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SERIES Y: GLOBAL INFORMATION
INFRASTRUCTURE, INTERNET PROTOCOL ASPECTS,
NEXT-GENERATION NETWORKS, INTERNET OF
THINGS AND SMART CITIES

Internet of things and smart cities and communities –
Frameworks, architectures and protocols

Open data application programming interfaces (APIs) for IoT data in smart cities and communities

Recommendation ITU-T Y.4472

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Recommendation ITU-T Y.4472

Open data application programming interfaces (APIs) for IoT data in smart cities and communities

Summary

A growing number of smart cities and administrations are inclined to collaborate and mutualize their efforts and resources for IoT deployments and open data sharing. This Recommendation studies the concept and potential of developing a secure open and interoperable API in the context of IoT deployment and open data management in smart cities. It analyses current solutions implemented by administrations around the world, where applicable, including those adopted by smart cities, to share their data through open and interoperable interfaces. It subsequently specifies an open and interoperable API for secure open data architecture, as well as for supporting IoT data interoperability for smart cities.

This Recommendation presents a complete set of Open APIs dedicated to smart cities offering different features covering the needs of interoperable smart city framework development. In order to achieve interoperability between heterogeneous platforms and the development of smart cities, the Recommendation has proposed "interoperability points" in southbound and northbound interfaces in a smart city framework.

It provides a list of core API sets focusing on data interoperability, including context data management APIs, data transactions APIs, data storage APIs and security APIs. Through the mechanism of subscriptions, it is possible to get a performant and scalable context data management. The data storage APIs allow a granular management of the saved data for all cases, in particular both for open data and private data. The data transaction APIs facilitate exposure and access to the data through a data marketplace. In addition, security and privacy APIs are seriously taken into account to provide secure data exchange.

It should be noted that data interoperability with open APIs can be completed by using common data models, which is briefly discussed. Common data models built upon the collaboration with several standard fora and European projects are open for public use.

The development of an interoperable framework makes smart city platforms cost efficient, flexible and extendable. Interoperability is not a choice but a must in smart city systems that embed multiple verticals.

History

Edition	Recommendation	Approval	Study Group	Unique ID*
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API, interoperable, IoT, open data.

* To access the Recommendation, type the URL <http://handle.itu.int/> in the address field of your web browser, followed by the Recommendation's unique ID. For example, <http://handle.itu.int/11.1002/1000/11830-en>.

FOREWORD

The International Telecommunication Union (ITU) is the United Nations specialized agency in the field of telecommunications, information and communication technologies (ICTs). The ITU Telecommunication Standardization Sector (ITU-T) is a permanent organ of ITU. ITU-T is responsible for studying technical, operating and tariff questions and issuing Recommendations on them with a view to standardizing telecommunications on a worldwide basis.

The World Telecommunication Standardization Assembly (WTSA), which meets every four years, establishes the topics for study by the ITU-T study groups which, in turn, produce Recommendations on these topics.

The approval of ITU-T Recommendations is covered by the procedure laid down in WTSA Resolution 1.

In some areas of information technology which fall within ITU-T's purview, the necessary standards are prepared on a collaborative basis with ISO and IEC.

NOTE

In this Recommendation, the expression "Administration" is used for conciseness to indicate both a telecommunication administration and a recognized operating agency.

Compliance with this Recommendation is voluntary. However, the Recommendation may contain certain mandatory provisions (to ensure, e.g., interoperability or applicability) and compliance with the Recommendation is achieved when all of these mandatory provisions are met. The words "shall" or some other obligatory language such as "must" and the negative equivalents are used to express requirements. The use of such words does not suggest that compliance with the Recommendation is required of any party.

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Recommendation ITU-T Y.4472

Open data application programming interfaces (APIs) for IoT data in smart cities and communities

1 Scope

This Recommendation proposes open and interoperable APIs for secure open data exchange, as appropriate, as well as for IoT data interoperability for smart cities.

2 References

The following ITU-T Recommendations and other references contain provisions which, through reference in this text, constitute provisions of this Recommendation. At the time of publication, the editions indicated were valid. All Recommendations and other references are subject to revision; users of this Recommendation are therefore encouraged to investigate the possibility of applying the most recent edition of the Recommendations and other references listed below. A list of the currently valid ITU-T Recommendations is regularly published. The reference to a document within this Recommendation does not give it, as a stand-alone document, the status of a Recommendation.

None.

3 Definitions

3.1 Terms defined elsewhere

This Recommendation uses the following terms defined elsewhere:

3.1.1 application programming interface (API) [b-ITU-T T.170]: A boundary across which a software application uses facilities of programming languages to invoke software services. These facilities may include procedures or operations, shared data objects and resolution of identifiers.

3.1.2 data marketplace [b-FG-DPM TS D0.1]: An electronic marketplace whose main product is provisioning of data and/or related services around data.

3.1.3 data model [b-ITU-T J.380.8]: A data model is a formal view of the data items contained in an information store to which an information service implementing this standard will provide access and is specified for purposes of formulating and executing queries against the information store's data.

3.1.4 interoperability [b-ITU-T Y.101]: The ability of two or more systems or applications to exchange information and to mutually use the information that has been exchanged.

3.1.5 Internet of things (IoT) [b-ITU-T Y.4000]: A global infrastructure for the information society, enabling advanced services by interconnecting (physical and virtual) things based on existing and evolving interoperable information and communication technologies.

NOTE 1 – Through the exploitation of identification, data capture, processing and communication capabilities, the IoT makes full use of things to offer services to all kinds of applications, whilst ensuring that security and privacy requirements are fulfilled.

NOTE 2 – From a broader perspective, the IoT can be perceived as a vision with technological and societal implications.

3.2 Terms defined in this Recommendation

This Recommendation defines the following terms:

3.2.1 common data models: Common data models are schemas representing the format of the data sets. They are interoperability points between the entities exchanging data through the common data models.

3.2.2 context data (entity): Structured data that contains status information of context entities and their related attributes and metadata. A context entity can represent everything in the real world such as users, places and devices that can be abstracted and represented using a predefined data model.

3.2.3 data monetization: Generation of economic benefits from different data sources.

3.2.4 northbound interfaces: Interfaces permitting a given component to communicate with other components located at a higher level.

3.2.5 open data: Data that can be publicly accessible to all through open standards and protocols or through other means. The use and redistribution of open data can be subject to rules.

3.2.6 smart city platform: A city platform that offers direct integration of city platforms and systems, or through open interfaces between city platforms and third parties, in order to offer urban operation and services supporting the functioning of city services, as well as efficiency, performance, security and scalability.

3.2.7 southbound interfaces: Interfaces permitting a given component to communicate with other components located at a lower level.

4 Abbreviations and acronyms

This Recommendation uses the following abbreviations and acronyms:

API	Application Programming Interface
ENISA	European Union Agency for Network and Information Security
GSMA	GSM Association
IoT	Internet of Things
JSON	JavaScript Object Notation
JSON-LD	JavaScript Object Notation for Linked Data
M2M	Machine to Machine
OASC	Open & Agile Smart Cities
RDF	Resource Description Framework
TMF	TM Forum
XACML	extensible Access Control Markup Language

5 Conventions

None.

6 General considerations about open APIs for IoT data in smart cities and communities

Smart cities are a key driver of large-scale IoT markets where a complex set of diverse technologies, consisting of heterogeneous IoT devices, network infrastructure, cloud systems and multiple IoT platforms, go together to provide a diverse smart city and application. The scale of the smart city use cases varies from a single local network-based system to a large-scaled cross-platform deployment. Various communication technologies are used to support the use case requirements and may include diverse IoT protocols, security and privacy, data analytics and management, service orchestration, business management, etc.

Considering the heterogeneity that a smart city embeds, interoperability is a pivotal index to consider from the design phase. Yet, there are large sets of interoperability solutions that can be applied in different layers of the components, systems, platforms, networks and services. The challenges become greater when it comes to a federation of the smart city systems, while the needs grow.

Instead of adding another complexity to thousands of existing solutions on interoperability of smart cities and further federation of two or more smart city platforms, this Recommendation is focusing on "data". The communication network protocols or protocols for platforms depend on the city infrastructure, budget, engineering, environment, etc. The common goal of the different smart cities is eventually the interoperability of the generated and obtained data for creating services. The need of open application programming interfaces (Open APIs) for IoT data lies on this point. The IoT data includes open data and also private data.

In order to ensure data interoperability between smart city platforms with minimal costs, "interoperability points" are introduced below. The core open APIs are defined to connect the interoperability points.

Interoperability points represent the main technical interfaces between smart cities' platform and external systems. Interoperability points are also a way to access basic smart city IoT functionalities and in particular to consume and provide data. They assure the replicability of solutions (i.e., services, applications) on different smart cities that are compliant to them, and they are completely decoupled from the specific technological implementation and deployment of the architectural components. Interoperability points are the logical and conceptual representation of a set of open APIs that can be concretely instantiated to provide a technologically-specific implementation.

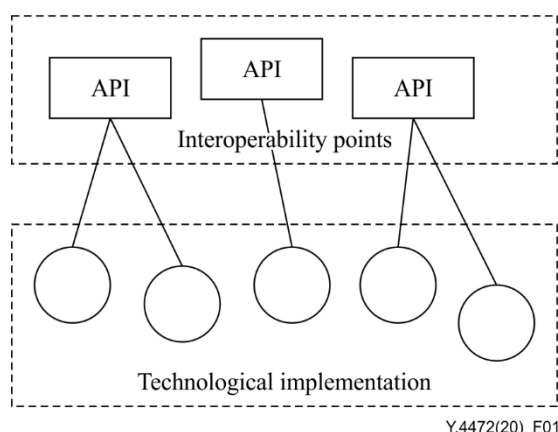


Figure 1 – Interoperability points

In general, there are two interoperability points in a generic smart city platform:

- **Southbound interfaces:** represent the main way for interacting with IoT devices/middleware and managing relevant IoT data. They include a set of interfaces used to connect a smart city platform to heterogeneous IoT devices and middleware. The southbound interfaces are intended to be exchanging IoT data with a smart city platform, hiding the complexity of the IoT protocols and communication issues, which are not covered by this Recommendation.
- **Northbound interfaces:** include a set of interfaces that provide IoT data and its elaboration to the external system and application interacting with the smart city platform. The northbound interfaces described in this Recommendation are not all those possible to be provided by a generic smart city platform, but only the basic ones which constitute an interoperability layer for IoT data provisioning.