Consolidated Report of Technical Specifications to Scale Living-in.EU

– A European Way of Digital Transformation in Cities and Communities

Context

This document contains the consolidated report of the working group regarding the maturity of essential technical mechanisms to support the Digital Europe Programme and the Living-in.EU upscaling declaration initiative. It is based on and complements the input paper of the declaration.

The document states the current state of the art and gives recommendations regarding specifications and standards, including those validated by SynchroniCity, the European IoT Large Scale Pilot project on Smart Cities & Communities.

The document describes the following topics: An overall Architecture Framework Model, Data Information Models, Context Information Management and Marketplace Enablers.

Each topic is described in following perspectives:

- Goals: Identifies what the topic aims to achieve and what the main purpose is.
- Capabilities: Focuses on how the goals are achieved and what the necessary requirements are.
- Recommended specifications: Specs and standards proven to attain the goals.

Contributers and rapporteurs

Martin Bauer, NEC Labs Europe
Martin Brynskov, Aarhus University, OASC
Hakima Chaouchi, Telecom-Sud Paris
Gert De Tant, OASC
Omar Elloumi, AIOTI
Raúl García Castro, UPM, SAREF
Thomas Gilbert, Alexandra Institute
Alex Gluhak, Digital Catapult
Eddy Hartog, European Commission
Thomas Kruse, Utrecht, EIP-SCC
Olavi Luotonen, European Commission
Martino Maggio, Engineering
Svetoslav Mihaylov, European Commission
Cathy Mulligan, University College London
Joann O'Brien, TM Forum
Rick Schager, Eindhoven
Boris van Hoytema, Foundation for Public Code
Jaime Ventura, Porto Digital

Architecture Framework Model

Goals

The goals of an architecture framework model for urban data platforms are to ensure that the capabilities of such platforms take into account functional and non-functional requirements to implement the minimal interoperability that cities and communities need to deliver a prosperous, sustainable and inclusive future for their citizens.

The requirements for such data platforms should lead to specifications that ensure that the platforms are reliable, durable and performant so that the city can build on the platforms and foster further innovations and evolution. These specifications also ensure that the platforms can scale to the needs of the cities and communities and guarantee privacy and security by design, making the platforms trustworthy.

The implementation of minimal interoperability provides a common technical ground that cities and communities need to enable choice, flexibility, value for money and independence avoiding vendor lock-in. The platforms should allow to support formal, de-facto and emerging standards, making sure they are future-proof and stable.

The trustworthiness and the interoperability of the platforms foster economic growth ecosystems, standards-based innovation and procurement across domains.

The urban platform architectures proposed in the recommended specifications and frameworks are proven by large scale pilots by a large variety of companies in close and direct partnerships with the cities and communities as well as networks of cities.

The group has recognised the Minimal Interoperability Mechanisms adopted by the Open & Agile Smart Cities Council of Cities[1] as a relevant way to organise the architectural framework model and to strike a balance of precision in the specifications, neither over- nor under-specifying. The current report covers MIMs 1-3 (Context Information Management, Data models and Ecosystem Transaction Management), which are already adopted, and two more, MIMs 4 and 5 (Personal Data Management and Fair AI), which have been proposed.

Capabilities

The frameworks provide a description and guidelines of a common architecture/framework, including a layered overview positioning of all the components and interfaces, as well as the associated requirements and specifications.

They include a description of reference implementations, including conformance testing and/or feedback from market use validation.

To go more into detail, we consider the following topics as common architectural design principles:

- A layered and capability-based approach to follow a common architectural model in different cities/domains.
- Based on open international standards (where available): we do not want to reinvent the wheel ensuring stable and widely used technological approaches.

[1] https://oascities.org/wp-content/uploads/2019/06/OASC-MIMs.pdf

- Compliant with existing technical solutions (e.g. already present in the cities with many legacy systems) focusing on interoperable interfaces rather than component implementation.
- Modular and scalable solutions for small and big cities: e.g. support different deployment scenarios and performance requirements.
- Security and privacy by design.
- Availability of reference implementations to foster and simplify the adoption in the cities.
- The architecture modularity assures the possibility to implement any component with different/proprietary technologies.
- Based on open API to enable both southbound/northbound interoperability.
- Data harmonization and semantic interoperability through the adoption of common (linked) data models.

A framework for such an architecture is shown below (Figure 1). In this document the following (orange) parts are further discussed:

- Data information models and Context information management: Context information management realizes the Northbound open APIs and the Southbound APIs as a high level open api. The Data information models provide the harmonized models.
- Marketplace: discusses the different marketplace apis and transaction management (commercial as well as non-commercial).

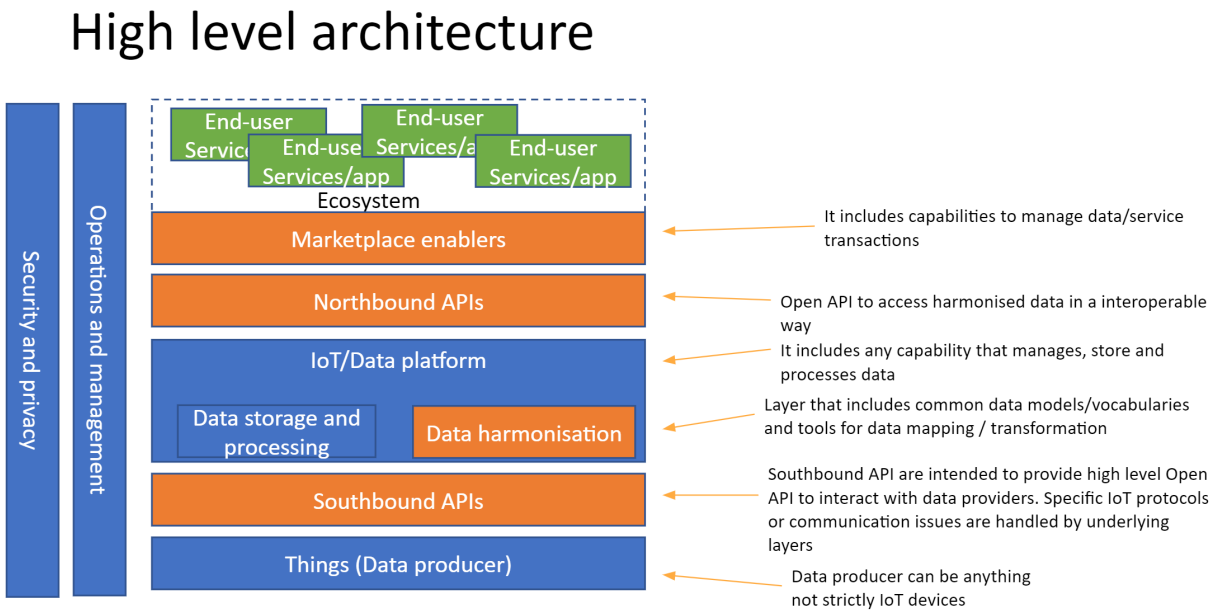

Figure 1. High-level architecture framework model.

Recommended specifications and frameworks

Below a list of specifications that are recommended:

- EIP SCC Open Urban Platform (DIN SPEC 91357:2017-12) - Reference Architecture Model Open Urban Platform (OUP) https://www.beuth.de/en/technical-rule/din-spec-91357/281077528

- Guidelines for SynchroniCity Architecture https://synchronicity-iot.eu/wp-content/uploads/2018/05/synchronicity_d1_3_guidelines_for_synchronicity_architecture.pdf
- Synchronicity Reference Architecture for IoT Enabled Smart Cities, Update https://synchronicity-iot.eu/wp-content/uploads/2018/09/SynchroniCity_D2.10.pdf
- oneM2M Release 2 and release 3 set of specifications. oneM2M Release 2 has been formally approved as ITU-T recommendation under Y.4500 series. oneM2M is a partnership project (where EU is represented by ETSI) that specifies a common service layer for IoT. OneM2M is applicable to many verticals including Smart Cities. oneM2M specifications cover requirements, architecture, APIs, security, interworking and data models. Although not chartered to produce open source, there are several open source implementations supporting oneM2M, those include Eclipse OM2M and S. Korea OCEAN.

References

- ITU-T (06/2012) Series Y: Global information infrastructure, internet protocol asppects and next-generation networks-frameworks and functional architecture models https://www.itu.int/rec/T-REC-Y.2060-201206-I
- ISO/IEC JTC1 Study Group on Smart Cities, “Resolutions 3, ISO/IEC JTC 1 N 11894, 201311-12,” 2012
- “ESPRESSO Project,” [Online]. Available: http://espresso-project.eu/.
- “The European Innovation Partnership on Smart Cities and Communities EIP-SCC,” [Online]. Available: https://eu-smartcities.eu/about
- ETSI GS CIM 009 V1.1.1 (2019-01) - Context Information Management (CIM); NGSI-LD API

Data Information Models and Context Information Management

Goals

The data information models guarantee that we can disseminate and scale out a common data lingua franca based on shared data models.

The context information management ensures a holistic and integrated data access, use, sharing and management of data.

Capabilities

The information that cities, regions and communities possess or gather is available and easily accessible to applications across different domains. To make the information usable the context information is key.

Applications are able to discover the information relevant to them. For example by specifying what is needed and retrieve or subscribe to this requested information. To share and re-use this information an agreement is in place on the concepts, this can be provided by data information models.

Discovery and querying of information, both current and historical, is possible, also in a geospatial way.

Applications can subscribe to changes of information, so that they are always aware of the current status.

The implementation across (and even within) the city, or any application ecosystem, can be very diverse and heterogeneous. An agreement on the interfaces is necessary to be able to access the information. This is enabled by the context management API and the data information models.

The common data and data models are available in a catalogue and guidelines are available so that het different verticals are integrated in a holistic/integrated city data lake to enable interoperability for applications and systems among different cities

Recommended specifications

- NGSI-LD, as specified by the ETSI Industry Specification Group on Context Information Management (ETSI ISG CIM), provides an API for managing and requesting context information and an underlying meta model based on entities - the core information elements, often the digital counterparts of real-world object - and their properties and relationships to other entities.
- NGSI-LD compliant data models for aspects of the smart city have been defined by organizations and projects, including OASC, FIWARE, GSMA and the SynchroniCity project and there is an ongoing joint activity of TM Forum and FIWARE to specify more.
- Existing data models and ontologies, e.g. the SAREF (Smart Applications REFerence ontology) standard by ETSI/oneM2M, can be mapped for use with NGSI-LD by identifying what are entities, properties and relationships, which can be managed and requested by the NGSI-LD API.

- Even though the NGSI-LD specification has been published relatively recently, there are already three Open Source implementations (Scorpio, djane and Orion-LD). Orion-LD is the NGSI-LD version of the Connecting Europe Facility (CEF) building block Context Broker.
- oneM2M base ontology (that is compatible with SAREF). Additionally oneM2M provides the means to instantiate ontologies as a means to provide semantic descriptions of the data exchanged (through the use of metadata)
- SAREF: Smart Appliances REFerence (SAREF) ontology specified by ETSI OneM2M committee with the extension of SAREF4Cities provides an ontology focused on smart cities

Sidenote:
Following specifications are in development and are getting more attention:

- INSPIRE: Infrastructure for spatial information in Europe is having the requirement to foresee WFS3 by OGC: https://gdal.org/drivers/vector/oapif.html

Marketplace Enablers

Goals

Scaling of IoT- and AI-enabled services across many cities requires easy and risk-free access to suitable urban data sources that are already deployed in cities and communities today. A Digital Single Market within Europe – and extending to other areas with free-trading agreements such as Japan – allows for easy and risk-free access to relevant and available urban data, solutions and other resources so that services and solutions already deployed in other cities can easily be scaled and reach mainstream deployment. The use and re-use leads to new revenue streams incentivising the infrastructure owners to share data, analytics, services and/or solutions in infrastructure partnerships based on key technology enablers.

With a set of marketplaces established within the European Digital Single Market, and even beyond, all parties can co-create applications, solutions, services and guidelines on top of the common data models and standardised APIs. Facilitating this ecosystem of providers and consumers leads to sustainable business models and fair mechanisms for sharing and compensating, and it reduces the risk for investments.

Capabilities

The marketplace realizes standardized exposure of data and data sets. The marketplace also realizes access to services that build on this data and transfer it to knowledge, intelligence and information for the consumers.

The marketplace provides catalogue management, ordering management, revenue (sharing) management, SLA management, quality management and data license management.

A crucial aspect of a market place is ecosystem transaction management. These functionalities enable effective matchmaking of urban IoT data sources from providers with respective data consumers, facilitate trusted exploitation of such data based on enforceable data usage agreements and secure value flow between these stakeholders.

There are various ways in realising such Ecosystem Transaction Management. A standardised way of doing so is provided by the TM Forum, who has created an API suite of specifications for digital marketplaces, named the Business API Ecosystem.

Recommended specifications

- Basic Data Marketplace Enablers https://synchronicity-iot.eu/wp-content/uploads/2018/09/SynchroniCity_D2.4.pdf
- Guidelines for the integration of IoT devices in OASC compliant platforms https://synchronicity-iot.eu/wp-content/uploads/2018/09/SynchroniCity_D2.6.pdf
- TM Forum Open APIs and component suites provide service and technology neutral suite of APIs that provide the minimum building blocks for interoperability across all operational management areas. Each API and component suite provide the specification, reference implementations and in most cases conformance test kits. Reference Implementations are available under the Apache2.0 license. These APIs have

gained global adoption in the Telecommunications industry and are proven to maximize reuse. They are designed to be extendable as required for specific services. The respective data models have been harmonized with FIWARE and GSMA data models. https://projects.tmforum.org/wiki/display/API/Open+API+Table

Version history
Version 1.0: October 20, 2019
Version 2.0: December 6, 2019