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my SMART Life

Deliverable due date: M36 – November 2019 (Final version M36)

D4.11 Lighthouse-specific IoT service, backend and sensoring systems in use backend and sensoring systems in use (WP4, Task 4.5, Subtask 4.5.1)

Transition of EU cities towards a new concept of Smart Life and Economy

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 731297.

Project Acronym	mySMARTLife		
Project Title	**Transition of EU cities towards a new concept of Smart Life and Economy**		
Project Duration	1st December 2016 – 30th November 2021 (60 Months)		
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Contributing beneficiary(ies)	HEL, VTT, CAR		
Task description	Subtask 4.5.1. Urban platform data upgrades and two demonstrator App deployments Definition of several lighthouse-specific IoT services, backend and sensoring systems.		

Date	Version	Author	Comment
20/10/2017	0.1	Timo Ruohomäki (FVH)	First draft
27/10/2017	0.2	Timo Ruohomäki (FVH)	Chapters completed
27/10/2017	0.2.1	Timo Ruohomäki (FVH)	Added references, fixed typos
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16/10/2019	1.1	Timo Ruohomäki (FVH)	Updates for M36 version.
27/11/2019	1.2	Timo Ruohomäki (FVH)	Updates after review comments.

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Abbreviations and Acronyms

Acronym	Description
API	Application Programming Interface, a set of functions and procedures that allow the creation of applications which access the features or data of an operating system, application, or other service.
AQ	Air Quality
CityGML	City Geography Markup Language
CKAN	Comprehensive Knowledge Archive Network, a web-based open source management system for the storage and distribution of open data.
ETL	Extract, Transform and Loading, a data processing method where data is extracted from source system, transformed and load to destination system. This method is used especially with legacy systems with proprietary data formats.
GDPR	General Data Protection Regulation is a legal framework that sets the guidelines for the collection and processing of personal information of individuals within the European Union
HAQT	Helsinki Metropolitan Air Quality Testbed, a comprehensive city-wide air quality sensor network and simulation service.
HTTP	Hypertext Transfer Protocol
ICT	Information and Communication Technologies
IEC	International Electrotechnical Commission
IoT	Internet of Things
IP	Internet Protocol
ISO	International Standardization Organization
JSON	JavaScript Object Notation
JSON-LD	JSON for Linked Data
KPI	Key Performance Indicator
LoRa	Long Range, low power wireless platform
LoRaWAN	LoRa Wide Area Network
mySMARTLife	Transition of EU cities towards a new concept of Smart Life and Economy
OCPP	Open Charger Point Protocol
OGC	Open Geospatial Consortium is an international industry consortium of over 531

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	companies, government agencies and universities participating in a consensus process to develop publicly available interface standards, especially in the domain of location-based services.
RDF	Resource Description Framework
REST	Representational State Transfer
SDK	Software Development Kit
SKOS	Simple Knowledge Organization System, a common data model for sharing and linking knowledge organization systems via the Web. The SKOS data model is maintained by the World Wide Web Consortium (W3C).
SOAP	Simple Object Access Protocol
STA	SensorThings API is an OGC standard specification for providing an open and unified way to interconnect IoT devices, data, and applications over the Web.
UCUM	Unified Code for Units of Measure
W3C	World Wide Web Consortium
XML	eXtensible Markup Language
YSO	Yleinen Suomalainen Ontologia (General Finnish Ontology)

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1. Executive Summary

This deliverable treats the definition of several lighthouse-specific IoT services, backend and sensoring systems for the Helsinki urban platform. As part of the mySMARTLife project, the urban platforms of the lighthouse cities are being improved by means of the integration of new services and IoT data. Thus, new verticals and real-time information together with data catalogues, such as the Helsinki Region Infoshare, provide new data-driven services.

These new data streams are coming from the IoT devices and data APIs that are being deployed under other actions across the project. For instance, electrical vehicles measurements or energy consumption are data-sets to be included and processed within the urban platform. Moreover, new data-driven services are foreseen, as for example the Carbon Neutral Helsinki Programme Dashboard, Climate Atlas and Carbon Neutral Me mobiles apps. Finally, the information is also helpful when calculating the KPIs defined in the project with the aim of assessing the impact of the actions. Hence, real-time data is necessary and this deliverable explains how to handle and manage these IoT data services.

One important aspect that is also taken into consideration when drafting the deliverable is the privacy and security. Therefore, when managing data, whichever the source is, current regulations should be cared. In this sense, the upcoming General Data Protection Regulation (GDPR) is evaluated with the objective of keeping the privacy and security of data, bearing in mind MyData principles for Helsinki.

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2. Introduction

2.1 Purpose and target group

The mySMARTLife project contains several activities that require additional functions on the Helsinki Urban Platform. While the Urban Platform is a somewhat an abstract concept, until now, the IoT data services have been developed as separate vertical silos. Using the real-time IoT data streams together with existing data catalogues such as the Helsinki Region Infoshare in order to provide more advanced data-driven services has been challenging for both technical and practical reasons.

The mySMARTLife project has a significant budget to improve the urban platform towards real-time data handling and managing IoT devices. The result of this activity will be an improved way of collecting data to calculate KPIs and to assess the impact of other actions. There are also actions where completely new sensors are required in order to prove the environmental impact of electrical vehicles. Many of the new, developed services are heavily data-driven such as the Energy Advisor (action 40) and CarbonEgo app (action 46). Also, several actions are related to data generated from building automation systems and electrical vehicle chargers.

The mySMARTLife project gives us also an opportunity to study the requirements that the upcoming General Data Protection Regulation (GDPR) introduces. Since the architecture of real-time data platform is created from scratch, it can now be created from the beginning keeping the privacy and MyData principles in mind in order to support fundamental principles such as the dynamic consent management and right to be forgotten.

This deliverable is related to actions 47-48 that also have the budget allocation for the effort, subcontracting and services related to delivery of the technical platform work. The relationship between the IoT actions and deliverables is depicted in Figure 1, where it is observed how actions 47 and 48 are related with IoT devices, while actions 44, 45 and 46 are more dedicated to implementation of new services and improvements in the urban platform. The action 47 is about mySMARTLife IoT repository up-take and integration of sensor sources to the repository. It is dedicated to connect the actions to the urban platform through monitoring. That is to say, it focuses on the integration of the new measurements from other actions by means of IoT devices and IoT middleware. The action 48 complements the work with the Up-take of new sensoring infrastructure in the smart districts to support actions. In this case, additional information is used to analyse the interventions in terms of mobility and use comfort. It should be also mentioned that the project has included elements of citizen science, meaning creating personal sensors together with the citizens as part of the living labs of action 2. Also, the action 6 of Flexispaces is relying on data exchange when the optimization is more based on the utilization rate of the space and less on new building automation. Finally, the urban platform also provides the backend for services like Carbon Ego (formerly Carbon Neutral Me, action 44).

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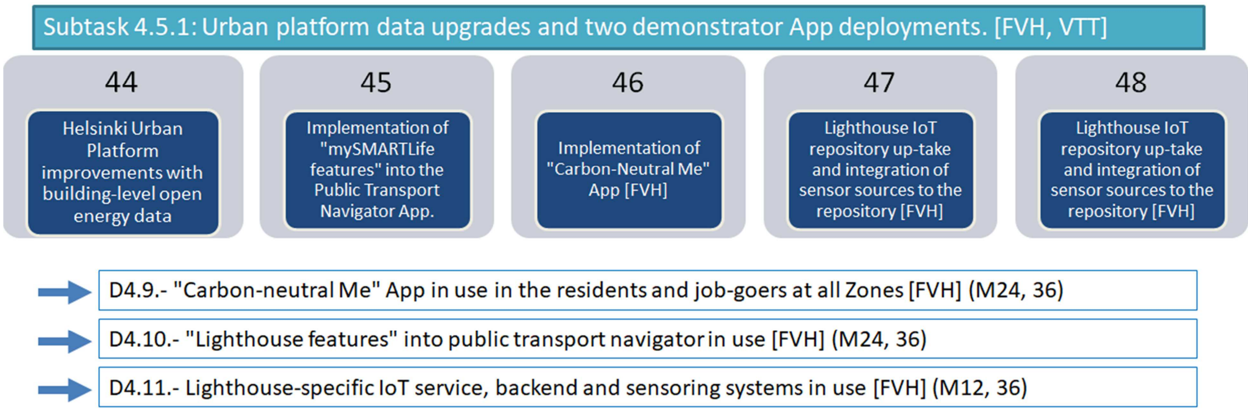

Figure 1: Relationship between deliverables and actions

With respect to the distribution of tasks, the combination between tasks, subtasks, actions and deliverables is very complex and the objective of the info packs. In particular, for this deliverable, Figure 2 represents how D4.11 is contained in the T4.5 dedicated to the ICT and urban platform developments. More in detail, it belongs to subtask 4.5.1 in terms of urban platform data upgrades. Within this subtask, it is foreseen the development of updates in the urban platform and development of "Carbon Ego " App to be used by the residents and job-goers at all Zones. As well, "Lighthouse features" are designed and deployed into public transport navigator in use and several Lighthouse-specific IoT service, backend and sensoring systems in use to support on e-mobility and analysis.

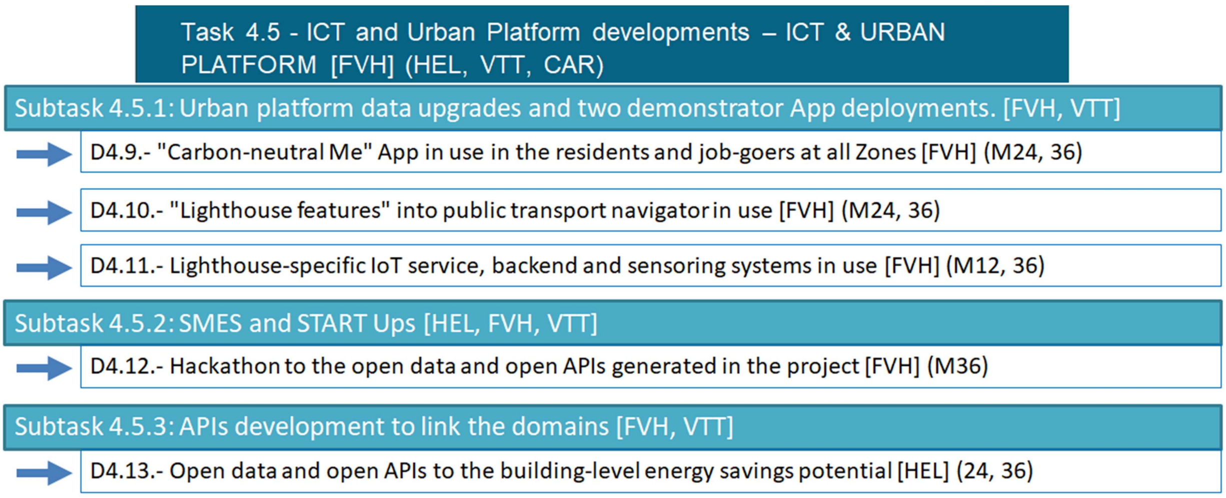

Figure 2: Distribution of the deliverable within the task

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This deliverable provides a non-technical overview on the plans and activities of the action. It is intended to other project members and other parties interested in the project developments.

2.2 Contributions of partners

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

Table 1: Contribution of partners

Participant short name	Contributions
FVH	Main author
HEL	Steering activities as a member of Action Group ICT Helsinki
HEN	Steering activities as a member of Action Group ICT Helsinki
VTT	Steering activities as a member of Action Group ICT Helsinki
NAN	Peer review
CAR	Review of content and format

2.3 Relations to other activities in the project

The following Table 2 depicts the main relationship of this deliverable to other activities (or deliverables) developed within the mySMARTLife project and that should be considered along with this document for further understanding of its contents.

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Table 2: Relation to other activities in the project

Deliverable Number	Contributions
D4.2	This deliverable provides the technical platform to support energy data collection from the buildings to support the definition of related KPIs
D2.16	This deliverable implements the technical platform that is in a high level defined in transversal deliverable
D4.9	Carbon Ego app shall use the static and live data sources made available by the urban platform
D4.10	The urban platform shall provide the data sources and service platform to include the lighthouse features into public transport navigator in use
D4.12	Urban platform would provide the data sources and the platform to run the developed service for the Hackathon to the open data and open APIs generated in the project
D4.14	Monitoring system of the effect of the electric fleet to district-level air quality, noise would use the urban platform as a target where to send the measurement data streams
D4.16	Urban platform would provide the endpoint in order to collect the data from EV chargers to collect information of the shared cars.
D4.18	Lighthouse-features integrated into public transport on-line system

3. Helsinki Urban Platform Vision

In Helsinki, the Urban Platform is seen as a concept that links together several data-related services, providing a single point of service for developers, city officials and citizens requiring information in a machine-readable format. The interoperability between services requires harmonization of data formats, metadata and application programming interfaces (API) that link the services together. The focus on API's and distributed services instead of monolithic central data servers started already several years ago with projects like CitySDK. It was seen as beneficial to put more effort on data flows than data lakes since the cities like Helsinki already have many of the key functions of an urban data platform in place. The cities also have to deal with legacy systems and in general, it is a lot harder to roll out a new data model than a new API.

The following image illustrates the concept of Urban Platform as a collection of city-related data sources and data-driven services:

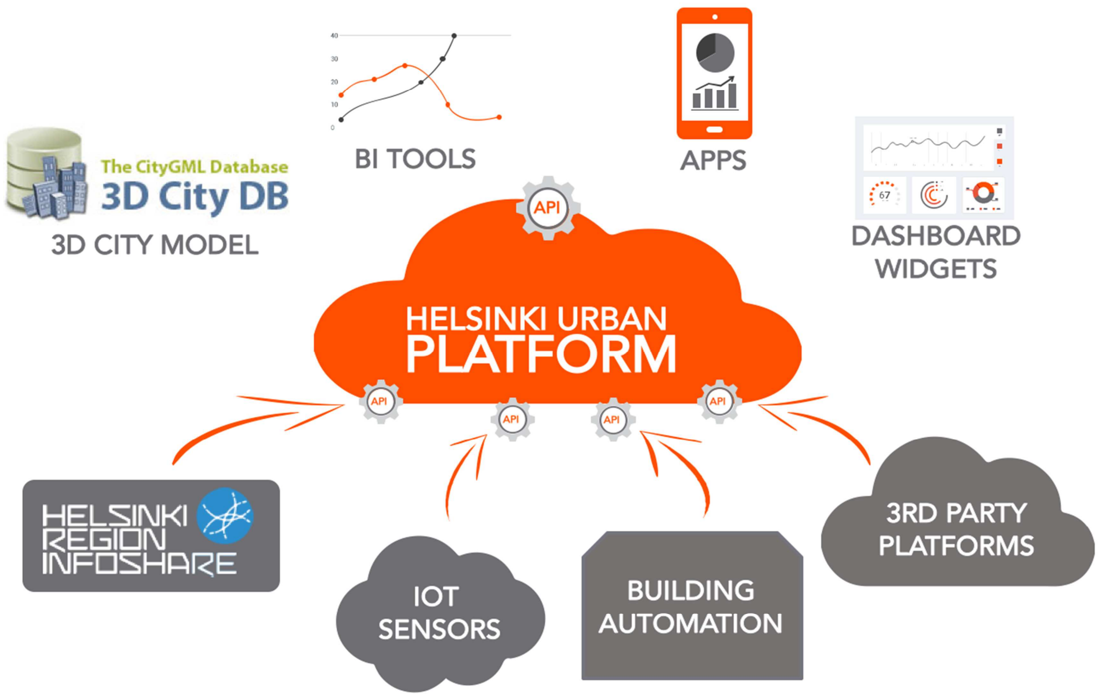

Figure 3: Urban Platform Overview

3.1 City-as-a-Platform

Following the long experience the city of Helsinki has about the business opportunities of open data, the data hub for real-time data shall be built from the beginning to support both public and commercial services and continuous on-boarding of new services. The city as a testbed concept will rely on high

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quality and relevant data sources but also has requirements for proper management of privacy issues. Helsinki introduced MyData in its renewed strategy and it fits well with the recent GDPR privacy requirements: the urban platform is expected to also manage citizen data in a way, that privacy and consent given to the data processing services can be maintained and audited.

The city-as-a-platform concept is illustrated in the following picture:

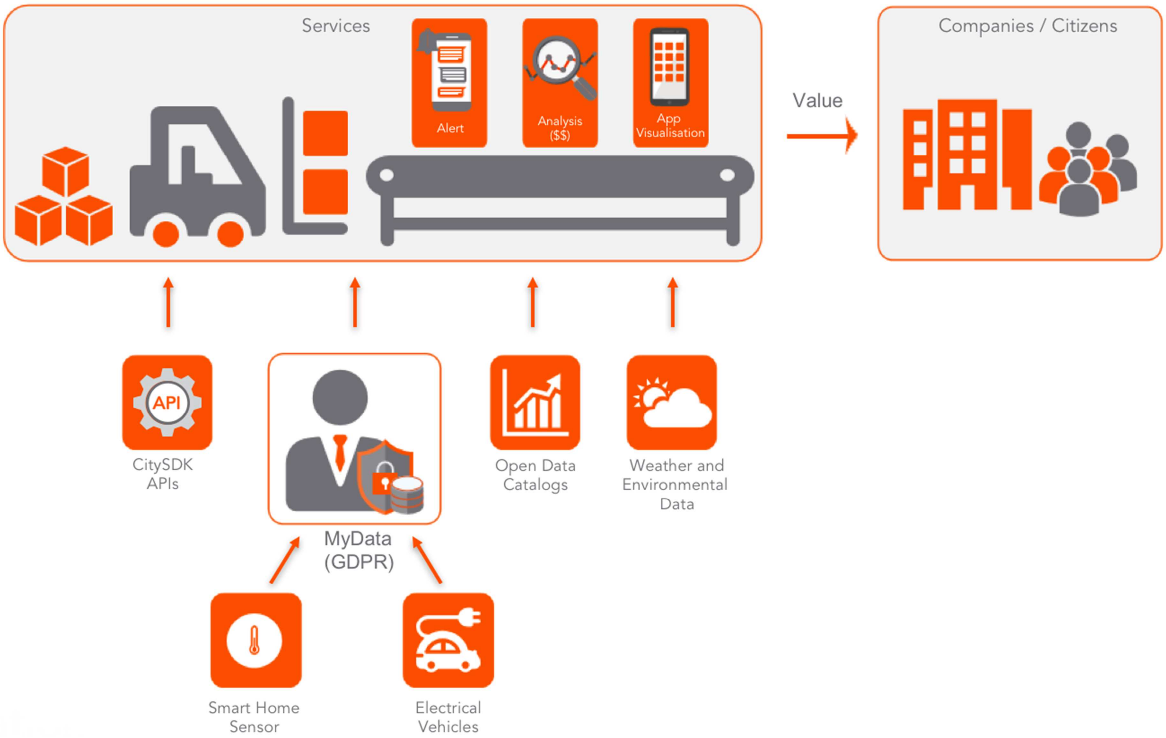

Figure 4: City As a Platform

In the City-as-a-Platform concept the role of the city is to provide opportunity to share and utilize open data sources. The data, the users and the platform together form an ecosystem that generates new services and business opportunities. The platform also has the role of providing a testbed for new trials and service concepts. When the raw data sources and users interested in taking part of co-creation efforts are made available for the service providers, the effort and investment required to test and pilot new services becomes significantly lower. It could be said that the ecosystem described here would be as vital for the development of future smart cities as industrial zones and lots in the past.

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3.2 Open Data

Currently the city strategy requires all city ICT platforms and services to provide their relevant data openly and freely available, mostly through Helsinki Region Infoshare[1], which is a CKAN-based service acting as a data catalogue. It forms the core of the Urban Platform by providing a sharing point for datasets with metadata API's. Since the service is already in use, it meets the requirement of technical readiness level (TRL) 9.

It is expected that the same "open as a method" principle would also apply on sensor data, e.g. data form air quality and noise level sensors. The CKAN platform will also be part of the document workflows intended to be covered with the ETL -processes: the production of temporal datasets with aggregated, calibrated and raw data should be automated. It also is expected that such public datasets are composed of more than a single source.

For more information about the relevant Open Data and Open API approaches in Helsinki, see the Deliverable 4.13 Open Data and Open APIs To the Building-Level Energy Savings Potential.

3.3 User Roles and Stories

In June 2017, the project together with key persons of other projects and the city ICT activities created a set of user stories and defined user roles related to data platform. The user stories are now maintained on a public Trello board[2].

During the work, the following user roles were identified and will be used in the future development: Citizen, Data Scientist, Data Publisher, Platform Administrator, Developer, Hardware Vendor.

In the future development work, the developers and technical architects will work mostly based on user stories, roles and possibly personas. Due to the nature of project, a complete technical specification will not be useful and the development projects will not be based on waterfall planning.

3.4 Dashboards and Visualization

Based on the experiences from Helsinki Region Infoshare data usage, visualization of the data is seen to have a growing importance on public data services. In mySMARTLife project, the visualization will mostly focus on illustrating data as layers on the 3D city model. However, together with other projects such as Synchronicity and Select4Cities the feasibility of widget –based, citizen-oriented dashboard was evaluated. The role of dashboards in smart cities can also be overestimated. Providing situation awareness with the support of a dashboard is common, but the cities as organizations do not have a

[1] https://hri.fi/en_gb/
[2] https://trello.com/b/nYa3Ez5F/helsinki-iot-platform-user-stories

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department or unit that had the task of monitoring such dashboards. Data-driven cities would also require tools and support for making informed decisions with correct and up to date indicators. In many cases those indicators are also required for further reporting when participating programmes like Covenant of Mayors.[3]

It can already be seen that especially air quality and environmental noise readings would better be illustrated as heatmaps and visual trends than as raw data. To improve interoperability and support the 3D city model initiatives, it would however be better to create such heatmaps on top of geospatial standards and then provide them as part of the city model information layers via WFS or WCS interface. Naturally it is also possible that for generic visualization needs some services or concepts will come up as a result from the Hackathons (Deliverable D4.12) and other smart city projects.

3.5 Data Protection and Privacy

On data protection and privacy, there are two concepts that complement each other quite well, the upcoming General Data Protection Regulation (GDPR) and MyData. MyData expects the person to have more power and control on data related to her while GDPR defines specific functions that the person can expect for data usage in order to keep personal data private.

MyData is an infrastructure-level approach for ensuring data interoperability and portability. It is expected to be sector independent, but a cooperative approach could work on all the sectors. MyData focuses on consent-based data management and control, but without a centralized data repository.

The GDPR regulation is seen as a major step to improve data privacy in the internet. While the data protection is also a relatively new EU right, what makes the GDPR significant is that the data protection is introduced as a fundamental right of the citizen.

From the data portal point of view, the most important technical impacts of the GDPR are the following:

- A person shall be able to transfer their personal data from one electronic processing system to and into another, without being prevented from doing so by the data controller (transfer = erase + create).
- A person will have total control over his/her profiling and over any automatically derived information, action or decision that is produced based on his/her personal data, including behaviour data.
- Consent should be given by a clear affirmative act establishing a freely given, specific, informed and unambiguous indication of the data subject’s agreement to the processing of personal data relating to him or her.

[3] https://www.covenantofmayors.eu

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The regulation also sets the requirements for data encryption on the platform and defines what types of data will fall into the category of personal data. As an example, when a sensor is sending location information as addition to the measured property, the location can make it personal data if through the location the data combined together with other data points could be associated to person.

The personal data is defined in the GDPR as following: Personal data means 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 identifier such as name, an identification number, location data, an online identifier or to one or more factors specific to the physical, physiological, genetic, mental, economic, cultural or social identity of that natural person.

It is important to notice, that the informed consent is not always required in data collection and processing services. The GDPR directive lists six alternative methods that can make data collection legal, and as addition to consent the cities can also justify data collection by legitimate interest or public interest. As an example, data collection for maintenance purposes is a legitimate interest of the facility manager. In the service design however, special attention needs to be put on the transparency of data collection and processing towards the data subjects no matter which criteria is used to prove the lawfulness of the data collection.

It should however be noted that the GDPR has also specific language when data is collected related to children of the age below 16 (or 13). The Article 22 defines the conditions related to automated individual decision-making, including profiling. This may require attention in cases where personal profiles are to be created to control conditions.

In the mySMARTLife project, the privacy issues have been tackled mostly by collecting a formal informed consent from the residents of apartment buildings. In other pilots and activities, privacy has been respected by carefully evaluating the benefits of data collection compared to the privacy of data subjects. One specific sensor trial was cancelled because of the risk in privacy that was related to traffic counting and vehicle type analysis based on camera monitoring.

3.6 Metadata

3.6.1 About Metadata

The data streams related to the project will mostly involve with energy consumption and mobility. The platform development and data stream handling should however be more generic. It is also not expected that much of harmonisation work can be made with reasonable effort, thus driving towards semantic, ontology based metadata models.

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3.6.2 Metadata for Energy, Automotive and Environmental Measurements

For the mySMARTLife project, the following protocols, interface specifications and other technical initiatives will form the basis for the metadata model:

- Building energy information requirements are derived from the Project Haystack terminology lists together with the Unified Code for Units of Measure (UCUM), which is based on ISO 80000 standard.
- Electromobility data model will be based on the related interface protocols, the Open Charger Point Protocol (OCPP) and the ISO/IEC 15118 standard
- CityKEYS indicators are included in supported metadata ontology as

It is expected that the data models will be dynamic and more domains of data will be added later on. In other projects the urban platform will be used as an example for healthcare monitoring, that would then introduce a number of clinical units to the system. There cannot be a fixed set of metadata so the requirements are driving the project into semantic approach, linked data and arranging terms and units as domain-specific ontologies created and managed by the project.

3.6.3 API Data Models

The ICT action group of mySMARTLife project had a meeting in Paris late May 2017 to agree some of the cornerstones of future development. It was agreed that for interoperability reasons, the southbound and northbound APIs of the platform should be harmonized (see D2.17). The chosen API protocol is the SensorThings API, which is an OGC standard. In order to support 3D city models with dynamic data, it is also expected that the platform should be capable of providing data structured on CityGML format. Currently (M36) there is a major update in progress with the main related data models. While the data acquisition part is already completed, northbound API's are to be developed for upcoming use cases. As part of those efforts the WFS3 and CityGML version 3.0 are to be studied. It is expected that there is no new need for development efforts and the project will rather wait for the first implementations of the new standards, e.g. on Geoserver and Cesium.

3.6.4 Linked Data and Ontology Services

The National Library of Finland has been a forerunner in providing resources for services based on semantic metadata. A major research initiative FinnONTO was carried out in 2003-2012 with the goal of providing a national level semantic web ontology infrastructure based on centralized ontology

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services[4]. Later, the service evolved to the Skosmos software[5], which is an implementation of SKOS common data model using the SPARQL query language.

The Skosmos service offers machine access to ontologies not only by publishing Linked Data but also with custom APIs to better support integrations with document and collection management systems. The system provides currently SOAP, HTTP and REST APIs supporting RDF/XML, Turtle and JSON-LD serializations. Currently the service supports over 100,000 accesses by day.

The core of the ONKI/Finto –service provided with the Skosmos server is the General Finnish Ontology YSO. The top-level ontology supports multi-lingual aspects. The role of the YSO is also to act as a central hub for all the domain ontologies on other ontology services. With this approach, the number of direct links between ontologies is minimized thus maintaining the referential integrity. The content of domain ontologies is aggregated into the unified ontology cloud KOKO. The ultimate goal is to use KOKO to relate the annotations in the datasets of the various organizations, facilitating interoperability and breaking down silos[4].

In mySMARTLife project, the Skosmos ontology server and the expertise from the National Library of Finland has been utilized in order to turn the static taxonomies such as UCUM into dynamic, hierarchical ontologies that could be later on supplemented with other domain specific terms.

3.7 Sensor Networks

3.7.1 About mySMARTLife Sensor Networks

The role of the sensor network in mySMARTLife project is to provide data for new KPIs related to other activities, thus proving the impact of completed actions. Such actions are in the domains of building automation and electromobility. In case of building automation, most of the data is gathered from building automation systems with IP-gateway products, that are capable of sending the data properties directly to the southbound API of the urban platform.

The type of data that will require separate and new sensors and sensor networks are air quality, environmental noise and in some cases, occupancy details of buildings.

[4] Suominen, O.,Pessala, S., Tuominen, J., Lappalainen, M., Nykyri, S., Ylikotila, H., Frosterus, M., Hyvönen, E. (2014) Deploying National Ontology Services: From ONKI to Finto. In Proceedings of the ISWC 2014 Industry Track.

[5] http://www.skosmos.org

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3.7.2 Air Quality Sensoring Network

After the project started, a new Finnish foundation called Helsinki Metropolitan Smart&Clean Foundation started major initiatives related to emission-free mobility, smart urban energy, resource wise citizens and sustainable built environment. Together with Finnish technology company Vaisala they have started a project to install a network of air quality sensors in the city area using the latest, lower cost sensor technology. The new AQ sensor network in their HAQT project is capable of providing real-time sensor readings. The Finnish Meteorological Institute will utilize the data and develop urban air quality simulations using their ENFUSER modelling tool.

To avoid duplicate work, mySMARTLife –project is going to use the data coming from the new AQ sensor network instead of building a new one. There may be few exceptions in case the coverage of HAQT sensor network does not cover the areas where mySMARTLife electromobility activities are based. There may be some integration work required to get the HAQT sensor data to the urban platform, but the budget for IoT sensors and middleware will cover that.

3.7.3 Environmental Noise Sensoring Network

The co-operation with Smart&Clean foundation in their HAQT project allows the mySMARTLife project to focus on environmental noise sensoring. The project will set up the first environmental noise sensor network capable of providing real-time sensor readings in key areas. Some of the areas are located closely to the areas where electromobility activities are, some will provide reference information as an example of areas, that are quiet.

The following map illustrates the original plan of noise level sensor locations in central Helsinki. Since then, some locations have changes to because of issues on the chosen sites.

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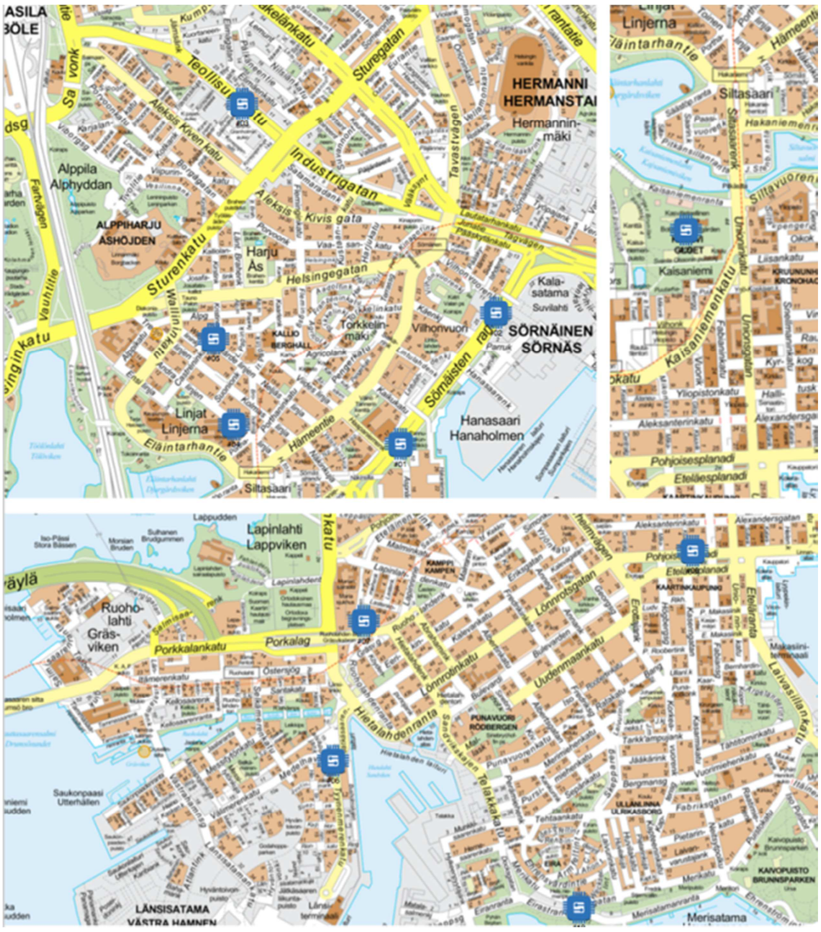

Figure 5: Environmental Noise Level Sensors

The tender process of environmental noise sensors was completed in September 2017 and the installation of the purchased ten sensors will be completed by the end of year 2017. The sensors are provided by Spanish company Cesva through their Finnish distributor Teknocalor. The sensors will send data directly to the developed data hub and a service will be built to provide the integration of data values in order to provide a time-series of average noise level values according to related standards.

3.7.4 Sensor Connectivity - LoRaWAN

In the project plan it was assumed that LoRa would be used as a method of connection to sensors in the urban environment. During the summer of 2017 some tests were made using the new, commercial LoRaWAN network provided by a Finnish company Digita Oy. The tests showed areas that would require focus, as an example the workflow how to add sensors in the network in larger scales and how to verify the strength of network in certain areas. Digita started to install their LoRa transmitters in late

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2016 and in theory, the network covers the Helsinki central area quite well. During the project the coverage was improved so that even inside the buildings, the sensors are able to connect the network.

3.7.5 Sensor Connectivity – Building Networks

While building automation systems are nowadays networked and have devices that can be connected to Internet, in practise, the building automation networks are not designed and maintained in a professional way. Typically, the building automation operates in a network of a user of building because active network appliances such as switches and firewalls have been outside of the scope of building automation contract. The physical network infrastructure would however require some governance in order to keep it reliable and safe.

In the case of Viikki Environment House the actions related to advanced room controls of heating were delayed because of the negotiations with City of Helsinki ICT deparment and whether the provided sensors could be connected to the city's network. A number of issues were identified, including security, maintenance of devices and access to wireless network that was outsourced as a service, thus limiting the options available for setting up a new network.

To solve the issues, the project Action Group decided to get a dedicated Internet connection and network equipment for the sensors and other trials going on in the house. Together with a Finnish Internet operator Suomi Communications Oy, a new service product was developed where they would provide the house an Internet connection, network equipment and all the services required for a monthly fee until the end of project time. This was an important commercial concept to create since in many buildings the problem is the same: the security and reliability of building automation network is not at the level where it should be, since the network requirements were never studied as part of the project and the network was not accordingly designed.

By the end of M36, the Viikki Environment House has been equipped with BACnet Web Service API with over 2.000 data points, a KNX Rest API with about 50 data points and three people counting cameras to provide detailed information on occupancy. The electrical metering is still to be completed due to the lack of resources available. In the beginning of the project the data has been collected to the VTT data acquisition system and Fourdeg system. By the end of the project, the data will also be forwarded to the city BEMS system called Nuuka for production use.

The following image illustrates the network design for building automation and the mySMARTLife actions.

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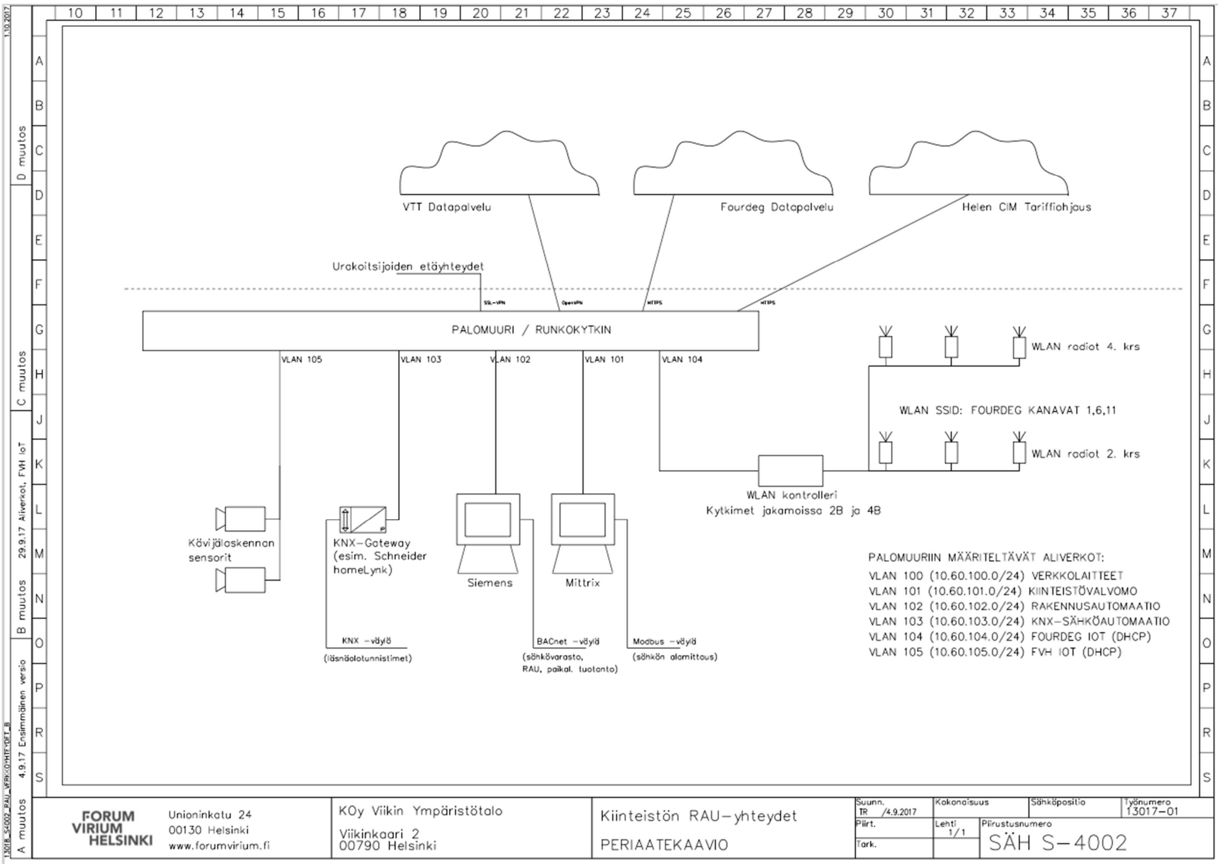

Figure 6: Viikki Sensor Network

3.7.6 Sporametri – moving sensors

After the HAQT -project, new planning round was organized in order to define a new focus for the mySMARTLife project on air quality monitoring in order to avoid duplicate work with the other project. Since the need for information related to environmental noise and air quality comes mostly from mobility, a plan was formulated to collect air quality information from street network with moving sensors. The platform for the pilot was chosen to be trams, since they would provide an installation height of about 4 meters and low interference due to no gas emissions because of being electric driven.

The trial was named as Sporametri (Tram-o-Meter). The request for tender for the equipment and data acquisition platform was raised in May 2018 and sent to three companies with suitable products and services. The winning tender came from company called Aeromon, that has specialized with emission monitoring using drone technology and their custom gas sensors. Their references included monitoring of methane emissions on landfills and sulphur emissions of vessels near harbours.

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The trial was set up in a way that four sensors were made available, three of them mounted on the roof of trams and one permanently installed on the HSY environmental monitoring station, where it's values could be compared with professional and calibrated sensors. With this approach it was possible to extend the trial without recalibration, since the degrading performance could have been monitored because of the similar sensor in the reference station. Since the City of Helsinki public transport department operates with over 100 trams, it wasn't possible to define where the three sensors would end up being. This was however not a problem, since the trial was looking for a maximum spatial coverage and not necessarily a repeatable trend over days. The collected sensor data would also be an interesting dataset for the future when creation simulation models for the built environment. The data collection frequency was set to be very high, one hertz. This was necessary to create a data set that would contain observations of emission values on small grid to observe locations like street corners and buildings of different size.

At the moment, the data from the first observation run that lasted about seven months is being analysed and compensation formulas calculated. A second round will be driven in the final year of the project to conclude over 12 months of data and also a possible change in emissions due to the change of the traffic on over two years of time period.

The gas emissions monitored are the following:

- Nitric Oxide
- Nitrogen Dioxide
- Ozone
- Carbon Monoxide
- Air Pressure
- Humidity
- Temperature

The following screenshot illustrates the driving route of the tram and the data collected:

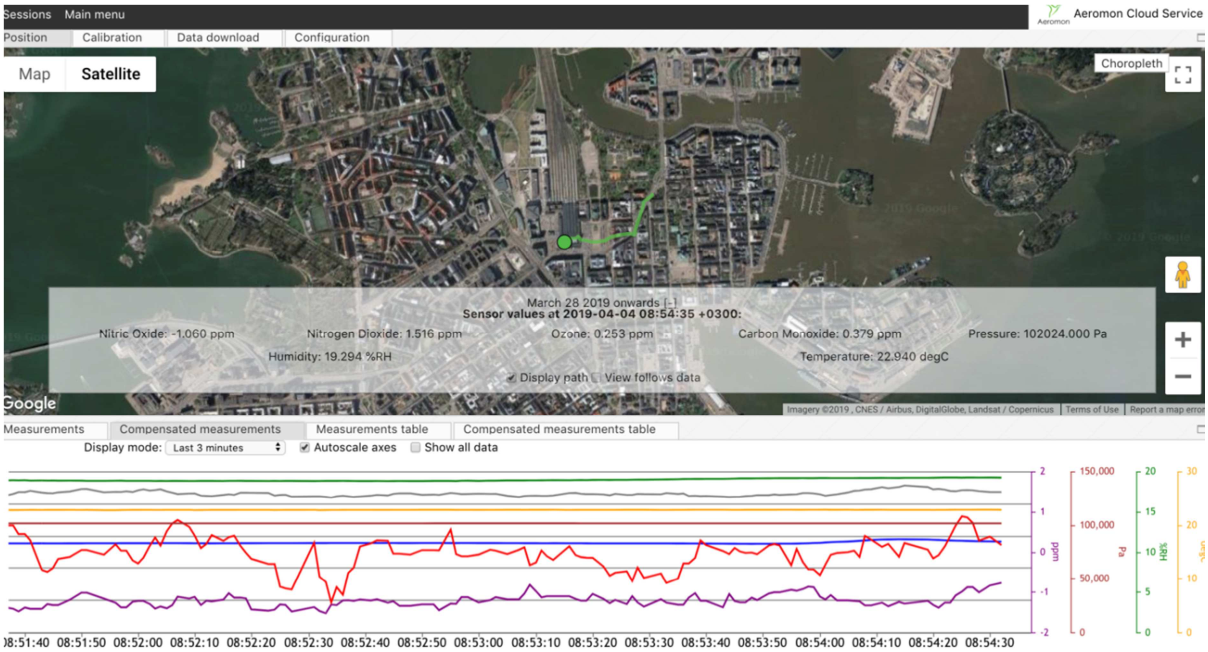

Figure 7: Sporametri Dashboard

The first trial was technically a success and had no major drawbacks. Some issues were identified with the power supply, since the electrical distribution systems of trams cannot provide clean supply of DC current. After installing a DC/DC regulator the issue was however solved.

3.7.7 Traffic Volumes

When the project started, the City of Helsinki had no traffic counters that were able to provide real time data on the numbers of vehicles passing by. The traffic counting system was based on offline induction loop counters on about 100 locations. The data was collected on each of them during a two-week metering period and then extrapolated with statistical methods to provide a view on traffic volumes throughout a year. This data was then used e.g. to estimate noise emissions of traffic.

The project attempted to first replace induction loop counter with an IoT sensor designed to observe changes in inductance. This was however more complicated in practise, and the experiment failed to provide meaningful data. As the second attempt, a trial was set up at the HSY sensoring station using cameras with license plate recognition feature. It was first planned that the license plate numbers would be used for the classification of vehicles using database from the national vehicle registry, but the cost of that dataset and the process of maintaining it were too complicated for the project. Also, there was a risk on privacy that wasn't fully clear and that is currently evaluated by the national data security authority. However, with the license plate numbers alone we were able to count vehicles so the outcome was better than with the induction loop system, because the data was collected in real

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time. This data is used when analysing the traffic emissions since the correlation between emissions and the traffic volumes is naturally strong. Even when counted from a single lane, the data can provide an indicator of traffic volume instead of an exact number of passing vehicles in order to define the peak hours for that particular area. The following figure displays the traffic counting data as visualised on the Grafana dashboard.

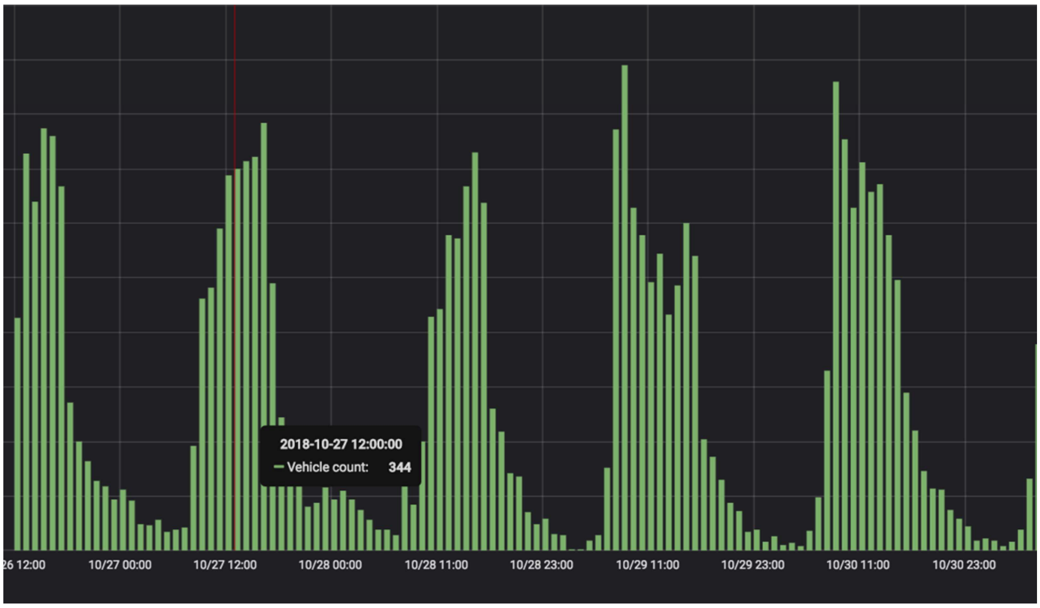

Figure 8: Traffic Counting

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4. Status Report

4.1 Project Milestones

The development effort of the data hub for the Helsinki Urban Platform has been structured to the following major milestones:

PHASE 0 Planning phase including a small LoRaWAN sensor pilot using new city-wide commercial network.

MVP A usable service including core functionality for southbound and northbound API's based on the SensorThings API. Capability to aggregate time-series data to Helinki Region Inforshare. An ETL tool to manipulate and fix data streams in an event-driven fashion. A utility to provide a proof-of-concept on MyData dynamic consent management for sensor data streams.

LIVE BETA 1 The service will be extended with service layer that allows introducing new data processing services as microservices.

LIVE BETA 2 The second beta will introduce API management or load balancing services for administrative use, a widget-based, personalized dashboard using Grafana and device management.

GO LIVE While the project does not intend to develop production-ready systems for the city, by the end of the project it is expected that the data hub would continue operation as part of the city related information systems.

The following image illustrates the development milestones and their intended timing:

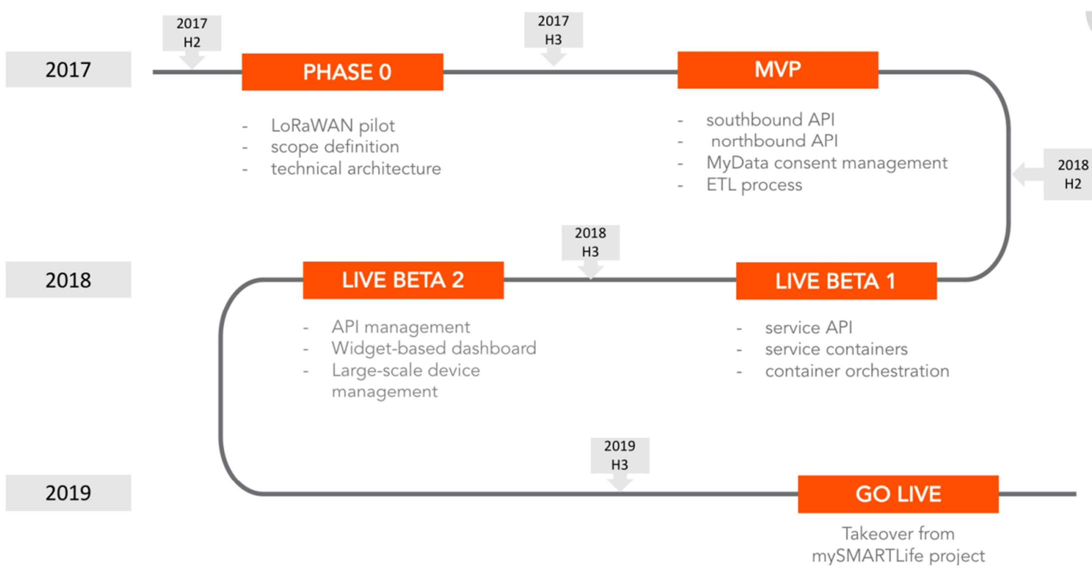

Figure 9: Datahub Development Milestones

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4.2 Status M36

Since the interim deliverable M12, the project has focused on the development of key components to allow easier piloting and proof of concepts of the project specific use cases. While in the beginning of the project the FIWARE Orion Context Broker was used to handle the sensor data streams, due to its limitations on privacy, secured data streams and data models a new design was formulated in 2018 to use the Apache Kafka messaging system with the extensions to handle and process data streams. While its adoption has been a significant effort, from the project impact point of view this is seen as an important investment since it seems to finally provide the platform with system of a system approach. The change of the core broker delayed the original milestones as they are illustrated in Figure 8, but it hasn't prevented collecting data on the earlier experiments.

As addition to development of the data platform, focus has been on automating the workflows of indicator calculation. The goal is to be able to calculate as many of them as possible in an automated fashion even in case when the source data is not in APIs but text files as long as they are accessible online. This work continues parallel to tasks 5.1, 5.2 and 5.3 when the indicator definitions get more complete and data sets for the indicators are provided.

4.2.1 Other Projects

Since Forum Virium Helsinki is already involved with several other projects, it has been natural to look at areas where co-operation could be utilized. The project plans have been shared with contacts on other Horizon2020 and European Regional Development Fund projects. Some of the most important projects working on related activities are:

- The Six City Strategy: 6Aika Open Data and Interfaces (ERDF)
- The Six City Strategy: StreetReboot (ERDF)
- Select4Cities: IoE Platform (H2020)
- Synchronicity: Large Scale IoT Pilots in 11 Cities, clean air route planning (H2020)
- Open Geospatial Consortium: SensorThings API project
- Open Geospatial Consortium: CityGML project
- Open Geospatial Consortium: IndoorGML project
- National Library of Finland: SKOSMOS open source SKOS browser and publishing tool
- Urban Innovative Actions (UIA): UIA HOPE[6], Healthy Outdoor Premises for Everyone

[6] https://www.uia-initiative.eu/en/uia-cities/helsinki

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The 6Aika Open Data and Interfaces project is further developing the CitySDK service development kit for cities and developers. Some of the CitySDK APIs are the Open311 API for feedback, Linked Events API for events and activities and Linked Data API to share data from document management systems. The CitySDK may in the future contain the FacilityAPI developed as part of the mySMARTLife project to harmonize and unify the methods of energy related data collection from buildings. By including the API in the “family” of CitySDK it would be easier to provide generic governance models and maintenance for the API after the mySMARTLife project has ended.

4.2.2 Events and Seminars

By the end of the current reporting period, every opportunity has been taken to communicate about the efforts and to learn from other projects and organizations. Some key international organizations the project has participated with are Open Geospatial Consortium (OGC), Open and Agile Smart Cities (OASC) and buildingSMART International. The participation has meant learning from the experiences of other cities and authorities and also participating in standardisation process, especially as part of the OGC Observations&Measurements actions due to their critical role on the semantic interoperability. In the OGC side, this work has further been influencing the standardisation at ISO TC/211 and ITU. On the national level, the project has participated no national geospatial platform work and provided comments on data interoperability issues on several Finnish JHS public procurement recommendation comment rounds.

The networking activity has been important for the project especially in the planning stage in order to avoid duplicate efforts and the mistakes already made elsewhere. Also, the smart city context industrial IoT, but in the market the majority of sensor data platforms targets on industrial use. The list of events and audiences the project and the urban platform concept has been introduced is reported separately as part of the dissemination activities.

4.2.3 Participatory Activities

Based on the experiences from Smart Kalasatama project, co-creation efforts have been included in the project as a measure to boost participatory approaches. Co-creation often focuses on co-designing upcoming activities, but co-production based on existing initiatives is seen important as well.

The Kalasatama Living Lab has provided the framework for actions throughout the project and also on the preparation phase of the project. Some major participatory activities are documented in other deliverables, as an example in D4.20 about the participatory design process of street lighting prior to the Korkeasaari public lighting action.

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In order to manage the participatory co-design and co-production efforts related to sensor development, the technical events and workshops are branded under the name Vekotinverstas ("Gadget Workshop") that has a logo and website. Some of the 20 living labs organized as part of the mySMARTLife project will be based on the Vekotinverstas concept of hands-on, co-production work.

Figure 10: Vekotinverstas Air Quality Sensor Workshop

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5. Conclusions

This document provides an overview of the activities so far. By M36 most of the actual work has been focusing on the design and implementation of an urban data platform and sensor networks that would support the project actions. While this work has been made prior and parallel to the actual project indicator definitions, it was also clear from the beginning to assume what the most relevant observations for the sensors were.

On this deliverable and the related tasks, we have not seen any major deviations. It was however communicated in the last project review meeting, that the effort on an action like this is ongoing and throughout the project we will improve the workflows and processes related to data acquisition and aim to calculate indicators as automatically as possible. This will also be a major output of the project for the city actions, including the new Carbon Neutral Helsinki 2035 programme management dashboard, which uses similar indicators to track the progress of the city climate program.

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