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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 – Requirements and use cases

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Requirements for the interoperability of smart city platforms

Recommendation ITU-T Y.4200

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Recommendation ITU-T Y.4200

Requirements for the interoperability of smart city platforms

Summary

Recommendation ITU-T Y.4200 defines the requirements for the interoperability of a smart city platform (SCP) and its reference points in order to ensure the correct functioning of city services.

The SCP offers services to a smart city. Interoperability between SCPs allows the increase in the number of services provided and their quality. It enables the provision of better services to citizens, and at the same time ensures maximum efficiency, scalability and simple integration.

By permitting interoperability with other platforms the SCP will also encourage local economic development through innovation and competition.

History

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Interoperability, platform, smart city, smart city platform and community, smart sustainable city.

* 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.

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Introduction

There is an increasing need for cities and communities to provide services while also reducing costs, resulting in the need to access different data sources.

The different systems in a city context can be classified as internal systems (mostly related to traditional community services), like waste, lighting, parking, traffic control, etc. and external systems, such as transport companies, ports, airports, buildings, hotels, social networks, etc.

All these systems could give useful information about the state of a city and can be managed through different types of control tools (IoT platforms, SCADA, non-IoT platforms, big data processors, etc.). However, most of the time these control tools, where they exist, are independent, non-standard and without the possibility of sharing resources and data.

The SCP should have access to different information sources, share resources, analyse capacity and coordinate services, usually based on predictive analysis. The concept of horizontality, where information from all kind of sources interact in order to provide specific services (instead of using its own sensors), is fundamental to the SCP concept.

The range of application cases of the SCP is very diverse, ranging from traffic control during an emergency to the anticipation of demand on a museum due to the arrival of an unexpected number of tourists.

This Recommendation presents the requirements for interoperability of SCPs and reference points in order to ensure the correct functioning of the city services.

Recommendation ITU-T Y.4200

Requirements for the interoperability of smart city platforms

1 Scope

This Recommendation identifies the technical requirements for interoperability of SCPs to enable the additional functions provided by external providers or other city platforms.

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.

[ITU-T Y.101] Recommendation ITU-T Y.101 (2000), *Global Information Infrastructure terminology: Terms and definitions.*

[ITU-T Y.4000] Recommendation ITU-T Y.4000/Y.2060 (2012), *Overview of the Internet of Things.*

[ITU-T Y.4201] Recommendation ITU-T Y.4201 (2017), *High-level requirements and reference framework of smart city platforms.*

[ITU-T Y.4900] Recommendation ITU-T Y.4900/L.1600 (2016), *Overview of key performance indicators in smart sustainable cities.*

[ITU-T Y.4552] Recommendation ITU-T Y.4552/Y.2078 (2016), *Application support models of the Internet of things.*

3 Definitions

3.1 Terms defined elsewhere

This Recommendation uses the following terms defined elsewhere:

3.1.1 city platform [ITU-T Y.4201]: A computer system or integration of computer systems that, under control of the city, uses information and communication technologies (ICTs) to access data sources and process them to offer urban operation and services to the city.

NOTE – The concept is extended to a community.

3.1.2 Internet of things (IoT) [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.

3.1.3 interoperability [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.

3.1.4 open interface [ITU-T Y.4201]: A public standard for connecting hardware to hardware and software to software. Open interfaces are designed and documented for safe and easy use by third party developers and freely available to all.

3.1.5 open standards [b-OpenStandards]: Standards made available to the general public and are developed (or approved) and maintained via a collaborative and consensus driven process.

NOTE – Open Standards facilitate interoperability and data exchange among different products or services and are intended for widespread adoption.

3.1.6 smart city platform (SCP) [ITU-T Y.4201]: 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 the urban operation and services supporting the functioning of city services, as well as efficiency, performance, security and scalability.

3.1.7 smart sustainable city (SSC) [ITU-T Y.4900]: A smart sustainable city is an innovative city that uses information and communication technologies (ICTs) and other means to improve quality of life, efficiency of urban operation and services and competitiveness, while ensuring that it meets the needs of present and future generations with respect to economic, social, environmental and cultural aspects.

3.2 Terms defined in this Recommendation

None.

4 Abbreviations and acronyms

This Recommendation uses the following abbreviations and acronyms:

API	Application Programming Interface
BIM	Building Information Modelling
ICT	Information and Communication Technology
IoT	Internet of Things
M2M	Machine to Machine
REST	Representational State Transfer
SCADA	Supervisory Control and Data Acquisition
SCP	Smart City Platform
SLA	Service Level Agreement
SSC	Smart Sustainable City

5 Conventions

In this Recommendation:

The expression "is required" indicates a requirement which must be strictly followed and from which no deviation is permitted if conformance to this Recommendation is to be claimed.

The expression "is recommended" indicates a requirement which is recommended but which is not absolutely required. Thus, this requirement need not be present to claim conformance with this Recommendation.

The expression "can optionally" and "may" indicates an optional requirement which is permissible, without implying any sense of being recommended. This term is not intended to imply that the vendor's implementation must provide the option and the feature can be optionally enabled by the network operator/service provider. Rather, it means the vendor may optionally provide the feature and still claim conformance with this Recommendation.

6 Evolution from city platforms to smart cities and communities platforms

City platforms provide various services in specific areas. These services are known in some places as verticals, and are provided by supervisory control and data acquisition (SCADA) or more complex platforms. Most of the time these platforms are independent and do not share resources, or they do so sparingly. In city platforms, the proprietary systems abound and the possibilities to offer open interfaces (necessary for the integration with city platforms and data sources) are low.

City platforms may offer some integration; however, currently interoperability problems, such as those below, with city platforms and external providers have been identified.

a) Many city platforms are conceived as data acquisition and processing systems, without additional possibilities such as data analysis or interoperability with other systems.

b) There is a tendency for mutual dependence among applications, devices and transport networks.

c) The concept of horizontality, i.e. allowing the data sensors to be shared by the different services, is barely used.

d) There is not a trend towards standard open interfaces (open platforms). Although there are already open non-proprietary platforms, the concept of horizontality is not considered.

e) In some cases, application interoperability is limited to a certain level of interface customization.

Figure 1 presents three vertical platforms which offer services to the city. In this example, these platforms are initially independent, each of them offering specific services to the city. They acquire data from the sensors and/or other data sources, process the data and offer services that are based only on the information that they have collected. These vertical platforms do not share information and each of them manages its own systems and resources.

In this context the introduction of an SCP enables the integration and optimization of vertical platforms and facilitates the exchange of information and resources between vertical platforms. On one hand, the resources and systems used by the vertical platforms supporting the same functions can be pooled and on the other hand, the information that is stored and processed by one vertical platform can be used by the others, enabling the generation of cheaper, more valuable and more complex services.

Vertical platforms can be integrated with the SCP in two ways. They can be deployed inside the SCP or can be integrated using open interfaces, in case the processes and resources required by the vertical platform could not be deployed inside the SCP.

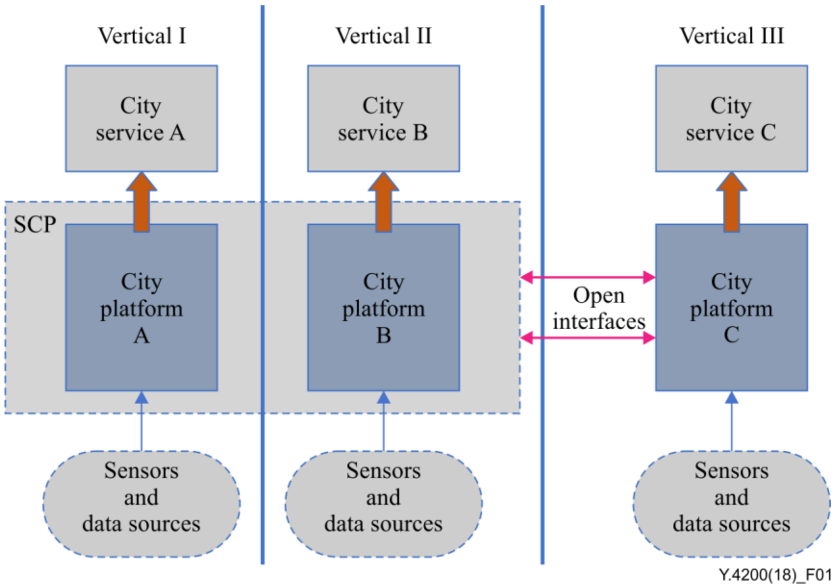

Figure 1 – Integration of vertical platforms of the city into the SCP

Figure 1 shows how the SCP could be built, integrating platforms A and B, while city platform C is not integrated inside the SCP. Therefore, open interfaces are required to interconnect the SCP with city platform C which also will enable other systems or platforms to interoperate with the SCP more efficiently. In the integration process some resources, such as data source, can be shared. Since the services can access more data sources, it could be possible to create new services and improve those that already exist. Predictive analysis is also more possible, because more data sources are accessible.

The SCP could interoperate with external providers' city platforms, and its interfaces are required to be adapted. The adaptation of these interfaces will depend on the type of platform.

7 Reference points for SCP interoperability with external providers

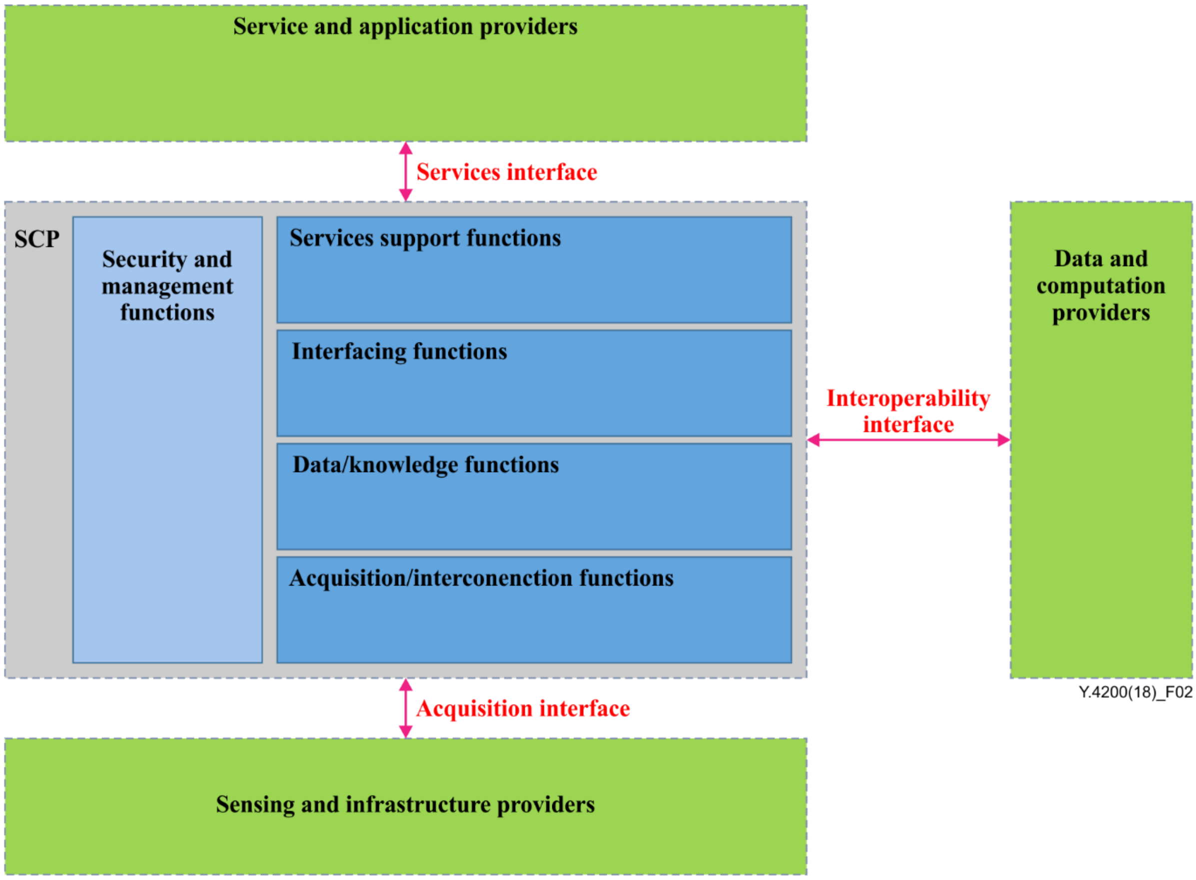

Figure 2 – Overview of an SCP and external systems/platforms [ITU-T Y.4201]

Figure 2 describes the architecture of an SCP and its communication with other elements.

The SCP provides the following group of functions as indicated in [ITU-T Y.4201]:

– **Acquisition/Interconnection functions**: These provide data capture mechanisms from the collection systems (see clause 8.2 of [ITU-T Y.4201]).

– **Data/Knowledge functions**: These support data processing, adding value and transforming information into knowledge (see clause 8.3 of [ITU-T Y.4201]).

– **Interfacing functions**: These enable access to information at different levels (see clause 8.4 of [ITU-T Y.4201]).

– **Service support functions**: These coordinate all the possible services involved in each action developed out of interoperability functions (see clause 8.5 of [ITU-T Y.4201]).

– **Security and management functions**: These provide horizontal functionalities such as audits, monitoring and security (see clause 8.6 of [ITU-T Y.4201]).

Figure 2 shows interfaces which enable the communication between the functions (red arrows). Details of these interfaces are described in the following list:

– **Acquisition interface**: This interface with the SCP enables information collection from the external elements. The features of this interface are described in clause 8.1.

– **Interoperability interface**: This interface with the SCP enables communication with external data providers and the third-party computation systems. The features of this interface are described in clause 8.2.

– **Service interface**: This interface with the SCP enables application to application access to support functions provided by the SCP (see clause 8.3).

All the above interfaces are required to be open and standardized.

8 Requirements for interoperability of smart city platforms

In order to ensure an adequate interoperability service the following aspects are required:

a) **Interoperability with different technologies**: capability of supporting different technologies for capturing information and communications standards, as well as internal/corporate and/or external information systems.

b) **Performance**: ability to handle a large number of devices, services and processes efficiently.

c) **Scalability**: ability to increase processing, interconnection and storage capacities without needing to change the architecture.

d) **Robustness and resilience**: capability to continue while facing problems.

e) **Security**: guarantee of security and reliability.

f) **Extensibility**: adaptability to meet new needs.

8.1 Acquisition interface

It is required that the acquisition interface of the SCP complies with the following technical characteristics:

– network access and sensor technology independence, i.e., compatibility with different network access and IoT/machine to machine (M2M) protocols;

– support for open protocols and protocol translation, to ensure that the platform remains independent from the complexity of devices and enables access to sensors/actuators from different manufacturers;

– access to sensors/actuators: sensor/actuators information is collected through a transport network;

– support of security and monitoring functions;

– discovery and access to IoT/M2M applications;

– support of identification and naming of devices and applications.

8.2 Interoperability interface

It is required that this interface enables the interoperability between the SCP and external systems and allows access to data, information and services that are stored or provided by the SCP.

It is required that this interface includes authentication and authorization aspects that allow control access to the functions. The authorizations will be granted according to the terms of use.

It is recommended that this interface enables internal access to the data management and basic capabilities offered by the acquisition/interconnection functions:

– to enable access to the metadata of sensors registered in the platform;

– to implement authorization and authentication functions for the different available actions;

– allowing real-time collection of data generated by a sensor or group of sensors.

It is recommended that this interface:

– allows operation with data sets. The interface should provide functionalities that allow mathematical operations on the data.

– The interface allows extraction and analysis processes. The interface should provide functionalities that allow analysis based on big data, that is, analytical capabilities to transform data into valuable information.
– It is required that this interface enables internal access to the information management offered by the service support functions through application programming interfaces (APIs) providing different data access modes, including push (subscription and notification) and pull (request and response).

8.3 Service interface

It is required that the service interface offers APIs and other tools such as a development kit and open data portals, which will be used to implement the services delivered to clients.

It is required that this interface:

– provides a secure access to the APIs, development kit, web portal, etc.;
– is based on open APIs (including the provision of an API manager) that can be used by the internal or external applications;
– follows the overall API representational state transfer (REST) trend.

It is recommended that this interface:

– makes available a web portal that can be used from the services offered;
– supports different data access modes, including push (subscription and notification) and pull (request and response);
– provides the mechanism necessary to adapt the communications to the data models and semantics.

Appendix I

Services and applications

(This appendix does not form an integral part of this Recommendation.)

The services and applications provide developments that are able to manage the city, facilitate the development of new business models, and provide added value to the city. This section is out of the scope of this Recommendation but provides insight into the services that the city can implement.

These services and applications interact with the SCP through the service interface.

The following services can be developed:

a) command centres deployment depending on user's profiles and permissions;

b) vertical service management applications such as mobility, energy efficient, smart irrigation, etc;

c) integrated maintenance contract management application, including service level agreements (SLAs) based on real data.

These services are recommended to include functions such as:

– dashboards
– forecast, simulation and planning systems
– data treatment systems, etc.

Examples of municipal services may involve sectors such as:

– energy and environmental sustainability
– management of public buildings and other urban infrastructure
– transport and mobility
– health services
– commerce
– safety
– e-government and relations with citizens
– education and culture
– tourism
– leisure.

Appendix II

Examples of interaction between SCP and other systems

(This appendix does not form an integral part of this Recommendation.)

This appendix shows examples of interaction between an SCP and other systems.

External platforms, SCADAs, sensor webs, web platforms, etc. are systems that can interact with the SCP.

II.1 Interaction with an IoT platform

Interoperability is possible between the SCP and other systems, like ports, airports, external communities, and even with another SCP. The communication could be established through the corresponding interface, which is expected to be standardized.

A variation of this scenario is an SCP communicating with several communities in order to share resources. This application could be of major interest for rural communities.

II.2 Delegation of the SCP

It could be envisaged that a platform could delegate some of its management functions to external entities, like communities. In certain cases, it could be of major interest where services can be managed locally, such as mobility control. In particular, this situation will be relevant when low latency systems are deployed.

II.3 External system interoperating with one or more SCP

This scenario includes plenty of variations, but the most relevant ones are related to decision making and those providing critical information, among which expert systems are included.

An application case is the tourism sector. In this sector, city resources are identified (museums, beaches, restaurants, etc., each one with a structured data model), and external services (not necessarily IoT) are associated with user profiles (family, preferences, stay in the city, etc.). The combination of both elements allows the assessment and optimization of the resources based on predictive touristic intelligence.

II.4 Communication with complex IoT nodes

Node identification characteristics and attributes, like type of service, status, etc. are taken into consideration, and could include sensor webs. An interesting example could be the smart building situation (public or private), where relevant information (building alarms, contamination levels, building access, energetic efficiency or even information of the building structure) can be provided to city managers.

For the inclusion of these smart city systems, it is necessary either to register the system with the complexity of the information supplied (like the building information modelling (BIM) systems in the case of smart buildings) and the actualization of the information previously provided, or to include all the information transmitted from the node to the platform, like with the integrated sensor web.

Currently, it is expected that external systems interoperate with the acquisition functions. Moreover, if these systems incorporate intelligent management functions (intelligent node, intelligent sensor web, etc.), they could be able to interoperate with higher levels of the SCP model.

Bibliography

[b-OpenStandards] Definition of Open Standards, <http://www.itu.int/en/ITU-T/ipr/Pages/open.aspx>

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