IRIS

Integrated and Replicable Solutions for Co-Creation in Sustainable Cities

Project Acronym:	IRIS
Project Full Name:	Integrated and Replicable Solutions for Co-Creation in Sustainable Cities
Grant Agreement:	No 774199
Project Duration:	5 ½ years (starting 1 October 2017)

Deliverable 2.2

Report on improvement of existing standards/interoperability issues of ICT

Work Package:	WP2: EU wide cooperation with ongoing projects, initiatives, communities
Task:	T2.2: Cooperation on barriers and drivers in standards and interoperability
Lead Beneficiary:	CIV
Due Date:	31 March 2023 (M66)
Submission Date:	31 March 2023 (M66)
Deliverable Status:	Final version
Deliverable Style:	R
Dissemination Level:	PU
File Name:	D2.2 Report on improvement of existing standards/interoperability issues of ICT.pdf

This project has received funding from the European Union's Horizon 2020 research and innovation program under grant agreement No 774199

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Version History

Version	Date	Modifications made by
1.0	1 March 2023	CIV, final version to be released to the EC

Disclaimer

Executive Summary

This Deliverable reports on the improvement of existing standards and interoperability issues of ICT in order to maximize the impact of IRIS. It provides an overview of most relevant standards, the adaptations and improvements that have been developed and deployed in IRIS, and recommendations for interoperability. With this, the deliverable demonstrates that the developments and deployments on standards and interoperability in the IRIS Lighthouse cities were matched with existing projects and initiatives, amongst others to ensure that data can be used in various systems without extra handling or loss of the significance of related information.

The deliverable discusses several use cases of the City Innovation Platform. These use cases are used to describe the lessons learned from them. The Deliverable demonstrates that IRIS cooperated with other SCC01 projects and initiatives on this, capitalized on existing knowledge and lessons learnt, and that IRIS has contributed significantly to clarification and improvement of the framework conditions for successful transformation towards intelligent, user-driven and demand oriented future proof urban infrastructures and services.

The deliverable focuses on standards and interoperability in ICT, notably, Urban Data Platforms, but also covers the deployment and valorisation potential of local flexibility in energy supply and demand (USEF/GOPACS), and in the deployment of a new international protocol for AC bidirectional smart charging (ISO 15118), as the IRIS contributions in these significantly supported and accelerated scale-up and replication.

This deliverable is closely linked with WP4, notably D4.2. *Functional & technical requirements for integrated, interoperable and open solutions, standards and new business models* (M6), D4.4 *Document with technical solution reference architecture for CIP-components Implementation and integration of core CIP components* (M12), and D4.3 *Data Governance plan* (M30).

In 2018, all three IRIS Lighthouse cities joined the newly established TMForum / FIWARE Foundation Frontrunner Program, a collaboration to support the adoption of reference architectures and compatible common data models that underpin a digital market of interoperable and replicable solutions for smart cities.

From these achievements, the following recommendations have arisen:

- To participate in the communities working on technical standards to contribute to their continuous improvement;
- Investigate iSHARE as a means of standardizing authentication and authorization and building a trust network for the exchange of data;
- Take organizational aspects such as a privacy impact assessment and procurement guidelines into consideration early in the project;
- Cooperate in both national and international structures to learn from each other.

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List of Abbreviations and Acronyms

Abbreviation	Definition
API	Application Programming Interface
BoC	Board of Coordinators (of all running Lighthouse projects)
CIP	City Innovation Platform
DSO	Distribution System Operator
EIP-SCC	European Innovation Partnership for Smart Cities and Communities (ended October 2020, merged with SCIS into Smart Cities Market Place)
EG	Expert Group
EMS	Energy Management System
EU	European Union
EV	Electrical vehicle
ICT	Information and Communications Technology
MIM	Minimum Interoperability Mechanism(s)
NGSI	Next Generation Service Interfaces
OASC	Open and Agile Smart Cities network
SCIS	Smart Cities Information System (ended December 2020, merged with EIP-SCC into Smart Cities Market Place)
SCMP	Smart Cities Market Place (established November 2020)

SLA	Service Level Agreement
SCC	Smart Cities and Communities
TG	Task Group (supporting the BoC)
TSO	Transmission System Operator
UDP	Urban Data Platform
USEF	Universal Smart Energy Framework
WP	Work Package

1 Introduction

1.1 Scope, objectives and expected impact

The Deliverable focuses on standards and interoperability in ICT, notably, Urban Data Platforms, but also covers the deployment and valorisation potential of local flexibility in energy supply and demand, and in the deployment of a new international protocol for AC bidirectional smart charging, as the IRIS contributions in these are significant for scale-up and replication.

However, since the drafting of the IRIS Grant Agreement in 2017, several changes have occurred in the context of this deliverable that affects its scope. Most notably, the IRIS Grant Agreement stated that D2.2 would match the experiences and needs of cities on standards and interoperability with "existing projects and initiatives such as ESPRESSO, EIP-SCC and USEF. Since 2017, these projects/initiatives have gone through the following changes.

ESPRESSO and EIP-SCC: integrated in Smart Cities Market Place

In the Grant Agreement, Task 2.2 is titled literally: "*ESPRESSO: cooperation on barriers and drivers in standards and interoperability*." However, the Horizon2020 project ESPRESSO (*Systemic standardisation approach to empower smart cities and communities*) ended on 31 December 2017, three months after the start of IRIS. The results of ESPRESSO were integrated into the EIP-SCC Action Cluster Integrated infrastructure reference architecture for urban platforms. In November 2020, the EIP-SCC and its Action Clusters merged with SCIS into the Smart Cities Market Place.

Cooperation between all Lighthouse projects: founding of BoC, Task Groups, SCALE

Since the beginning of IRIS in 2017, the family of selected SCC01 Lighthouse projects has grown to 18 Lighthouse projects, 3 of which finished in 2020 (see D2.1). The Lighthouse projects cooperate on visibility and impact in the Board of project Coordinators (BoC), which is supported by five Task Groups [Summer 2020]: Business Models and Financing, Replication, Communication, Data, and Monitoring and Evaluation. BoC and each Task Group is chaired by one Lighthouse project. The Task Group Data has been chaired since 2017 by RUGGEDISED project (Albert Engels). From 2021 onwards, the BoC and Task Groups are supported by SCALE, a consortium co-funded under Horizon 2020, to accelerate the scale-up and replication of the Lighthouse projects solutions.

USEF

USEF (Universal Smart Energy Framework) was included in T2.2 to support the international deployment and valorisation potential of local flexibility in energy supply and demand. The local electricity trading platform USEF was intended to reduce grid stress and curtailment of in the electrical grid, through home and district Energy Management System (EMS). The sum of contracted flexibility could be the starting point for aggregators, who could contact the Balance Responsible Party and the Distribution System Operator capability to activate flexibility, as a solution to grid stress. In December 2018 there was substantial international interest in USEF for the implementation of parts of USEF. Broader adoption then slowed down due to pending new regulations, and because investment in a specific market mechanism for flexibility was considered too high risk. In 2019 the USEF organization contributed to guidelines that

were published in 2019 by the EU Smart Grids Task Force EG3. USEF has been incorporated into GOPACS. GOPACS is a flex trading protocol intended to reduce congestion on electricity networks. The original intention was to apply USEF to reduce peak loads in renovated apartment buildings in the Kanaleneiland neighbourhood in Utrecht using second life batteries. This goal was not achieved since it a) took much longer than anticipated to renovate the apartment buildings and b) proved impossible to install second life batteries into the designated areas.

1.2 Relation to other activities

This Deliverable is closely linked with WP4, notably D4.2. *Functional & technical requirements for integrated, interoperable and open solutions, standards and new business models* (M6), D4.4 *Document with technical solution reference architecture for CIP-components Implementation and integration of core CIP components* (M12), and D4.3 *Data Governance plan* (M30).

D2.2. also has relations with:

- WP5, 6 and 7 (Demonstrations in the three IRIS Lighthouse cities): notably T5.6, T6.6 and T7.6 (*Launch of T.T.#4 activities on City Innovation Platform and information services* per Lighthouse city);
- WP2 (EU-wide cooperation with ongoing projects, initiatives and communities): notably T2.1 *Cooperation with other Lighthouse projects on institutional bottlenecks*. The ongoing monitoring of and reporting on IRIS work on improvement of existing ICT standards and protocols provide a reference for cooperation with other SCC01 projects and related initiatives, for example in the SCC01 TG Data.
- WP3 (Development of Bankable Business Models and Exploitation Activities): for example T3.6 *IRIS City innovation management performance and roadmaps*, and *T3.8 IRIS exploitation plan and operations.*
- WP8 (Replication): for example T8.3 *Replication toolbox*.

1.3 Structure of the deliverable

Chapter 2 explains the methodology used in this task: lessons regarding (need for) standards and interoperability have been learned from the different use cases of the City Innovation Platform. Chapter 3 discusses those use cases and the lessons learned from them. Chapter 4 describes how the IRIS project partners worked in different cooperation structures and networks to address the issues from these lessons learned. Chapter 5 focuses on the standards deployed within the frame of IRIS. Chapter 7 summarizes the work, draws conclusions and provides recommendations for future projects.

2 Methodology

A lot of the data that are being collected in a smart city are tied up in what is often referred to as verticals or silos. For example, a vendor installs a sensor (or another system which generates data) for a customer, collects the data from this sensor and delivers a dashboard or an app using the data collected by the sensor. And while this often solves the use case for which the sensors are initially being installed, it also prevents the data from being used for alternative use cases. In addition it prevents replicating a solution from one environment to another, combining similar data from different silos or verticals or replacing one component in the silo or vertical with another one.

That's why standards and interoperability are important. They are used to open up the silos and verticals and facilitate the re-use of data being collected outside of the silo or vertical, they enable replication and they allow us to replace components of the silo or vertical with other, for whatever reason more suitable components. The City Innovation Platform (CIP) does just that. Sensors often produce data in a proprietary, highly optimized format. These data are ingested into CIP where they are transformed to commonly used open data models and combined with other data sources before being published using different open API's.

This deliverable describes different use cases for the City Innovation Platform from the three lighthouse cities Göteborg, Nice Côte d'Azur and Utrecht. From these use cases, lessons regarding standards and interoperability can be learned. These lessons are related not only to technical standards and interoperability but also to organizational aspects which would benefit from standardization. Once the lessons learnt have been described, it is described what has been done within the frame of the IRIS project to improve the standardization and interoperability regarding these topics: IRIS project partners participated in different cooperation structures / networks for standards and interoperability issues in smart city ICT. And several standards were deployed within the frame of IRIS.

3 City Innovation Platform use cases

3.1 Use case fact sheets

Table 1 "Laden zonder bord" fact sheet

Name	City	Lessons learned
“Laden zonder bord”	Utrecht	3.2.1 Harmonization 3.2.2 Access control
Usually, the parking sports designated for charging electrical vehicles are equipped with a traffic sign stating that parking is only permitted when charging an electrical vehicle. Installing these traffic signs requires a permit and installation and maintenance of these traffic signs requires resources. In addition, it leads to additional clutter in public space and, consequently, more resistance to charging stations for electrical vehicles than is strictly necessary. The purpose of “Laden zonder bord” or “Charging without traffic sign” was to investigate what would happen if such a traffic sign was not installed with parking spots designated for charging electrical vehicles. Would a parking spot without a traffic sign attract more illegal use (parking without charging an electrical vehicle) than a parking spot equipped with a traffic sign? To be able investigate this, 40 parking spots were equipped with a parking sensor which could determine whether a car was parked at the parking spots. Of those 40 parking spots, 20 were equipped with a traffic sign stating that parking was only permitted if you are charging an electrical vehicle and 20 were not equipped with such a traffic sign. The idea was to combine the data from the parking sensors with the data from the charging stations (payment information) to determine legal and illegal use for both categories.		

Figure 1 Example of charging station and parking sensor with a sign

Table 2 Hisingsbron bridge factsheet

Name	City	Lessons learnt
Hisingsbron bridge	Göteborg	3.2.2 Access control
When the Urban Transport Administration of the City of Göteborg was planning a new bridge to connect the city center to the Hisingen island, they wanted to collect input from citizens. The Hisingsbron bridge crosses the Gota River to connect Göteborg with the Hisingen city. The bridge is wide enough to accommodate different types of traffic: not only cars and busses but also trams, cyclists and pedestrians. This requires sharing of data to allow visualization tools to use data regarding existing or planned infrastructure.		

Table 3 Energy consumption factsheet

Name	City	Lessons learnt
Energy consumption	Utrecht	3.2.1 Harmonization 3.2.3 Privacy
To be able to determine the effect of energy saving measures taken during the renovation of a couple of apartment buildings in the Kanaleneiland neighbourhood, data regarding energy consumption were collected from various sources. To be able to measure energy consumption, the following variables must be known: • The amount of energy delivered from the network to the connection (both electricity and gas); • The amount of energy generated by the PV panels (electricity); • The amount of energy returned from the connection to the network (electricity). Data from smart thermostats (so called Toon smart thermostats) which measure energy delivered from the network to the connection and energy returned from the connection to the network were combined with data from BeNext which measures the energy generated by PV panels. Unfortunately, not all apartment buildings with PV panels were equipped with the BeNext devices to measure energy generation. Consequently, data from a building equipped with these devices had to be used to estimate energy generation for similar buildings nearby without those devices.		

Table 4 Sustainable smart parks factsheet

Name	City	Lessons learnt
Sustainable smart parks	Göteborg	3.2.4 Procurement
The purpose of the sustainable smart parks project is to allocate resources to manage parks and green spaces better. Instead of a frequency based maintenance schedule, a more flexible schedule based on the actual needs is applied. To accommodate for this, soil moisture sensors have been installed near trees. The information from these sensors is used to determine whether or not trees need watering. Data from these soil moisture sensors have been collected using the City Innovation Platform.		

Table 5 Sustainable smart parks factsheet

Name	City	Lessons learnt
Bathing water	Göteborg	3.2.4 Procurement
Swimming in open water is very popular in Sweden. As a consequence, citizens are In a similar fashion, information from bathing water temperature sensors is being collected using the City Innovation Platform. This information allows swimmers to decide whether or not the water temperature is OK to go for a swim.		

Table 6 Battery usage factsheet

Name	City	Lessons learnt
Battery usage	Utrecht	3.2.5 Access to silo
A battery has been installed in the Kanaleneiland neighborhood to store energy generated by PV panels. This battery allows for energy storage when energy production is high but consumption is low. This energy can be used to reduce peak loads in the energy network, when production is low and demand is high. Data resulting from operating this battery could be used to simulate the optimal behaviour of this battery on the energy market.		

Table 7 City Innovation Platform NCA factsheet

Name	City	Lessons learnt
City Innovation Platform NCA	Nice Côte d'Azur	3.2.2 Access control
The City Innovation Platform has been deployed in the Nice Côte d'Azur Métropole to serve as a platform to support the IRIS demonstrators. It allows to recording, update and present data produced by city sensors and technical systems and components, historicization of these data and API management. Examples of datasets handles by the CIP include air quality, battery storage, district heating and cooling, EV charging, traffic flow, water, weather, noise levels and parking data. Data are used to a) create new datasets and b) create dashboards.		

Table 8 Smart street lighting factsheet

Name	City	Lessons learnt
Smart street lighting	Utrecht	3.2.5 Access to silo
In the Kanaleneiland neighbourhood, smart street lighting has been installed. In order to save energy, these street lights are only turned on when it is actually needed. In addition, a smart zebra crossing was installed. This zebra crossing is also equipped with lights to warn drivers for the presence of the crossing to increase safety, but is only turned on when traffic is detected. Data from these street lights are collected for two purposes: for inclusion in a digital twin (a 3D model of the Kanaleneiland neighborhood) and to be able to calculate the amount of energy being saved because of the smart street lights.		

3.2 Lessons learned

3.2.1 Harmonization

Harmonization (from both the API's and the datamodels used) is important for all use cases in case of replication to other cities. But for the "Laden zonder bord" and energy consumption use cases it was even important without replication since those use cases rely on the integration of different data

sources into one new data source. Within the frame of “Laden zonder bord”, data from parking spots and EV charging stations were converted to NGSI using the Parking Spot and EV Charging station Smart Data Models. For the energy consumption use case, it was important to come up with clear definitions of “deliver” and “return” since these terms have different meanings from different perspectives. Figure 2 provides an example of a drawing created to make clear what is meant by the different variables involved in measuring energy consumption.

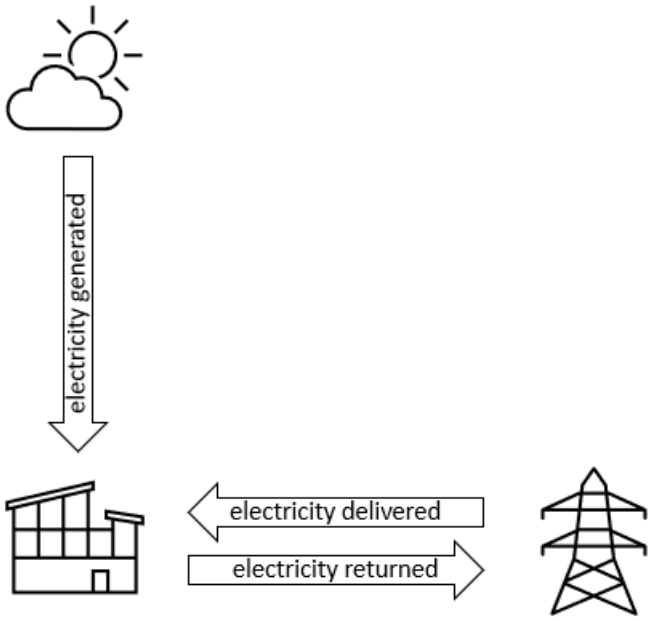

Figure 2 Example picture created to define energy consumption variables

3.2.2 Access control

Different use cases (“Laden zonder bord”, Hisingsbron bridge) highlight the need for access control. In situations where it is beneficial to be able to exchange data but not possible to publish the data as open data, mechanisms to control who can do what using the data are needed. In the case of the Hisingsbron bridge, providing unrestricted access to traffic data is not possible due to security reasons. In the case of “Laden zonder bord”, access to detailed information regarding the use of charging stations would allow charging station providers (competitors of the company who installed the charging stations used for this project) to “cherry pick” locations to install new charging stations, leading to an uneven spread of charging stations across the city. This is not only an undesirable perspective for the charging station provider, but also for the municipality that is handing out permits to install charging stations.

3.2.3 Privacy

The energy consumption use case highlights the importance of considering privacy aspects. In order to comply with applicable rules and regulations (GPR), providing access to energy consumption data from individual households had to be prevented at all cost. Therefore, data were aggregated at the apartment building level. Since apartment buildings are renovated as a whole, this allows us to investigate the

effect of energy saving measures at the apartment building level. However, comparing different apartments (for instance apartments in the top left or top right corner with apartments in the middle) is not possible since that would allow you to link energy consumption data to a limited number of households.

3.2.4 Procurement of a CIP

Doing a pilot and running a prototype is not that difficult. Scaling up a successful pilot or prototype to an actual production system is often more difficult than anticipated since it requires integration with the existing IT infrastructure of an organization. This existing IT infrastructure poses both an opportunity and a threat: it contains components (for instance an access control system or a state of the art relational database) which can be re-used for the new application. On the other hand, these existing components might not be compatible with components needed for the new application (especially when the existing IT infrastructure is based on proprietary standards and the new application relies on open standards) and specifying what has to be purchased/tendered for in order to come up with a successful implementation is rather difficult. This lesson materialized in the bathing water and Sustainable Smart parks use cases.

3.2.5 Access to silo's/verticals

When procuring hardware and software (a silo or a vertical) for a particular use case, providing access to the data in the silo should already be top of mind. Since it is often not in the interest of the vendor of the silo or vertical nor of the customer purchasing the silo or vertical, providing others with access often does not get priority. Providing access to data in a readable format should be part of the tendering process when purchasing one or more devices which collect data. This was not taken care of for the smart street lighting and the battery use cases.

4 IRIS in EU-wide cooperation structures

How to get 80.000 municipalities in Europe to embrace Urban Data Platforms as a cornerstone of their development as a smart city, while keeping their technical sovereignty? This question has given rise to many collaboration structures in the EU, mostly established already before the start of the IRIS project (October 2017). The IRIS partners have been and are active in these structures: to capitalize on existing knowledge and lessons learnt, contribute themselves to clarification and improvement of the framework conditions for successful transformation towards intelligent, user-driven and demand oriented future proof urban infrastructures and services, and accelerate the scale-up of smart city solutions and services.

4.1 Open and Agile Smart Cities Network

To promote interoperability, the Open & Agile Smart Cities organization (OASC) describes a number of 'Minimal Interoperability Mechanisms' (MIMs). The purpose of these MIMs is to ensure that applications and solutions implemented using those MIM's by one data provider can be easily transferred to another data provider (for example, from one municipality to another municipality). OASC features three MIMs: management of context information, common data models and marketplace enablers (Open & Agile Smart Cities, 2021). For the management of context information, OASC relies on the FIWARE context broker (see paragraph 4.2), the FIWARE/TM Forum Smart data models collection (see paragraph 4.3) provides a good starting point to search for data models and the marketplace enablers are selected from TM Forum (see paragraph 4.3).

In M28 (Jan 2020) IRIS participated in the annual conference of the OASC network (Connected Smart Cities and Communities, January 2020 in Brussels), which brought together more than 500 key decision-makers from municipalities, European institutions, international organisations, research and academia, and businesses. IRIS presented in the tech-track 'Operating urban data platforms based on minimal interoperability' a Practitioners guideline on open urban platforms which was developed for the most part by the Dutch partners of three Lighthouse projects (TRIANGULUM, RUGGEDISED and IRIS), and published by NEN, the Dutch standardisation body (NEN, 2023). The aim of this guideline is to strengthen the joint development and procurement of open urban data platforms (NEN, 2021).

4.2 FIWARE

For the "management of context information" MIM, OASC relies on the FIWARE context broker which implements the NGSI specification. A context broker provides access to real-time context information using a so called publish-subscribe mechanism. Third parties interested in the data of a specific entity (for example a sensor) subscribe to updates from the entity. Once new data becomes available for this entity, these data are sent to the context broker who in turn notifies all subscribers of this update. It is up to the subscribers to decide what to do with this data. Components subscribed to these updates are, for

instance, components creating a times series database, actuators which must change the state of a specific device or data-driven models which must process the new data.

NGSI comes in three flavors of which two are still being used: NGSI, NGSI v 2 and NGSI-LD. NGSI is the original version of NGSI which has been deprecated, NGIS v2 is the current version of NGSI and NGSI-LD is the NGSI version for linked data. A context broker must support the following operations:

- Query**:** the context broker should be able to provide the current state of the entities present in the context broker;
- Subscription and notification: a third-party application should be able to subscribe to updates from entities in the context broker;

Federation: to prevent duplication from one context broker to another, a context broker must be able to participate in a federative network of context brokers. In May 2019, IRIS participated in the FIWARE Summit (Genoa), presenting smart charging stations based on FIWARE data models and the open NGSI API. Moreover, IRIS participated in a discussion group with other European cities about the TMForum/FIWARE joint collaborative Front Runner program developing new data models and further standardisation. IRIS partners have since then continued to promote the use of a common data model and common API for the CIP Data Market.

4.3 Smart Data Models

Whereas NGSI describes and standardizes the envelope in which data are being transferred, it does not standardize the contents of the envelope. That is where data models play an important role. Standardized data models provide a harmonized representation of entities in the real world and can be used to both consume and publish data. The FIWARE Foundation and the TM Forum are working together on a set of common data models for different sectors to facilitate the replication of solutions between different stakeholders. These data models are published in a Github version control repository (Github, 2021). They can also be found on the FIWARE website (FIWARE, 2021).

IRIS applied the smart data models extensively in the City Innovation Platform. Findings from these applications have been reported back to the community.

4.4 TM Forum

The Marketplace enabler consists of a marketplace API which exposes functionalities such as catalogue management, ordering management, revenue management, Service Level Agreements (SLA), license management etcetera. Marketplace API's are based on the TM Forum business API's (TM Forum, 2021). The marketplace API facilitates the monetization of different types of assets (both digital – for example data services - and physical – for example devices). The entire life cycle of a service is supported, from creating an offer, charging, account settling and sharing revenues.

The TM Forum Open API's adhere to the OpenAPI Specification (OAS). OAS is used to document RESTful APIs without using any programming language-specific constructs. This allows us to understand the capabilities of any service without accessing the source code. As a result, OpenAPI documentation is understandable for both human beings and computers.

In November 2018, all three IRIS Lighthouse cities joined the TM Forum and FIWARE Foundation joint collaborative Frontrunner program to support the adoption of reference architecture and compatible common data models that underpin a digital market of interoperable and replicable solutions for smart cities. This cooperation was established during the Smart City World Expo & Conference 2018 in Barcelona, where nine partners from IRIS participated, and elaborated during the FIWARE summit later that month, in Malaga, where three IRIS partners participated.

4.5 SCC01 Task Group Data

Since its start, IRIS has participated in the SCC01 Task Group Data. IRIS co-prepared a SCC01 Task Group Data exchange of best practices in June 2019 in Brussels with TG Data chair Ruggedized, in which five Lighthouse projects participated, as well as representatives from FIWARE and Open and Agile Smart Cities (OASC) network.

5 Standards deployed

5.1 Overview of standards deployed in IRIS

5.1.1 FIWARE NGSI

In 2019-2020 UTR implemented the Sniffer Bike which uses the FIWARE Context Broker to consolidate air quality data, and was recognized as a Connecting Europe Facility Digital showcase. Sniffer Bike is a bicycle equipped to measure air quality and cycling routes with mobile sensors for citizens and politicians to make more informed, healthier decisions, resulting from a strong collaboration between research institutes (RIVM), government agencies (Province, cities), and local groups of citizens.

Within the frame of IRIS, data services such as the ones described in the use cases section have been developed. These rely on FIWARE NGSI standards and Smart Data models, just like the Sniffer Bike CEF showcase. Metadata of these services are described with DCAT using the CKAN generic enabler.

5.1.2 City GML

The implementation of the City Information Manager (CIM) developed by CSTB, NCA and IMREDD for the Nice Côte d'Azur territory includes a hyper visualisation tool to display and navigate cities, buildings etc. in 3D, using static and dynamic data. The visualization tool exploits CityGML, an open standardized data model and exchange format to store digital 3D models of cities (an application of Geography Markup Language 3, the international standard for spatial data exchange issued by the Open Geospatial Consortium (OGC) and the ISO TC211). For 3D building representations, the platform-neutral, open Industry Foundation Classes semantic data model (IFC, ISO 16739-1:2018) is used. The application to display and navigate the geographical information of the city and buildings is implemented with the open source software Cesium, which is connected to the open source database NOSQL and to the FIWARE time series collection platform with an API that is compliant with the TM Forum's Open API recommendations.

5.1.3 Real estate core

In Göteborg, RealEstateCore ontology is used. RealEstateCore is a common language that will enable control over buildings and development of new services. Although it is not a standard, RealEstateCore uses and maps existing standards aiming to merge and bridge three domains: digital representation of the building’s elements, control and operation of the building, emerging IoT technologies.

5.1.4 Smart mobility

In March 2019, IRIS Lighthouse city Utrecht became the first city in the world with a large-scale network of V2G-chargers, deploying a new global open protocol for AC bidirectional charging: **ISO15118**.

5.1.5 Valorizing flexibility in energy supply and demand

IRIS explored the potential of the Universal Smart Energy Framework (USEF). This smart energy management platform assesses the value of flexibility in energy supply and demand delivered in low / medium tension grids to the Transmission System Operator (TSO) as well as to the DSO (Distribution System Operator).

GOPACS mitigates capacity shortages in the electricity grid (congestion) and thus contributes to keeping the grid reliable and affordable. GOPACS uses USEF rules to assess the value of flexibility. USEF/GOPACS has resulted from active collaboration between the Dutch national grid operator (TSO) TenneT and the regional grid operators (DSOs).

5.2 Contributions from IRIS to the advancement of standards and interoperability outside IRIS

5.2.1 Practitioners guideline on open Urban Data Platforms

IRIS developed a Practitioners guideline on open urban platforms, together with Dutch partners of the Lighthouse projects TRIANGULUM and RUGGEDISED . The guideline was published by NEN, the Dutch standardisation body, and presented in English in the annual conference of the Open & Agile Smart Cities (OASC) network, January 2020 in Brussels, which was attended by more than 500 key decision-makers from municipalities, European institutions, international organisations, research & academia, and businesses.

5.2.2 Smart mobility

In M13-M30 IRIS applied a new global open protocol for the communication between charging pole and car: the ISO15118-protocol for AC bidirectional charging (March 2019). With this protocol different car brands can communicate with the charging poles on how charged the car battery is and when charging or discharging can take place. Thanks to bidirectional charging electric cars can participate in smart energy networks, and contribute substantially to the energy transition.

In September 2019, IRIS delivered a webinar on vehicle-to-grid (V2G) technology, open to all. It was attended by 42 stakeholders and has been viewed 1329 times since (status April 2020). In the webinar the process of the realization of the IRIS world premiere of AC-V2G based on open standards was explained, including the cooperation with different stakeholders.

5.2.3 Valorizing flexibility in energy supply and demand

Within the frame of IRIS, Stedin worked on USEF. USEF published amongst others an update of the Flexibility Value Chain, as well as new insights on Flexibility Value Stacking, Flexibility Platforms, and Flexibility Services for Citizens Energy Communities. The USEF Flexibility Trading Protocol Specification further stimulates the use of flexibility across all EU markets and products.

6 Output to other Work Packages

6.1 WP3 Development of Bankable Business Models and Exploitation Activities

Whereas implementations of the TM Forum API's allow organizations to implement MIM3 (the marketplace enablers), there are also other aspects which need to betaken into consideration. These mainly relate to governance aspects. The ecosystem of public and private parties involved in a City Innovation Platform requires a governing body to make sure all parties involved comply with norms and values within the ecosystem. The "openness" of the City Innovation Platform is important, but also raises an organizational issue: who owns (and provides the resources) for the City Innovation Platform?

6.2 WP8 Replication by Lighthouse regions, Follower cities, European market uptake

IRIS provides reference implementations of the City Innovation Platform or in other words an open urban data platform. Partners involved with the City Innovation Platform in the light house cities have been in contact with people in the follower cities to provide information on these reference implementations.

7 Conclusions

Purpose of this deliverable was to reflect on the standards and interoperability of systems deployed within the frame of IRIS. The findings can be divided into two categories: findings regarding technical aspects of a City Innovation Platform and findings which are more organizational by nature.

7.1 Conclusions

7.1.1 Technical standards and interoperability

From the City Innovation Platform, it can be concluded that standards and interoperability are important to facilitate a) integration from data from different data sources and b) facilitate replication to other environments. While open standards are by no means perfect - they are after all the common denominator of different tailor made solutions and the cartoon in Figure 3 does hold some truth - they do promote interoperability when they allow for enough flexibility to support different use cases but do not allow for too much freedom. Tailor made solutions may be better in covering edge cases, they do obstruct interoperability.

Figure 3 Cartoon on standards

The API's which determine how the exchange data used from the City Innovation Platform (the FIWARE NGSI API's) do work. The FIWARE Smart data models used to harmonize the data exchanged using those API's do work as well. There are many data models available which cover a lot of aspects. An open process allows for proposing modifications to the Smart data models. What does need more work from a standards and interoperability perspective is preventing unauthorized access to data as some of the use cases highlight the need for access control to allow for data sharing in a secure fashion. Authentication and authorization is not part of the FIWARE standards. Reliable mechanisms to verify the identity of parties involved and build networks of trusted parties are needed. iSHARE and i4Trust are working on this topic.

7.1.2 Organizational aspects

Other standards and interoperability lessons learned do not so much relate to technical aspects of a City Innovation Platform, but are more legal or organizational by nature. These should be taken into consideration before starting the implementation of a City Innovation Platform. As discussed in this deliverable, the IRIS partners have been involved in international cooperation structures in which these topics are being discussed. These structures are important for learning from each other. Outcomes are sometimes published using for instance reports or white papers. Not all cooperation structures are a success though, sometimes cooperation structures cease to exist or are merged with other structures.

7.1.2.1 Tender process

Creating a prototype or a proof of concept is often feasible. When trying to extend this prototype or proof of concept to an actual production system, the existing IT infrastructure can be both an opportunity and a threat. This has been discussed as one of the lessons learned from the City Innovation Platform use cases. Guidelines on how to tender for a City Innovation Platform or in other words an open urban data platform are helpful to come up with high quality tenders.

7.1.2.2 Vertical or silo

When purchasing a vertical or a silo it is important to make sure that access to the data produced in the silo using an open format (not a format which requires purchasing a license to be able to actually read the data) is in the contract. This often requires someone at a higher level in the organization to keep an eye on this as it is not necessarily in the interest of the department purchasing the vertical or silo. No need to re-invent the wheel every time: legal departments must be able to come up with standard formulations to properly include this in contracts.

7.1.2.3 Privacy

Even if a dataset does not contain privacy sensitive information, it is important to take privacy aspects into consideration at the start of a project. Organizations employ privacy or security officers who can help you to assess the impact of collecting certain data on privacy. It is important to involve them in the early stages of a project. If the data collected does not contain privacy sensitive information it is beneficial to make this clear from the start. If the data collected does contain privacy sensitive information, they can assist you with taking the proper measures to prevent unauthorized access to this information using pseudonymization and anonymization techniques.

7.2 Recommendations

7.2.1 Technical standards and interoperability

Open standards require constant attention. It is important to be part of the community working on these and provide feedback on the standards. The FIWARE NGSI API's and Smart Data Models are in place and need feedback to be able to constantly improve. iSHARE could become the mechanism to standardize authentication and authorization (iSHARE Foundation, 2023). To make this work, more iSHARE compliant implementations are needed.

7.2.2 Organizational aspects

Regarding organizational aspects it is important to take aspects such as privacy issues, procurement of platforms and silos/verticals into consideration at the start of the project. The City Innovation Platform should be adopted by one or more organizations who are taking the initiative to implement such a platform. If the platform does not receive sufficient support from the initiator(s), it will probably not become a success. The organization(s) should appoint employees who are responsible for providing high quality datasets for the platform.

Both national and international cooperation structures and working groups are important to work on these topics and discuss lessons learned. These working groups could work on:

- A template for privacy impact assessments;
- A list of topics to take into consideration during a tender process for a City Innovation Platform;
- Re-usable formulations to be included in contracts to facilitate proper access to data collected within silos and verticals;
- Compatibility matrices for hardware and software in the smart city domain.

8 References

FIWARE. (2021, 03 02). *Smart data models*. Retrieved from Smart data model: https://www.fiware.org/developers/smart-data-models/

Github. (2021, 03 02). *Github*. Retrieved from Smart Data models: https://github.com/smart-data-models/data-models

iSHARE Foundation. (2023, 01 31). *iSHARE*. Retrieved from iSHARE: https://ishare.eu/

NEN. (2021, 03 02). *Normcommissie Smartcities*. Retrieved from NEN: https://www.nen.nl/normcommissie-smartcities

NEN. (2023, 01 23). *NPR 8284:2020 en Open urban platform.* Retrieved from NEN: https://www.nen.nl/npr-8284-2020-en-270238

NKL. (2020). OCPI Open Charge Point Interface 2.2.

Open & Agile Smart Cities. (2021, 03 02). *MIMS*. Retrieved from Minimal Interoperability Mechanisms – MIMs: https://oascities.org/minimal-interoperability-mechanisms/

TM Forum. (2021, 03 02). *TM Forum Ecosystem API Portal*. Retrieved from Open Api Table: https://projects.tmforum.org/wiki/display/API/Open+API+Table