particular city. In general, this process can be summarized in 4 steps:

1) Analysing the Needs & Requirements: In this stage, the reasons for making the data public must be clarified, existing method for storing the data must be identified, private and confidential data sets must be specified. The type of the data (e.g. static, dynamic etc.) must be identified.
2) Implementation plan
3) Implementation Process
4) Support: Once the portal is public, it must be continuously fed with the recent data.

Indeed, there are many examples of standardized initiatives associated to the smart cities, some of them are: **City Protocol Society** (City Anatomy Ontology) [6], **The British Standards Institution** (PAS 182 Smart City Concept Model) [7], **ETSI** (SmartM2M, Smart Appliances, Reference Ontology and oneM2M mapping) [8], **ISO 30145** (standardization work on Smart City ICT Reference Framework) [9], **KM4CITY** (platform with Smart City tools) [5, 6].

There is no such a standardized open data platform architecture, therefore the aspect of considering open data platform is settled on three pillars; existing open government data standards, legislative expectations of sharing open data and technical expectations in general architecture.

These definitions are valid for all kinds of open data but there are some specific principles for open government data which was decided at a meeting held in Sebastopol, California in 2007. During this meeting, eight principles were decided:

- **Complete**. All data which is not private should be made available.
- **Primary**. Data is presented with the highest level of granularity and collected at the source.
- **Timely**. Data should be shared as quickly as possible.
- **Accessible**. All data should be shared.
- **Machine processable**. Data must be structured so that it is machine-readable.
- **Non-discriminatory**. Anyone should be able to access the data.
- **Non-proprietary**. Data must be shared in a format which is available to anyone.
- **License free**. No copyright, patent or trademark should prevent the data from being shared.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement N°774477

After series of detailed analyses, it is consider that CKAN has no deficiency to meet with these principles.

No confliction is determined about open data share in CKAN features with Turkey (KVKK) or Europe Union (Directive 95/46/EC, EU Regulation 2016/679, GDPR Directives and PSI Directives) legislations.

There are 4 aspects as technical expectations focused on and compared with other popular open data platforms [12]:

- **Data Inputs**: Many formats were supported and because of that, a lot of options for entering metadata were available such as XML, Excel, CSV, HTML, JSON, PDF. These are all supported by CKAN infrastructure.
- **Data output (API):** CKAN has 2 APIs correlated with each other:
- **CKAN DataStore extension:** Provides an ad hoc database for storage of structured data from CKAN resources. Data can be pulled out of resource files and stored in the DataStore [13].
- **CKAN FileStore API:** FileStore allows users to upload and download data files to CKAN resources, and to upload logo images for groups and organizations. Users can see an upload button when creating or updating a resource, group or organization [14].

FileStore which provides 'blob' storage of files with no way to access or query parts of that file, the DataStore is like a database in which individual data elements are accessible and queryable [14].

CKAN's APIs are coherent with JSON, which is going to be used for architecture and has functionality in CRUD operations, and they have advantage in average response time with compared to big data competitors.

Data Output (Visualizations): CKAN could present tables with filtering functions, charts in a number of ways and maps with markers for the data.

Data Output (File download): CKAN allows only the data in the original format for download but its response time is put forward CKAN.

SLA (Service Level Agreement): CKAN offers to customers, packages with different SLAs.

Theme Customization: CKAN provides multiple front-end design themes for its users.

There is a considerable number of examples to the city-wide open data portals worldwide, such as in Vienna [15], Barcelona, Paris [16], Zurich [17], Munich [18], Helsinki [19], Milan [20], Berlin [21]. As can be seen from these examples, the common software of the open data portals is CKAN, which is encouraged to further investigate the properties of it within MAtchUP.

In Turkey, there are no country wise open data portals, however, they have been getting popular in recent years [27].

With respect to the MAtchUP ICT objectives, Antalya also have its first open data portal where all the data of the predetermined indicators related to the MAtchUP interventions and the existing sources are integrated. In addition, the data produced by all the present and

This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement N°774477

intended data acquisition systems that deployed are transferred in to the Antalya's open data portal. In MAtchUP, it is agreed on ~197 indicators of which data is to be calculated for Antalya as well as other pilot cities Dresden and Valencia.

All the indicators are also used to form a policy in the sense that they are used for the comparison with other Turkish and European cities.

At this stage, the details of the data sources and the implementation methods are formed and policies for the Antalya's urban platform is concretized. The technical development of the portal has been completed and the portal ready for being open to the public. After obtaining the relevant permissions to open the data portal and completing the municipal correspondence, the platform will be opened. Afterwards, data will be collected and analysed.

5.1 Open Data Specifications

5.1.1 Open Data Sources

In general, the data which made available for the use of public might be presented in many categories as they have been obtained from the related sources. These categories can range from agriculture, science & technology, transportation, energy to environment, education, population. In MAtchUP, the categories are classified in four main titles which are the ICT, Mobility, Energy and Social.

In particular, it is defined in MAtchUP according to the actions (see D4.14) for creating the relevant data acquisition sources. These include deployed IoT Sensors, Smart Energy efficient building, Smart city transportation and predefined indicators of the cities categorized under four main MAtchUP pillars (i.e. ICT, Energy, Mobility and Social) and the details of these indicators are given in deliverable D1.4.

5.1.2 Open Data Privacy and Security

Open data reinforces communities, society and facilities. It has a wide range of usage from social services to educational achievement. However, there is no such technology without its own risks. The primary concern about open data is privacy and security of individual's data. Basic solution against privacy concerns about open data is that no individual data will be shared with any third party as part of this initiative. However, there is still such a risk that multiple sources of data can be combined to yield information about individuals.

The open data portal should respect and protect the personal data of the citizens. Associated regulations such as GDPR for EU states and KVKK for Turkish states should be considered.

Sharing public data should not have contradictions with the rights of citizens about private data which is also protected by laws. Reuse of the private data is strictly shaped by regulations. Definition of personal data is presented in Directive 95/46/EC (on the protection of individuals with regard to the processing of personal data and on the free movement of such data). EU Regulation 2016/679 of the European Parliament and of the Council of April 27th, 2016 on the protection of natural persons with regard to the processing of personal

This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement N°774477

data and on the free movement of such data, repealing Directive 95/46/EC (General Data Protection Regulation) as “any information relating to an identified or identifiable natural person ('data subject'); an identifiable person is one who can be identified, directly or indirectly, in particular by reference to an identification number or to one or more factors specific to his physical, physiological, mental, economic, cultural or social identity”. In wider scope, the PSI (Public Sector Information) Directive entirely obeys the data protection regulations in Directive 95/46/EC. In this way, if a dataset includes sensitive personal data it needs to be discarded to access and reuse of private data part. There is a generous set of PSI still includes personal data. Every kind of racial or ethnic, religious, philosophical or other beliefs, political opinions, membership of political parties, unions, associations or organizations of a religious, philosophical, political union and personal data includes health and sex life is a topic of sensitive data and cannot be shared in any situation. If certain conditions are established the personal data which other than sensitive ones can be accessed and reused. In some situations, personal data used, data usage need to be consistent with the relevant regulations and must be depended to the original goals which PSI holder collected the personal data. Under these conditions, personal data can be reused with an explicit through a public disclaimer addressed to third party. The disclaimer, referring that such data will be shared via Internet and reused, need to be addressed to the provider of personal data.

The European Data Portal shared a report on Open Data and privacy in June 2016 [29] as a guideline for data controllers to prevent such violation against the personal data and utility of data. This report includes 8 suggestions, as follows:

1. Understand the data. Consider potential use cases, the value of the data and potential risks.
2. Consult. Engage stakeholders about the publication program, be mindful of additional risks that are identified.
3. Remember the three pillars of privacy, data protection and public confidence.
4. Be very sure of the grounds for publishing personal data.
5. Anonymize well and thoroughly. Follow guidelines for anonymizing personal data.
6. Remember utility. There is no point publishing data which has been denuded of serious content.
7. Don’t release and forget. Anonymization and Open Data are not cheap options.
8. Have a plan in place in the event of a problem. Be not only transparent, but also transparent about your transparency.

5.1.3 Open Data Availability and Access

In the process of integration of the data portal to the Antalya Metropolitan Municipality’s urban platform, access permissions to ensure only the relevant authorized and related personnel’s entry to the appropriate modules have been implemented. With respect to this, the total of 21 municipality units have been created in order the relevant personnel to access and to be authorized:

- Information technology department

This project has received funding from the European Union’s Horizon 2020 research and innovation programme under Grant Agreement N°774477

- Environmental protection and control department
- Department of earthquake risk management and urban improvement
- Support services department
- Foreign relations department
- Property management department
- Department of studies and projects
- Science Department
- Legal consultancy
- Department of zoning and urbanization
- Human resources and education department
- Fire department
- Culture department
- Department of cultural assets
- Corporate development and management systems department
- Financial services department
- Department of cemeteries
- Head of department of headmen and food affairs
- Department of park, garden and green areas
- Rail system department
- Health department

According to the user list that Antalya Metropolitan Municipality provides which includes personal's names, surnames, emails, departments and roles in the open data platform, the user credentials can be created to transmit to the email of each user. Thus, any user can create their user profile within the platform using the credentials given. Afterwards, the municipality system administrator or user given the role of editor can appoint authorization to the responsible personnel for each municipality department.

As the result of this process, any authorised user can create, add, delete, modify and resource any dataset within the open data portal. Every activity made in the portal can be checked on the Antalya Open Data Portal Activity Stream tab one of which designed capabilities that User Page has.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement N°774477

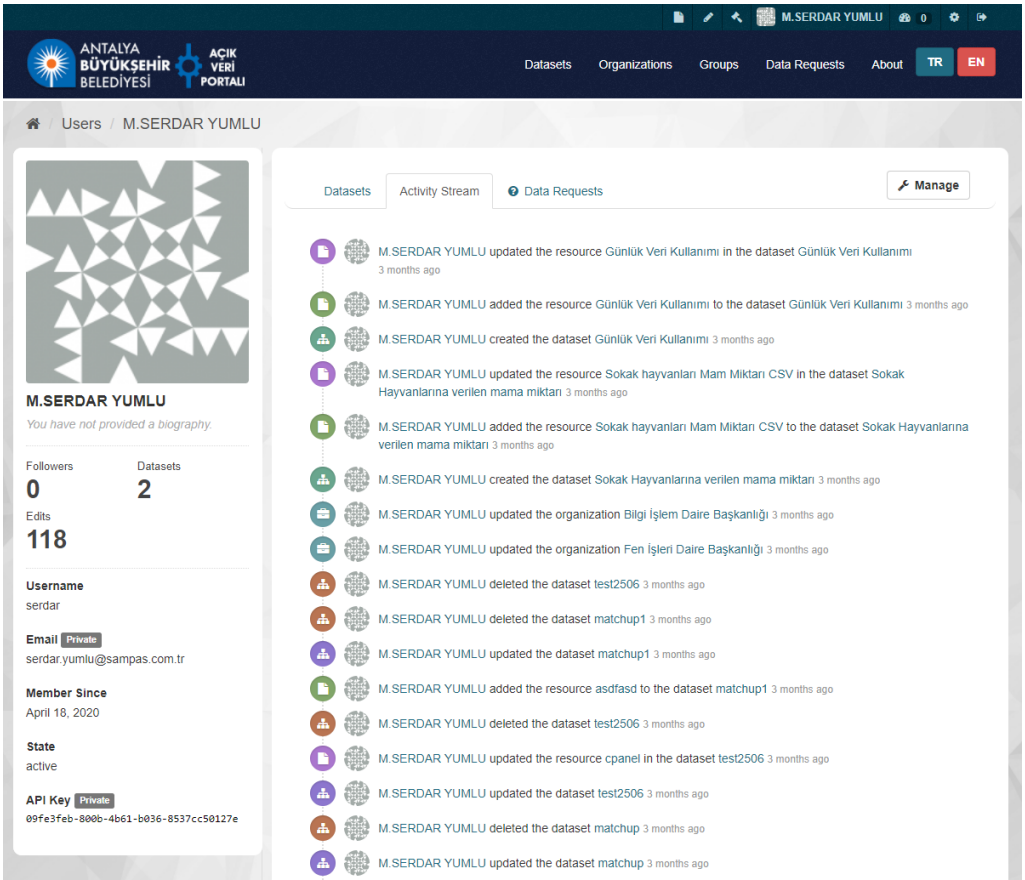

Figure 12 Antalya Open Data Portal Activity Stream

5.2 Antalya Open Data Portal

In scope of the MAtchUP project, all the available data sources are being determined to be implemented in the open data gateway. For this purpose, a data catalogue is created jointly with the WPs1-2-3-4-5 and Antalya takes advantage of this catalogue in creating the open data portal. It is intended to accommodate all the available data through the catalogue which is manually entered by the cities at the first stage.

At this stage of the project, the open data portal developments within SAMPAŞ are fully completed and ready for the beta tests and the release for the use of citizens.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement N°774477

Figure 13 Antalya Open Data Portal Home Page

The current step includes feeding the new sets of data as they are obtained from Antalya Metropolitan Municipality in addition to the visual improvements. Datasets are being uploaded through different methods to the Open Data Platform. First method is manually uploading data to the platform by municipality personals. Another method is reading data from database and automatically uploading it to the platform. Antalya Metropolitan Municipality has a lot of data on its database and uploading this data directly from database to platform and updating when new data arrives at the database is an efficient method. Another solution is collecting data from Rest APIs of municipality's different services and updating the dataset at specific time intervals. In particular, the data which is being collected through the existing channels are the smart city sensors and aforementioned set of indicators (e.g. GDP, unemployment rate, Voter participation, digital literacy, data privacy

This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement N°774477

etc.), which are calculated through the data obtained from official channels. Few examples can be given to these institutions supplying the data: TUIK (Turkish Statistical Institute), T. C. Ministry of Health Istanbul Provincial Health Directorate, ACCI - Antalya Chamber of Commerce and Industry, T.C. Family and Social Policies Provincial Directorate. In particular, Antalya Municipality exploits the CKAN technology to make the collected data to become publicly available.

The open data portal at its current state have the several functioning modules including:

- Open Data Portal Home Page
- Data Categories Page
- Open data portal search engine
- Dedicated open data category / dataset pages (including Datasets / Activity Log / About)
- User Page (Datasets / User activity log (Activity Stream) / Data Request)
- About Page
- Administration Page (Sysadmins / Config / Trash)
- Blog and Article Page

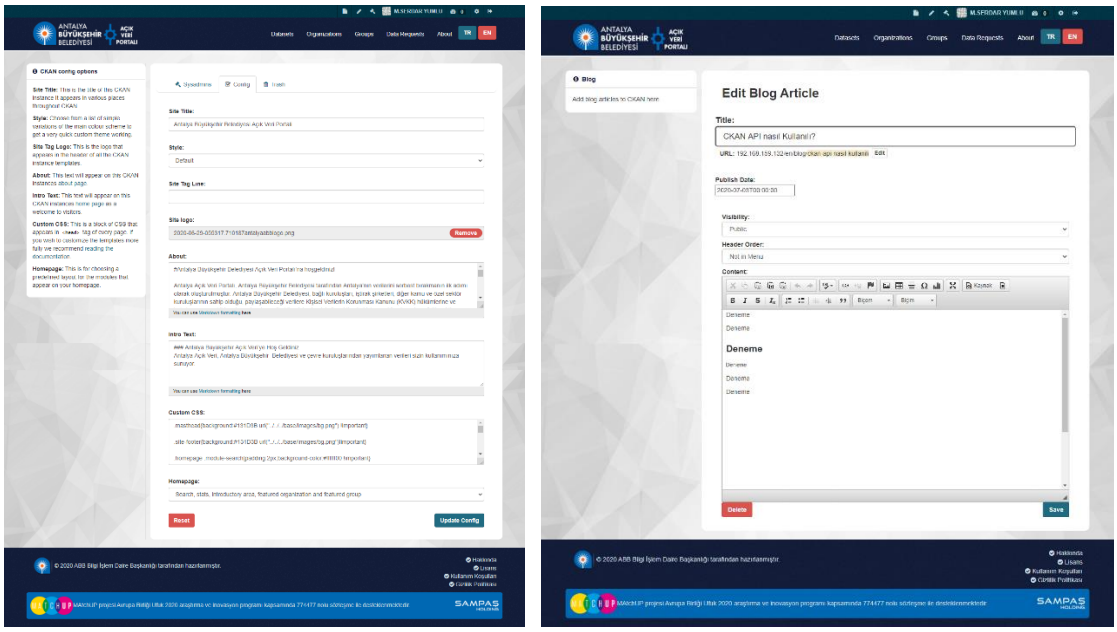

Figure 14 Open Data Portal Config and Blog Article Pages

This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement N°774477

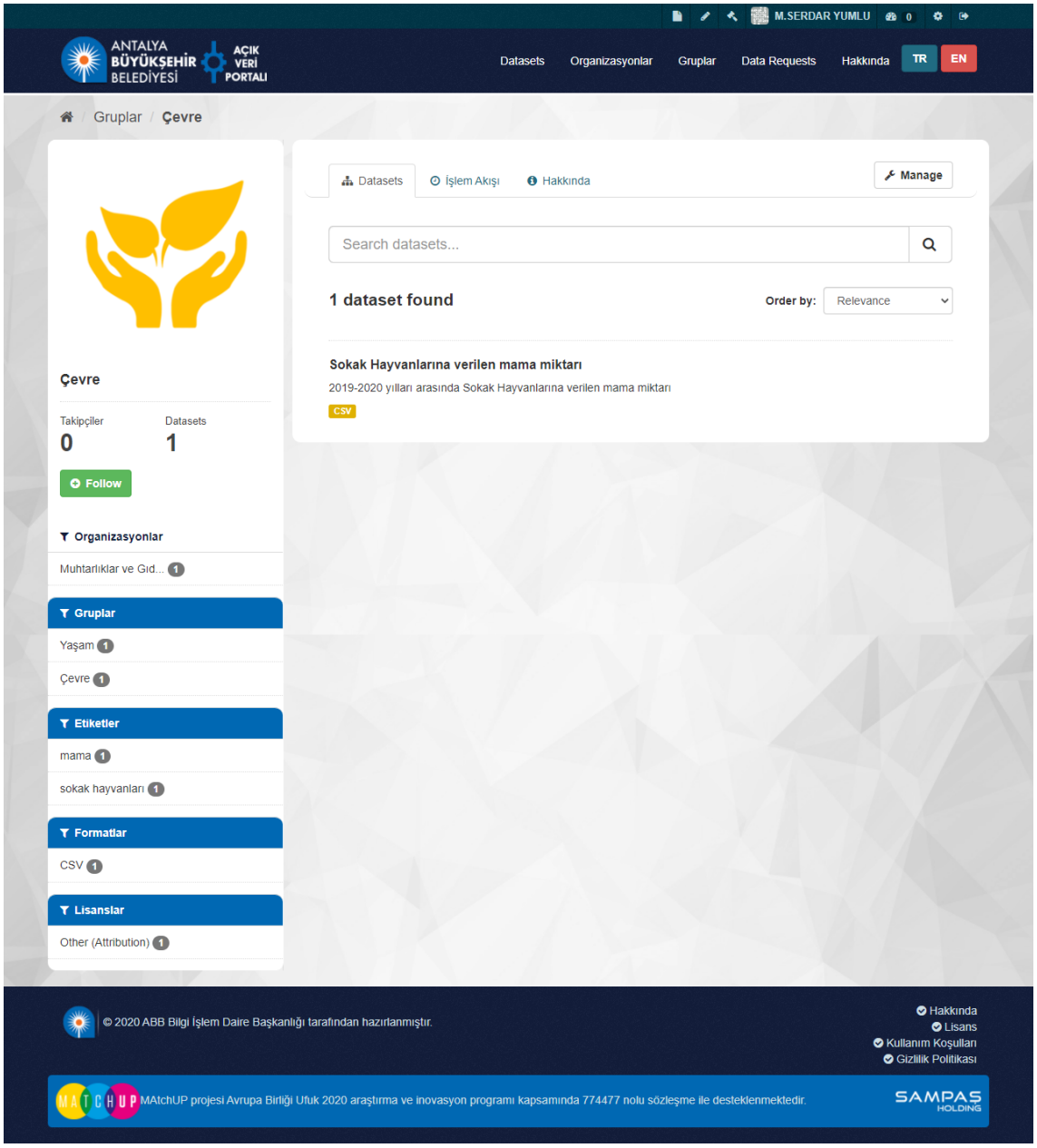

Figure 15 Dedicated Dataset page for Environmental Data

5.3 Open Data Operability

The data catalogue is created through collecting data in each city from the associated legal authorities as well as the municipal databases, APIs, local archives. A template for this catalogue has been jointly created within MAtchUP, to be sent to the cities to manually enter the data by the support of the technical partners. The data collection process is being initially organized and performed by the thematic working groups created in each city in each pillar (i.e. ICT, Energy, Mobility). At this stage, Antalya provided the baseline data for each pillar regarding project months M19-M31. Currently, this data is integrated into the open data platform manually. Once the process is settled, the whole process will be made autonomous.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement N°774477

The user interface of the Open Data Portal is configured according to Antalya Metropolitan Municipality. The platform has different input points for datasets. Platform is ready to connect to specific databases, different API endpoints and local archives of the Antalya Metropolitan Municipality. The initial dataset categories are created as given in Figure 16 and will increase in number as more new datasets are collected.

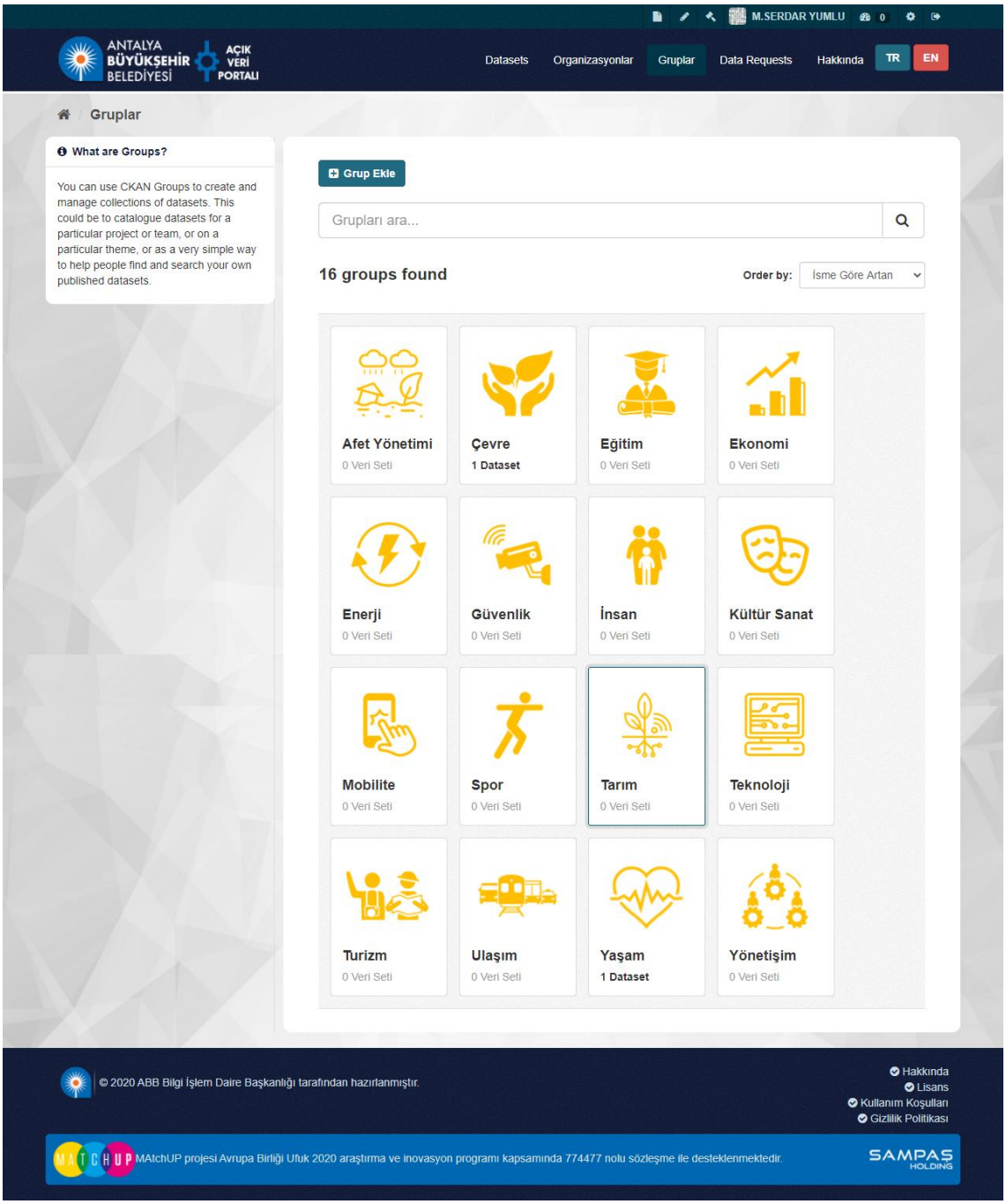

Figure 16 Antalya Open Data Portal Data Categories

This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement N°774477

6 Open API Adaption

Cities aim to share open and transparent data to their citizens as part of their goal to become real smart cities. Application Programming Interfaces (API) are software intermediary protocol based on REST/HTTP to answer requests or responses that allow applications to talk to each other. In this way, Urban Platforms can use them to share their data with accepter. API's are commonly static and cannot smoothly accommodate to data changes and properties.

As can be seen in Figure 17, CKAN has its own APIs to share datasets among visitors, developers.

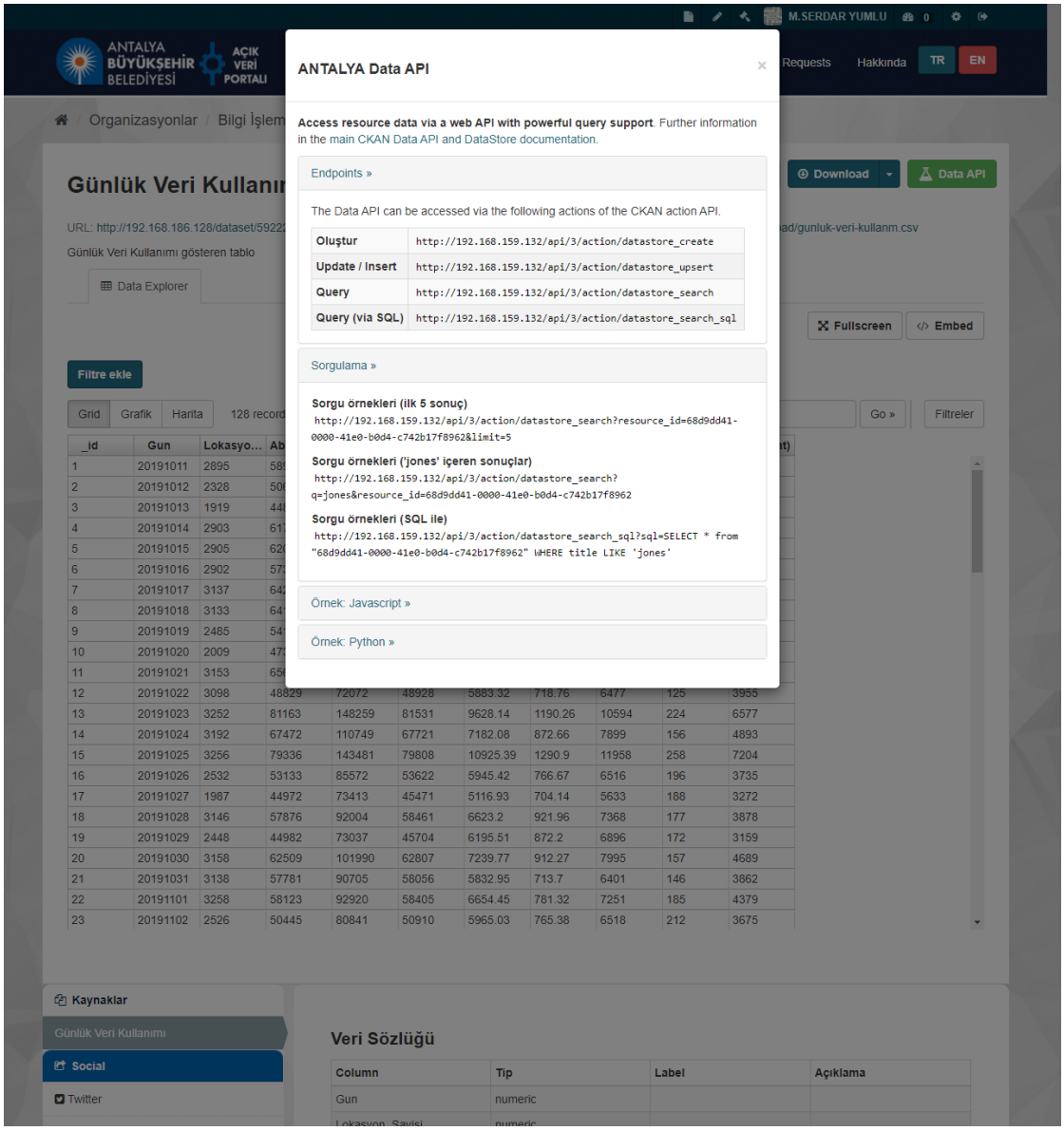

Figure 17 Antalya Open Data Portal API

This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement N°774477

6.1 Open APIs Context

The future concept of competition between smart cities is being clever as much as having the most high-tech. Urban Platform APIs have crucial roles to make cities smarter not just about sharing data with citizens also touching sustainability, improving the lives of residents, as well as providing companies, organizations and public administrations with everything they need.

As with a more specific scope on sustainability, the data collected from Urban Platform API's can be used to develop estimation about energy consumption and carbon footprints. These estimations have vital importance to sustain efficiency of energy consumption and to control carbon based pollution. On the one hand, these data can be employed to provide solutions for on-going city problems like traffic and public transformation by public administrations; on the other hand, it can lead to economic growth and more job opportunities by creating new enterprise ideas or raising transaction volume of the existing private companies.

6.2 City APIs

6.2.1 Existing City APIs

Antalya Metropolitan Municipality is in a digital transformation process including different smart city initiatives. Most of the services and APIs are developed and provided during the project phase and these are linked with the urban platform and APIs in MAtchUP for Kepez Smart City district.

Antalya is currently providing different set of services and APIs through its web channels. Some of them are below:

- Antalya e-Municipality Services
  - Description: Antalya Metropolitan Municipality provides several online services for remote municipal operations. Among these services Antalya Metropolitan Municipality provides services for Social Training, Courses Applications, Wholesale portal, Local District Authorities Demand & Complaint Services, Payment Services, Tax Management & Querying, Procurement, Pharmacies on Duty and e-declaration applications for municipal operations such as ticketing, information request, wedding appointments, etc. Some of these services also are provided as APIs.
  - Access URL: https://online.antalya.bel.tr/
- Antalya GIS Services
  - Description: Antalya has provided several GIS querying services and WMS/WFS APIs through its GIS portals. These services includes zoning, mapping and feature based services.
  - Access point: http://cbs.antalya.bel.tr/arcgis/rest/services
  - https://cbsportal.antalya.bel.tr/apps/vatandas-imar/
- E-Government Portal Integrated Services

This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement N°774477

- Description: Antalya Metropolitan Municipality has already integrated some of its APIs to the e-Government portal of Turkey. These services are mainly related with taxation, ownership and payment operations.
- Access point: https://www.turkiye.gov.tr/antalya-buyuksehir-belediyesi

6.2.2 New City APIs

New City APIs will be developed during MAtchUP for New Kepez Smart City interventions.

Antalya has provided new services for questionnaire in this period. Survey and questionnaire is a generic app for different types of surveys that can be implemented during the project lifecycle.

Antalya Questionnaire services is a generic app hosted by Antalya Metropolitan Municipality is used for citizen interaction for all departments and used also beyond MAtchUP project. This service is hosted at http://abbform.antalya.bel.tr. The service is implemented using .Net Technology Web Communications Framework.

This survey is a generic survey application that provides flexibility to use in different purposes for MAtchUP interventions and citizen engagement. Currently there is only one Anket for a recreation area and waterfall and is ready to use for MAtchUP interventions. Antalya Urban platform can easily integrate the real-time responses of the questionnaires easily using the following APIs.

Questionnaire GetSurveyResults

Questionnaire services provides GetSurveyResults method to retrieve the results of the survey.

REST API URL: http://abbform.antalya.bel.tr/api/survey/GetSurveyResults

JSON Response:

[{"Key":"anket_old_survey_57832_20190326125205","Value":[]},{"Key":"anket_old_survey_57832_20190503114441","Value":[{"id":1,"submitdate":null,"startlanguage":"tr","ipAddress":"10.20.2.59","refUrl":"","questionsAndReplies":[{"question":"Date","questionId":441,"reply":"","codeReplies":{},"other":null},{"question":"Gender","questionId":442,"reply":"","codeReplies":{},"other":null},{"question":"Age","questionId":443,"reply":null,"codeReplies":{},"other":null},{"question":"Education","questionId":444,"reply":null,"codeReplies":{},"other":null},{"question":"Occupation","questionId":445,"reply":null,"codeReplies":{},"other":{"text":"","comment":null}},{"question":"Address","questionId":446,"reply":"","codeReplies":{},"other":null},{"question":" How did you find out the services?","questionId":440,"reply":null,"codeReplies":{},"other":{"text":null,"comment":null}}

This requires a specific authorization mechanism. The authorization key has to be requested from the Antalya ICT department and provides a secure and seamless way of REST based integration service.

New APIs of interventions (energy, LFG, PV plants, residential units, public buildings, lighting, e-vehicles and charging point services) are going to be integrated into the repository

This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement N°774477

and reported in upcoming reports during the implementation of all specific interventions for residential units and public buildings. All services will follow the monitoring stages.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement N°774477

7 Big Data Functionalities and Adaptation

In MAtchUP, calculation of KPIs and new knowledge are carried out using the analysis of Big Data. In the Antalya demo, this task is addressed in Action 41. This task provides Big Data and data analytics functionalities for the calculation of new knowledge acquired from the actions developed in Antalya. All data available (from sensors, real-time, near real-time and even historical time) of control and monitoring of energy efficiency measures sustainable mobility, high performance buildings and environment are able to be analyzed. A set of common data analytic functionalities prepared for reuse are created to enable the design of more complex big data analysis required.

In Antalya demo, in all interventions under energy, mobility, ICT and social, data sets coming from sensors, legacy systems are expected to generate big data. In Antalya big data is evaluated by four important aspects of general big data projects, 4V's [30]:

- Volume: Big Data implies enormous volumes of data. It used to be human created data. Now that data is generated by machines, networks and human interaction on systems. Like social media, the volume of data to be analyzed is massive.
- Variety: refers to the many sources and types of data both structured and unstructured. Data used to be stored from sources like spreadsheets and databases. In MAtchUP it is expected that data comes in the form of emails, photos, videos, monitoring devices, PDFs, audio, etc. This variety of unstructured data creates problems for storage, mining and analyzing data.
- Velocity: Big Data Velocity deals with the pace at which data flows in from sources like business processes, machines, networks and human interaction with things like social media sites, mobile devices, etc. The flow of data is massive and continuous. This real-time data in MAtchUP help us to make valuable decisions that provide strategic competitive advantages.
- Veracity: Big Data Veracity refers to the biases, noise and abnormality in data, whether the data that is being stored, and mined is meaningful to the problem being analyzed.

Figure 18 provides several MAtchUP big data sources and 4V's perspective in Antalya lighthouse actions.

Big data processing clearly deals with issues beyond volume, variety, veracity and velocity to other concerns like validity and volatility.

- Validity: is accepted as the data correctness and accuracy for the intended use. Clearly valid data is key to making the right decisions.
- Volatility: Big data volatility refers to how long is data valid and how long should it be stored. In this world of real time data, you need to determine at what point data is no longer relevant to the current analysis.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement N°774477

The executed interventions in Antalya in the areas of energy optimization, sustainable mobility, high performance buildings and environment end up with a generation of a huge amount of data. New devices, such as smart meters, smart home sensors, smart controllers in buildings, residential homes or in buses, send data in real time to the urban platform, and then, KPIs are generated after the analysis of this considerable volume of data. Usually, this vast amount of data is commonly known as Big Data.

Figure 18 MAtchUP Big Data Sources

Not only the term Big Data makes reference to such a big and complex amount of data beyond the traditional processing mechanisms, but also to the processing techniques, analysis and exploitation of those big data volumes that support the extraction of valuable information from these data.

Regarding the exploitation and analysis of the obtained data in the execution of the aforementioned interventions, MAtchUP use both real time data and historical data stored in archives. It is worth noting that Big Data analysis are carried out inside the urban platform as previously described. Moreover, the basic functionality to analyse common data from the cities are divided into functional building blocks as far as possible, in order to obtain a modular and reusable system, with the aim of ensuring the replicability in other cities. The next section discusses big data processing and platforms to be considered in Antalya.

7.1 Big Data Analysis Platforms

Antalya does not have Big Data processing experiences up to now. With MAtchUP, it is considered Apache Hadoop [31] as an open source software framework for distributed storage and processing of very large data sets, based on a modular cluster distribution with several nodes. Hadoop is one of the most popular and widely used platforms today. This platform is distributed under the Apache License 2.0.

Other alternative big data processing frameworks under evaluation are:

- Apache Spark: Apache Spark is a batch processing framework that has the capability of stream processing, as well, making it a hybrid framework. Spark is most notably easy to use, and it's easy to write applications in Java, Scala, Python, and R. This open-source cluster-computing framework is ideal for machine-learning, but does require a cluster manager and a distributed storage system. Spark can be run on a

This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement N°774477

single machine, with one executor for every CPU core. It can be used as a standalone framework, and you can also use it in conjunction with Hadoop or Apache Mesos, making it suitable for just about any business. Spark has components like:

- Spark SQL, which provides domain-specific language used to manipulate DataFrames.
- Spark Streaming, which uses data in mini-batches for Resilient Distributed Dataset (RDD) transformations, allowing the same set of application code that is created for batch analytics to also be used for streaming analytics.
- Spark MLlib, a machine-learning library that makes the large-scale machine learning pipelines simpler.
- GraphX, which is the distributed graph processing framework at the top of Apache Spark.

- Apache Storm: provides distributed, real-time stream processing. Storm is mostly written in Clojure, and can be used with any programming language. The application is designed as a topology, with the shape of a Directed Acyclic Graph (DAG). Spouts and bolts act as the vertices of the graph. The idea behind Storm is to define small, discrete operations, and then compose those operations into a topology, which acts as a pipeline to transform data.
- Samza: offers a near real-time, asynchronous framework for distributed stream processing. More specifically, Samza handles immutable streams, meaning transformations create new streams that will be consumed by other components without any effect on the initial stream. This framework works in conjunction with other frameworks, using Apache Kafka for messaging and Hadoop YARN for fault tolerance, security, and management of resources.
- Flink: is a hybrid framework, open-source, and stream processes, but can also manage batch tasks. It uses a high-throughput, low-latency streaming engine that is written in Java and Scala, and the runtime system that is pipelined allows for the execution of both batch and stream processing programs. The runtime also supports the execution of iterative algorithms natively. Flink's applications are all fault-tolerant and can support exactly-once semantics. Programs can be written in Java, Scala, Python, and SQL, and Flink offers support for event-time processing and state management.

In the selected framework, Hadoop, the following core components can be found:

- **Hadoop Distributed File System (HDFS),** used for storing data in the Hadoop ecosystem. HDFS is a distributed file system, scalable and optimized for storing a large amount of data, commonly used in clusters of nodes. Internally, every file to be stored is divided into one or more blocks with the same size (64 MB or 128 MB each by default) and these blocks are distributed for storing among the nodes of the cluster.

- **Map Reduce**, is a programming model included into the Hadoop ecosystem used for distributed processing. This programming model allows processing in parallel a large amount of data distributed all along the Hadoop cluster. Map Reduce is based on the paradigm of parallel algorithm design called "Divide-and-Conquer", which consists of solving a problem by dividing it recursively in smaller sub problems until the derived sub problems are small enough to be solved without no more partitioning. Following this approach, Map

This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement N°774477

Reduce divides the whole computation into smaller sets of computation whose results are recombined at the end of the processing to give rise to the final solution. Thus, the processing consists of two stages. In the first one, named *Map*, data is partitioned in small pieces that are mapped onto the nodes of the cluster. Input data is a list of pairs *key-value*. In the second stage, named *Reduce*, the resulting output data produced by the Map processes, that are cast into several lists of pairs *key-value*, are gathered by the Reduce processes that combine them into output lists, each one for a different *key*.

The two core components interact with each other as can be seen in the next diagram:

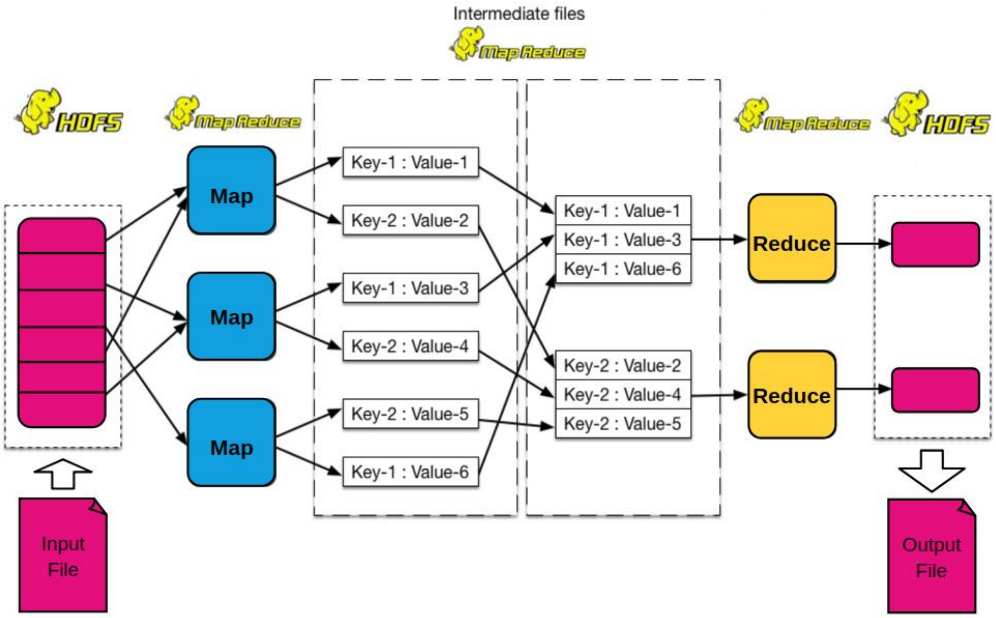

Figure 19 Hadoop Map Reduce Flow

As it can be seen in the diagram, the input files are divided and mapped onto different nodes. The result of the Map process generates *key-value* pairs that are grouped by key. Thus, the data with the same key will be sent later to the same Reduce process. The Reduce process combines each group of *key-value* pairs with the same key within a single *key-value* pair and saves the results in files. The Hadoop File System (HDFS) is used to read the input file and to write the output file at the end of the process.

At the level of use of these components, it is necessary to define the *Map function* and the *Reduce function* that are necessary to express the transformation we want to perform. Both the *Map function* and the *Reduce function* can be implemented using different languages like, e.g. Java or Python.

Other components of Hadoop are:

- **Hive** is a tool contained into the Hadoop ecosystem that exposes a SQL interface to the user. With Hive, it is possible to perform data analysis through SQL queries that the tool transforms into MapReduce functions. At the user level, it is necessary to define the schema of the database along with the tables and data types typical of structured databases before

This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement N°774477

carrying out the initial data load. Once all this initial structure is built and is loaded, all desired SQL queries can be performed.

- **Pig** is a tool that exposes a scripting interface to the user in the Hadoop ecosystem. With Pig, it is possible to create Map and Reduce functions in a simple way using a dedicated programming language called *Pig Latin*. This language is simple and its notation is close to the SQL syntax.

- **Hadoop User Experience (HUE)** is a tool used as a web interface in the Hadoop ecosystem. With HUE, it is possible to view data of the HDFS files, to edit Map and Reduce functions with the Hive editor, or to make queries with the Pig editor. In few words, HUE it is the tool that acts as a graphical interface to Hadoop.

In addition to these components, the Hadoop framework has others such as YARN (a framework for job scheduling and cluster resource management) or Avro (a data serialization system).

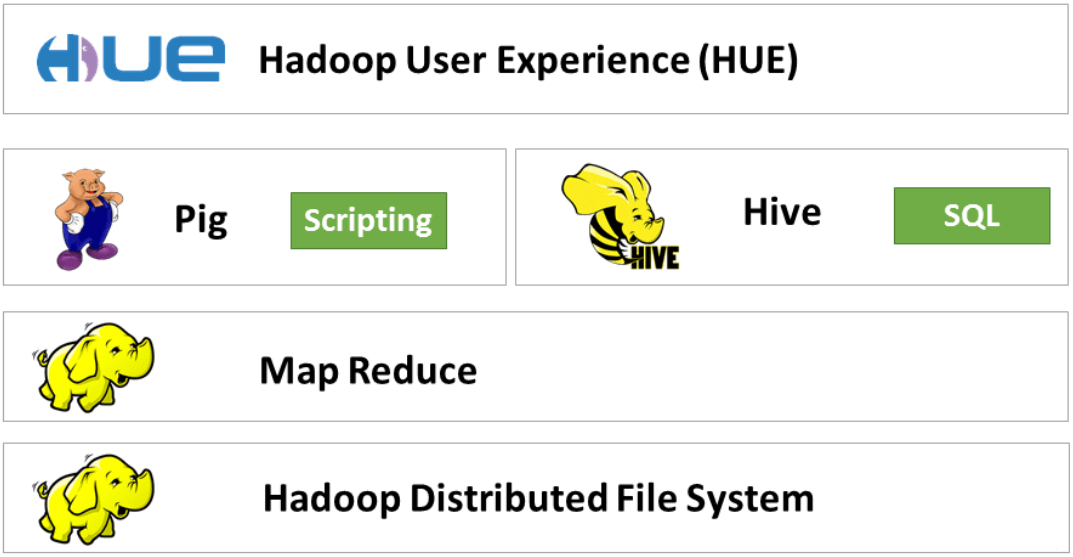

Figure 20 Hadoop Framework Components

7.2 Urban Platform Architecture & Big Data Analytics

Antalya Urban Platform has a flexible n-tier architecture (Figure 21) and the platform has three main integrated layers:

This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement N°774477

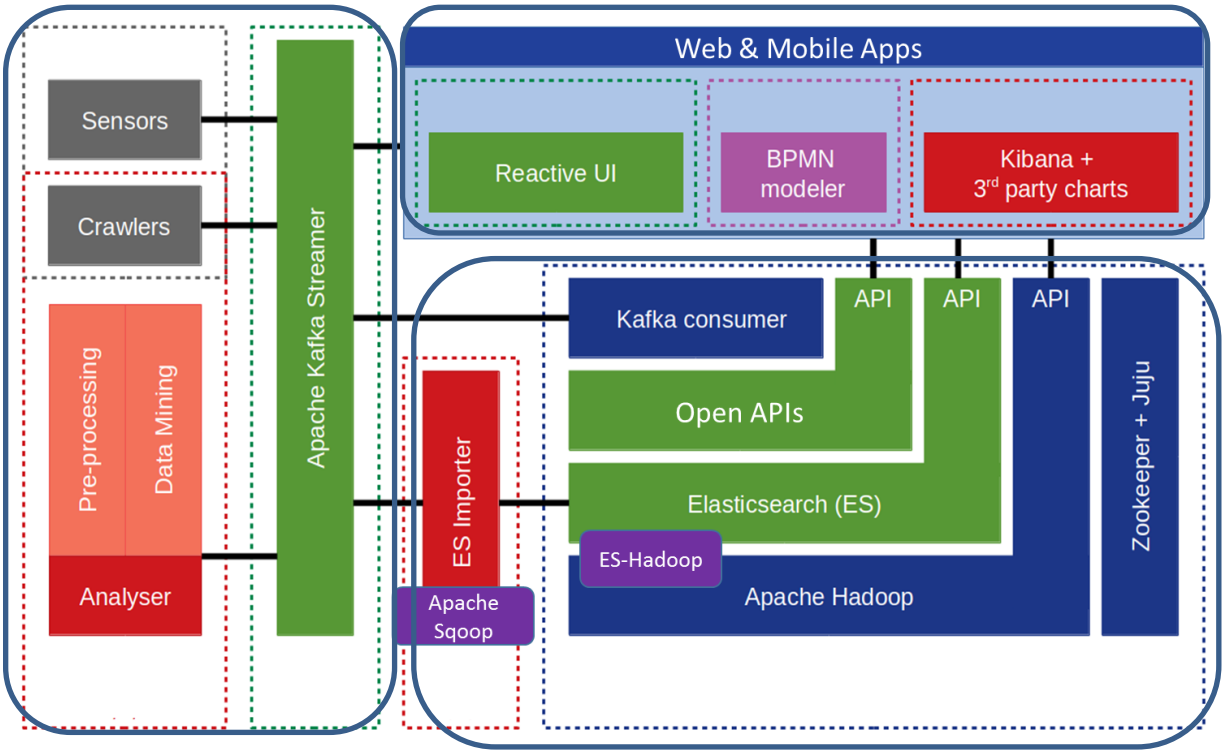

Figure 21 Flexible Urban Platform Architecture

- **the Big Data Collection, Pre-processing & Integration layer** (left) is responsible for data collection, pre-processing and integration. Components integrated under this layer include data collection mechanisms from sensing infrastructures and data crawlers for interventions and also legacy systems to be integrated in the platform. This layer is supported by Apache Kafka[15] as the main messaging gateway between the various components, and Apache Flume[16] as the complementary solution for transferring big data by some crawlers directly to Apache Hadoop.
- **the Big Data Storage & Processing layer** (bottom) is responsible for the general management of big data and data processing. Elasticsearch[17] for real-time data management and Hadoop[18] for big data management and processing are used as the main components of this layer. The platform also includes a business process management engine, i.e. Camunda[19], for workflow and business process management (BPM).

[15] https://kafka.apache.org

[16] https://flume.apache.org

[17] https://www.elastic.co/products/elasticsearch

[18] https://hadoop.apache.org

[19] https://camunda.com

This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement N°774477

- the top layer of the platform, i.e. **the Big Data Visualization & UI layer** (top), provides the front-end user interfaces, mobile applications, Kibana[20] for data visualization, widgets and dashboards, management interfaces.

Platform has the following structured applications, services and servers:

- MAtchUP Front-end Interface application
- Hadoop DFS Management
- Hadoop Resource Management
- Apache2 – Web server
- ElasticSearch-communication
- ElasticSearch-HTTP
- Kibana Dashboard
- ZooKeeper clients → servers
- ZooKeeper peer servers
- Zookeeper leader election
- Kafka Servers

Big Data Analysis can be defined as the process of examining large volumes of data to discover patterns, correlations, trends, preferences and other valuable information that helps decision-making.

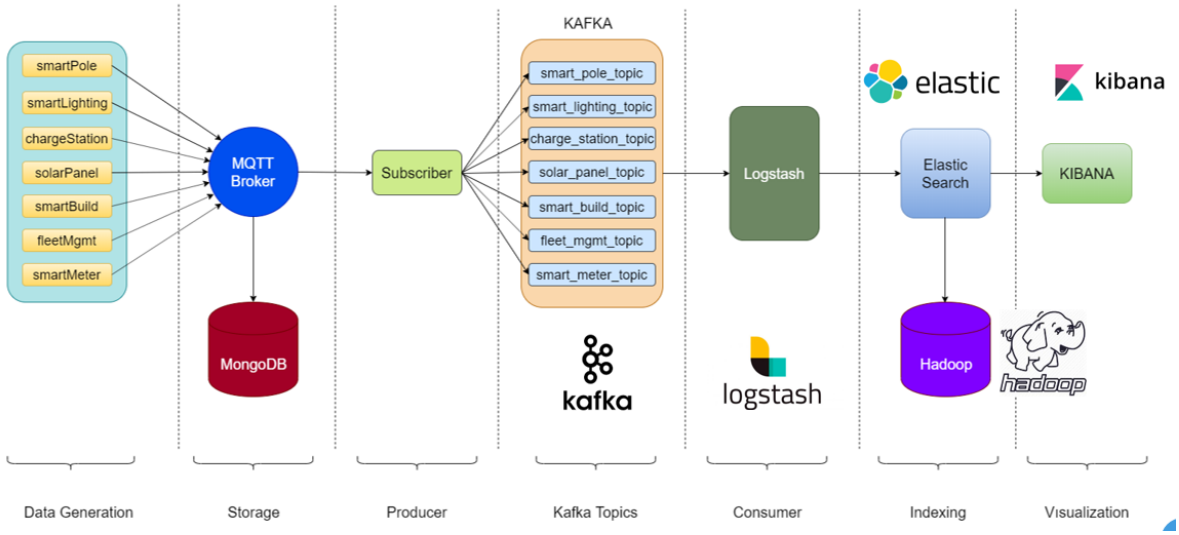

Figure 22 Big Data Flow in Antalya Urban Platform

Antalya Urban Platform (AUP) uses a modular and service oriented approach for integrating this big data. The data is mostly populated in real-time, but also in hourly, daily or even yearly basis. Not only for scalability and fault-tolerance but also to have real-time streaming and messaging between the various platform components, AUP requires strong integration and messaging gateways, scalable and distributable big data storage and processing, and

[20] https://www.elastic.co/products/kibana

This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement N°774477

powerful data analytics and visualization. As seen in the figure above, the Big Data collection and visualization architecture has different components.

Data Generation: Data is being collected from synthetic IoT sensors (chargeStation, smartPole, smartBuild, solarPanel, smartMeter etc.) which are generated with Python. Each sensor is creating data in different time intervals. When data generated from any sensor above, instantly it is transferred to the MQTT Broker.

MQTT: MQTT is a machine-to-machine "Internet of Things" connectivity protocol. It was designed as an extremely lightweight publish/subscribe messaging transport.

MongoDB: MongoDB is an open-source and leading NoSQL database. MongoDB is a cross-platform, document oriented database that provides, high performance, high availability, and easy scalability. MongoDB works on concept of collection and document. [21]

Kafka: Apache Kafka is a distributed messaging system and a robust queue that can handle a high volume of data and enables you to pass messages from one end-point to another. Kafka is suitable for both offline and online message consumption. Kafka messages are persisted on the disk and replicated within the cluster to prevent data loss. Kafka is built on top of the ZooKeeper synchronization service. It integrates very well with Apache Storm and Spark for real-time streaming data analysis. Kafka is a unified platform for handling all the real-time data feeds. Kafka supports low latency message delivery and gives guarantee for fault tolerance in the presence of machine failures. Kafka is very fast, performs 2 million writes/sec. Kafka persists all data to the disk, which essentially means that all the records go to the page cache of the OS (RAM). This makes it very efficient to transfer data from page cache to a network socket.

Like other publish-subscribe messaging systems, Kafka maintains feeds of messages in topics. Producers write data to topics and consumers read from topics formatted as String, JSON, and Avro commonly. Kafka act as a messaging broker in the architecture between data collection and analysis components and data processing and visualization components. Sensor data will be shared through the Kafka messaging component and will be transferred to big data storage and processing into Elasticsearch via Kafka consumers.

[21] https://www.tutorialspoint.com/mongodb/index.htm, 5/09/2019

This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement N°774477

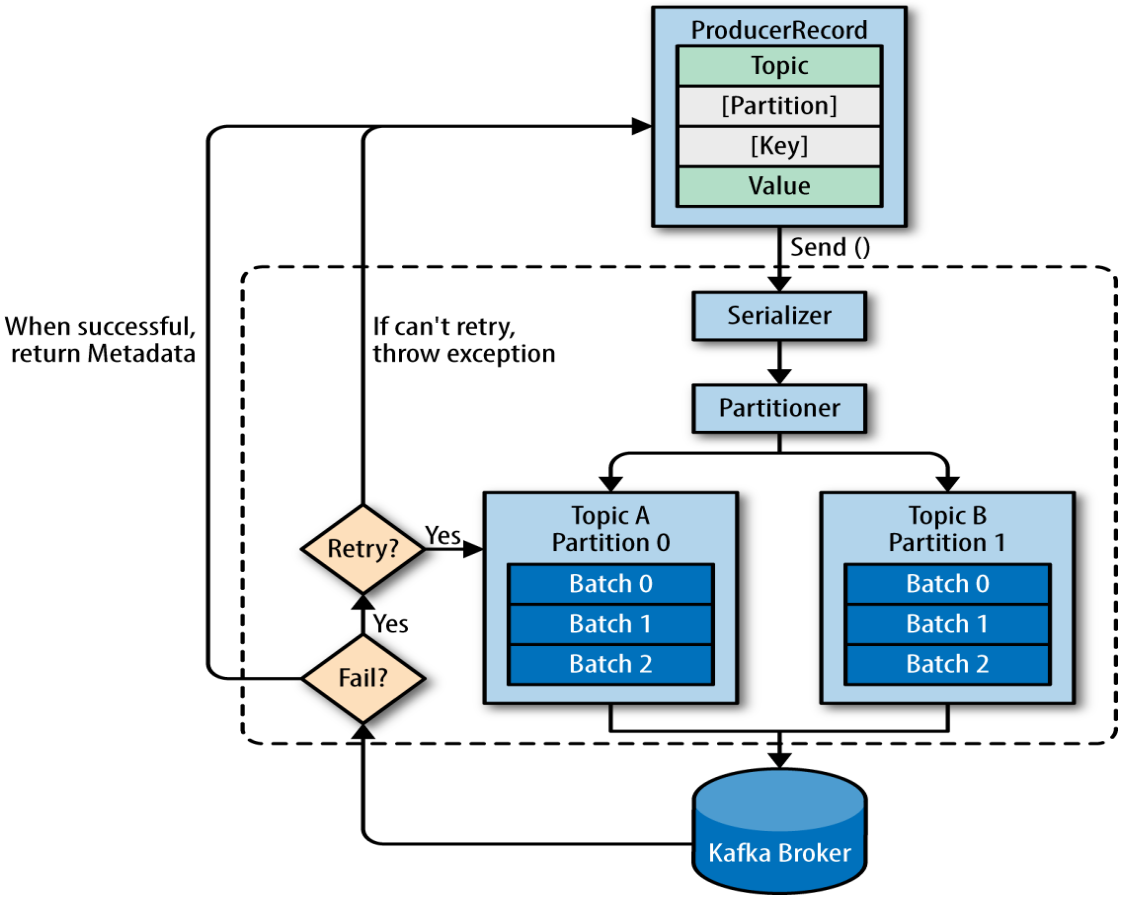

Figure 23 Kafka Architecture

Kafka is a distributed, scalable and robust publish-subscribe messaging system for transferring large amounts of data. Data is transferred as **messages**. These messages are assigned to categories called **topics**. The elements that are used during Kafka distributed messaging are as follows[22]:

- **Message**: Messages are simply byte arrays that can be stored in any format (xml, json, string, etc.). Messages are assigned in Kafka Topics.
- **Kafka Topic**: A Topic is a category/feed name to which messages are stored and published. If you wish to send a message, you send it to a specific topic and if you wish to read a message, you read it from a specific topic.
- **Producers**: Producers are the processes that broadcast the messages to one or more topics.
- **Consumers**: Consumers are the processes that read the messages by subscribing to one or more topics in Kafka.
- **Record**: Producer sends messages to Kafka in the form of records. A record is a key-value pair. It contains the topic name and partition number to be sent. The Kafka

[22] https://kafka.apache.org/intro

This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement N°774477

broker keeps records inside topic partitions. Records sequence is maintained at the partition level. You can define the logic on which basis partition will be determined.

- **Partition**: A topic partition is a unit of parallelism in Kafka, i.e. two consumers cannot consume messages from the same partition at the same time. A consumer can consume from multiple partitions at the same time.
- **Offset**: A record in a partition has an offset associated with it. We may consider partitions like an array; and offsets like indexes.

The Kafka messaging flow is illustrated in Figure 23. Kafka runs as a cluster and the nodes are called brokers. Brokers can be leaders or replicas to provide high-availability and fault tolerance. Brokers are in charge of partitions, being the distribution unit where messages are stored. Those messages are ordered and they are accessible by an index called offset. A set of partitions forms a topic, being a feed of messages. A partition can have different consumers, and they access the messages using its own offset. Producers publish messages into Kafka topics.

Logstash: is a tool based on the filter/pipes patterns for gathering, processing and generating the logs or events. It helps in centralizing and making real time analysis of logs and events from different sources.

When new data generated from any of the IoT devices, it uses the MQTT protocol and publishes a message to the MQTT Broker. There are subscribers which are listening to the MQTT Broker. Each subscriber listens to the corresponding part which receives data from IoT devices.

After the subscriber gets the data, it sends the data to the corresponding topic in Kafka. Here, subscribers act as a producer of Kafka.

Logstash has corresponding config files which are listening the Kafka topics. Here, Logstash acts as a consumer of Kafka. After the relevant configurations done in Logstash, it sends the modified data to the ES and Kibana for visualizations.

7.3 Big Data Visualization

In Antalya Urban Platform, based on some evaluations two popular big data visualization frameworks, Kibana and Knowage (priorly SpagoBI) have been studies. In Antalya, it was decided to use Elasticsearch and Kibana with support of Hadoop and Apache Kafka integration (explained in D.4.24 Urban platform Integration and Interoperability in Antalya). Kibana is used to show all environmental, technical, economic and social data using different visualization capabilities. The foreseen architecture for MAtchUP Antalya visualization is given in Figure 24.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement N°774477

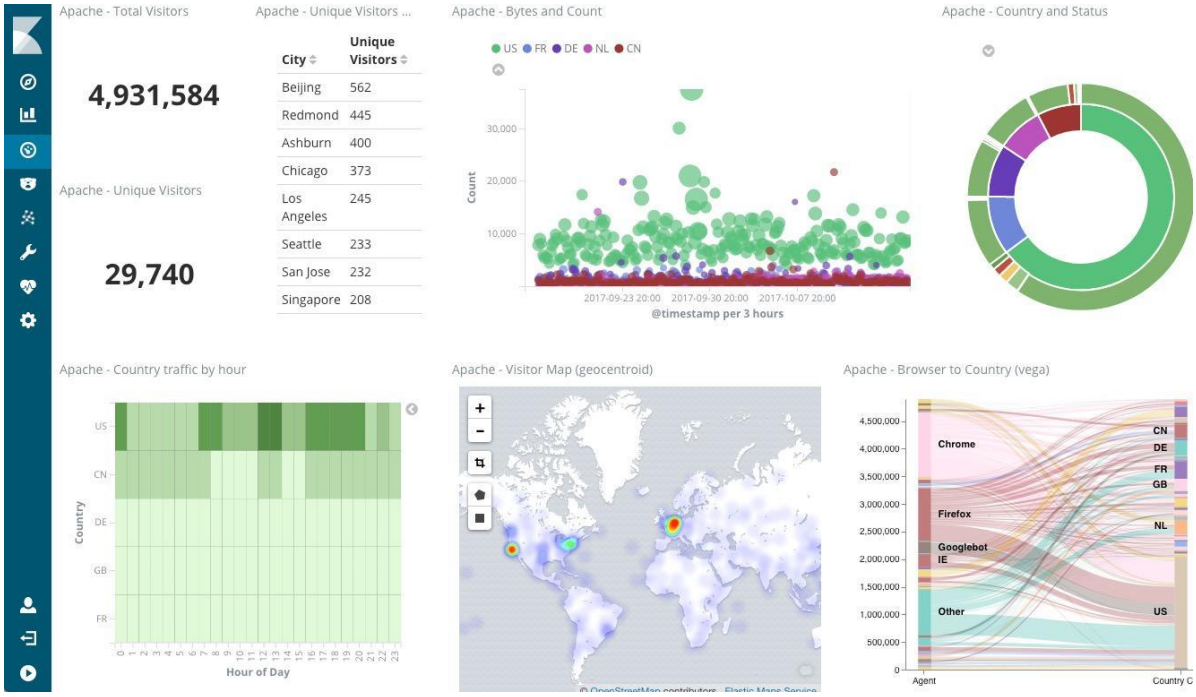

Figure 24 Kibana Visualizations

Elasticsearch [32]**:** Elasticsearch is quite flexible scalable data analytics and text search engine. It allows us to analyze, search and store big data very fast and near real time. It is generally used as the underlying engine/technology that powers applications that have complex search features and requirements. Elasticsearch can perform queries within millions of documents and brings high accurate results in a second. Another advantage of Elasticsearch is relevancy and scoring on the other hand in a typical SQL database you may try to write can see trends on your data and includes three main components for blog storage engine, log analytics tools and document repository.

Kibana [33]: Kibana is a general purpose graphing and visualization tool from the Elastic Team. It was originally written in Node.js, so it's easy to distribute and install as a package. No runtime installations are required. Some of the benefits of using Kibana to visualize your log data are: it's free, it's built to work easily with Elasticsearch, it provides many included visualization widgets like pie charts, line graphs, and more, and it provides an easy dashboard setup and sharing method. It's quick and painless to create dashboards of useful and related data, and share that dashboard with fellow co-workers. Kibana is able to read the Logstash-enhanced GeoIP data and create a heat map almost instantly.

As a rough summary, hundreds of IoT devices are connected to the platform. These data providers create a big data pool. The platform, the main tool for the development of the Smart City strategy of the city of Antalya, is developed based on the architecture shown in the Figure 21 above.

The Big Data collection, pre-processing & integration layer is responsible for data collection, pre-processing and integration. Components integrated under this layer include data

This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement N°774477

collection mechanisms from IoT devices. This layer is supported by Apache Kafka as the main messaging gateway between the various components.

The Big Data Storage & Processing layer is responsible for the general management of big data and data processing. Elasticsearch real-time data management and Hadoop for big data management and processing are used as the main components of this layer.

The top layer of the architecture, the Big Data Visualization, provides the mobile application, Kibana for big data visualization, widgets and dashboards, and Open Data Portal.

Antalya Urban Platform big data visualization component is based on Elasticsearch Kibana and is very powerful in terms of managing and visualizing large scale big data sets.

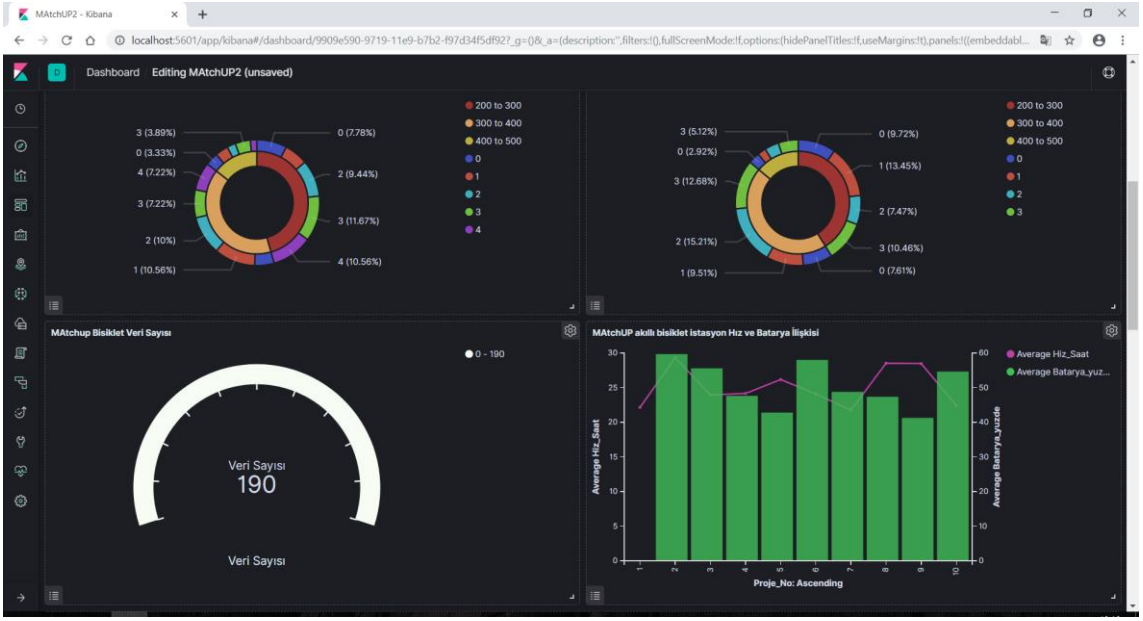

Figure 25 AUP Big Data Visualization

Platform provides several different capabilities of handing versatile data sets and used for creating visualizations and dashboards for all relevant interventions. Supported visualizations are area, input controls, maps, data tables, gauges, heat maps, horizontal, vertical bars, lines, pie charts, metrics, tag clouds and several other time series charts. (Figure 26)

This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement N°774477

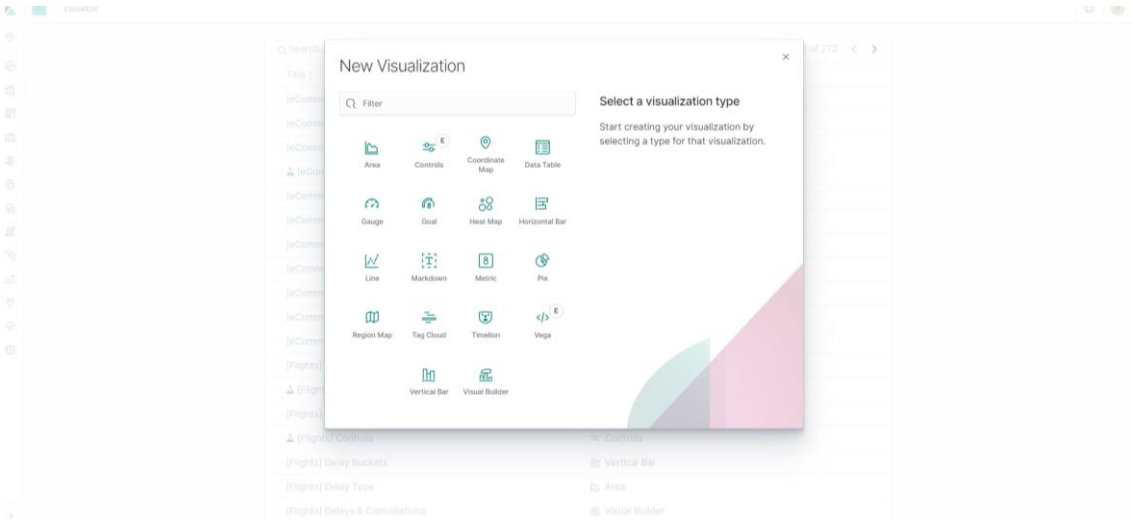

Figure 26 Visualization types

7.4 Application of Machine Learning Methods to Big Data

Machine Learning (ML) is a scientific discipline included in the field of Artificial Intelligence. ML is based on the system that automatically identifies complex patterns into large volumes of data. There are different techniques in machine learning for regression and classification problems. They will be employed in the following period and report the development during the 3rd reporting period of the project.

But, considering Hadoop and Elasticsearch usage, Elasticsearch X-pack will be investigated as a good opportunity to apply machine learning algorithms to the datasets in MAtchUP.

Complex, fast-moving datasets make it nearly impossible to spot infrastructure problems, intruders, or business issues as they happen, using rules or humans looking at dashboards. Elastic machine learning features automatically model the behaviour of your Elasticsearch data — trends, periodicity, and more — in real time to identify issues faster, streamline root cause analysis, and reduce false positives.

X-Pack is an Elastic Stack extension that bundles security, alerting, monitoring, reporting, and graph capabilities into one easy-to-install package. While the X-Pack components are designed to work together seamlessly, you can easily enable or disable the features you want to use.

Prior to Elasticsearch 5.0.0, Shield, Watcher, and Marvel plug-ins had to be separately installed, to get the features that are bundled together in X-Pack. With X-Pack, there are no doubts whether or not the right version of each plugin, just install the X-Pack for the Elasticsearch version you are running.

As highlighted, machine learning techniques will be investigated more in the upcoming period after monitoring several parameters coming from interventions. Most of the data sets are time series based data sets for energy and mobility interventions. The idea here is to

This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement N°774477

find anomalies and outliers, having forecasting capabilities based on trends of energy and mobility patterns, and identify areas of interest in Antalya urban platform data sets using machine learning for time series. For anomaly detection and outliers' detection in the urban platform, unsupervised learning and time series analysis techniques are going to be occupied. This allows to draw conclusions from a set of data instead of using training a model (i.e., supervised learning) to make predictions, like it is applied within regression analysis using different techniques, including neural networks, least squares, or support vector machines. With this approach, it is planned to identify anomalies, seasonality's, trends and also analyse the distribution of the data set (Gaussian, etc.).

7.5 Benefits of Big Data Analysis

There are many benefits of Big Data analysis. The first one is that this type of analysis allows collecting data from different sources and types, mixing structured, semi-structured and unstructured data. Conventional analysis does not permit this, or in the best case carrying out this task could prove too expensive.

The second benefit is that an advanced analysis of the data can be carried out to assist in the decision-making process producing as a result very competitive advantages. Advanced analysis includes predictive models and pattern analysis, to obtain aggregated good quality data. This leads to implement new and effective strategies.

Another advantage of big data analysis in real time is noticing and understanding errors instantly. Noticing errors early, prevents bigger problems and saves energy, time and cost for organizations.

The last benefit is that these analyses are carried out in a short term, quickly, so that results are immediately available to satisfy the need of getting useful information at a high speed.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement N°774477

8 Action Plan

The ICT related deliverables Dx.22, Dx.24 (x=2, 3, 4) are being created in cooperation with the technical partners in each city namely SAM (in Antalya), UPV (in Valencia) and TUD in Dresden). For the general analysis of the MAtchUP ICT topics and to take actions accordingly in addition to collaboration on the technical deliverables, an ICT working group is established in MAtchUP and invites all the relevant partners from each city to get their opinion on each of these matters.

In the first year of the project, Antalya local team has worked mainly on intervention definition and KPIs. Parallel to these efforts, in ICT, we have already started to define and implement the urban platform for Antalya, including the New Kepez Smart City area and also started the open data initiatives.

In the second year of the project, SAM has worked on the open data platform development and implementation of the infrastructure systems that serve as the foundation of the data collecting, analysis and interpretation.

In the third year, the initial beta versions of the urban platform are completed and ready for the data collection through IoT. However, due to the unprecedented Covid-19 virus outbreak and pandemic, the planned work has been affected negatively. The IoT instalments in residential units, municipality building and mobility actions are limited and the platform integration practices in Antalya are facing delays due to the travelling restrictions and several curfews. Because of the circumstances, the developments are facing approximately 5 months of delay where the monitoring period was planned to be started at M36. Therefore, the anticipated Action plan is expected to string out to 4th year of the project 2021 through M42.

Antalya will be following up the Action plan in Figure 27 in upcoming period.

	2019				2020				2021			
MAtchUP Antalya Action Plan	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Urban Platform Developments												
Urban Platform Integration with Legacy Systems												
Urban Platform Interventions Integrations												
Open Data Implementation												
Open Data Catalogue Generation												
Open Data Enhancement with Demo Area Datasets												
Big Data Analytics Adaptations												
Big Data Visualization												
Big Data Adaptation & KPIs												
Integration & Implementation												

Completed In Progress to be Completed

Figure 27 Antalya Action Plan for Open Data & Big Data Adaptations

This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement N°774477

9 Conclusions

In the third and final version (M38) of this deliverable, the specified details of the urban platform adaptation that Antalya performed until M38 are further developed, the insights to the current status amplified and the performed actions, as well as the planned ones, briefed.

Firstly, Antalya's smart city vision and existing infrastructure has been analysed with Antalya Urban Platform components to be realized during MAtchUP. Integration strategies provide the integration approach among different components of the Urban Platform and also between three lighthouse cities urban platform. Studies on the integration continued during the 3rd reporting period. In addition, Antalya open data adaptation approach has been provided with implementation details and integration aspects for Open APIs. Open data adaptations also provide detailed explanations on the data sources and their privacy and security constraints. Moreover, as part of the MAtchUP technical partners (SAM, UPV, TUD, VTT), the creation of a data catalogue has been initiated, which hosted all the available MAtchUP data until M38 and still counting. In open data APIs adaptation, both existing and new APIs to be developed during MAtchUP implementation are described with relevant details.

One of the most important aspects of Antalya Urban Platform is the big data functionalities and adaptations part which covers various big data sources, big data analytics and visualization components to be used for Antalya Urban Platform with machine learning perspectives. The last part of the deliverable provides concrete action plans for the urban platform adaptations for the following periods.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement N°774477

10 References

[1] "Home - FIWARE." [Online]. Available: https://www.fiware.org/. [Accessed: 17-Sep-2018].

[2] "Data Models - FIWARE." [Online]. Available: https://www.fiware.org/developers/data-models/. [Accessed: 17-Sep-2018].

[3] "Remourban." [Online]. Available: http://www.remourban.eu/. [Accessed: 18-Sep-2018].

[4] "Triangulum | The three-point project Triangulum is one of currently nine European Smart Cities and Communities Lighthouse Projects, set to demonstrate, disseminate and replicate solutions and frameworks for Europe's future smart cites." [Online]. Available: https://www.triangulum-project.eu/. [Accessed: 18-Sep-2018].

[5] "Grow Smarter: Home." [Online]. Available: http://www.grow-smarter.eu/home/. [Accessed: 18-Sep-2018].

[6] "Publications | City Protocol." [Online]. Available: http://cityprotocol.org/publications/. [Accessed: 12-Sep-2018].

[7] "PAS 182 – Smart Cities Data Concept Model | BSI Group." [Online]. Available: https://www.bsigroup.com/en-GB/smart-cities/Smart-Cities-Standards-and-Publication/PAS-182-smart-cities-data-concept-model/. [Accessed: 12-Sep-2018].

[8] Smartm, "TS 103 264 - V1.1.1 - SmartM2M; Smart Appliances; Reference Ontology and oneM2M Mapping," 2015.

[9] "ISO/IEC JTC 1/WG 11 N 48," 2016. [Online]. Available: www.iso.org. [Accessed: 12-Sep-2018].

[10] P. Bellini, M. Benigni, R. Billero, P. Nesi, and N. Rauch, "Km4City ontology building vs data harvesting and cleaning for smart-city services," *J. Vis. Lang. Comput.*, vol. 25, no. 6, pp. 827–839, Dec. 2014.

[11] "Km4City App." [Online]. Available: http://www.km4city.org/. [Accessed: 12-Sep-2018].

[12] H. Lindén and J. Stråle, "AN EVALUATION OF PLATFORMS FOR OPEN GOVERNMENT DATA FOR OPEN GOVERNMENT DATA."

[13] "DataStore extension — CKAN 2.7.3 documentation." [Online]. Available: http://docs.ckan.org/en/ckan-2.7.3/maintaining/datastore.html. [Accessed: 13-Sep-2018].

[14] "FileStore and file uploads — CKAN 2.7.3 documentation." [Online]. Available: http://docs.ckan.org/en/ckan-2.7.3/maintaining/filestore.html. [Accessed: 13-Sep-2018].

[15] "Offene Daten Österreich | data.gv.at." [Online]. Available: https://www.data.gv.at/. [Accessed: 12-Sep-2018].

[16] "Open Data Paris — Explore." [Online]. Available:

This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement N°774477

https://opendata.paris.fr/explore/?sort=modified. [Accessed: 12-Sep-2018].

[17] "Open Data Zürich - Stadt Zürich." [Online]. Available: https://data.stadt-zuerich.ch/. [Accessed: 12-Sep-2018].

[18] "Willkommen - Open-Data-Portal München." [Online]. Available: https://www.opengov-muenchen.de/. [Accessed: 12-Sep-2018].

[19] "Open data service – Making better use of public data in the Helsinki region." [Online]. Available: https://hri.fi/en_gb/. [Accessed: 12-Sep-2018].

[20] "Portale Open Data | Comune di Milano." [Online]. Available: https://dati.comune.milano.it/. [Accessed: 12-Sep-2018].

[21] "Offene Daten Berlin | Offene Daten lesbar für Mensch und Maschine. Das ist das Ziel." [Online]. Available: https://daten.berlin.de/. [Accessed: 12-Sep-2018].

[22] "opendata.swiss." [Online]. Available: https://opendata.swiss/en/. [Accessed: 12-Sep-2018].

[23] "Open Government." [Online]. Available: https://open.canada.ca/en. [Accessed: 12-Sep-2018].

[24] "Data.gov." [Online]. Available: https://www.data.gov/. [Accessed: 12-Sep-2018].

[25] "data.gov.au - beta." [Online]. Available: https://search.data.gov.au/. [Accessed: 12-Sep-2018].

[26] "Home page - European Data Portal." [Online]. Available: https://www.europeandataportal.eu/en/homepage. [Accessed: 12-Sep-2018].

[27] "Open Data Portal - Dijital Dönüşüm." [Online]. Available: https://www.dijitaldonusum.gov.tr/en/open-data-portal/. [Accessed: 12-Sep-2018].

[28] "Şahinbey Municipality Open Data Portal." [Online]. Available: http://acikveri.sahinbey.bel.tr/opendatamanagement/. [Accessed: 12-Sep-2018].

[29] "European Commission Directorate General for Communications Networks, Content and Technology Unit G.1 Data Policy and Innovation Daniele Rizzi-Policy Officer DISCLAIMER."

[30] "Infographic: The Four V's of Big Data | IBM Big Data & Analytics Hub." [Online]. Available: https://www.ibmbigdatahub.com/infographic/four-vs-big-data. [Accessed: 17-Sep-2018].

[31] "Apache Hadoop." [Online]. Available: http://hadoop.apache.org/. [Accessed: 17-Sep-2018].

[32] "Open Source Search & Analytics · Elasticsearch." [Online]. Available: https://www.elastic.co/. [Accessed: 17-Sep-2018].

[33] "Kibana." [Online]. Available: https://www.elastic.co/products/kibana. [Accessed: 17-Sep-2018].

[34] "Knowage - Open Source Suite for your Business Analytics." [Online]. Available: https://www.knowage-suite.com/site/home/. [Accessed: 17-Sep-2018].

This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement N°774477