

Recommendation

ITU-T Y.4499 (01/2025)

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

Framework for urban infrastructure monitoring based on crowdsourcing

ITU-T Y-SERIES RECOMMENDATIONS

Global information infrastructure, Internet protocol aspects, next-generation networks, Internet of Things and smart cities

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Recommendation ITU-T Y.4499

Framework for urban infrastructure monitoring based on crowdsourcing

Summary

Recommendation ITU-T Y.4499 specifies a framework for urban infrastructure monitoring based on crowdsourcing, including requirements, functional architecture, common procedures, as well as security and privacy considerations.

Urban infrastructure includes the physical facilities and systems that a city must have for its operation and development. It has the characteristics of large quantity, wide distribution and high management difficulty. Crowdsourcing is the practice of engaging a group of people for a common goal. It can provide a scalable and financially viable way to monitor urban infrastructure.

History *

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Crowdsourcing, IoT crowdsourcing, system, urban infrastructure monitoring.

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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.

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Recommendation ITU-T Y.4499

Framework for urban infrastructure monitoring based on crowdsourcing

1 Scope

This Recommendation specifies a framework for urban infrastructure monitoring (UIM) based on crowdsourcing.

This framework is based on the requirements and reference model for crowdsourced systems related to the Internet of things (IoT) [ITU-T Y.4205].

The scope of this Recommendation includes:

- an introduction to UIM based on crowdsourcing;
- requirements for UIM based on crowdsourcing;
- a functional architecture of UIM based on crowdsourcing;
- common procedures of UIM based on crowdsourcing;
- security and privacy considerations.

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.4205] Recommendation ITU-T Y.4205 (2019), *Requirements and reference model of IoT-related crowdsourced systems*.

[ITU-T Y.4217] Recommendation ITU-T Y.4217 (2022), *Service requirements and capability framework for Internet of things-related crowdsourced systems*.

3 Definitions

3.1 Terms defined elsewhere

This Recommendation uses the following terms defined elsewhere:

3.1.1 crowdsourced resource [ITU-T Y.4205]: The device, hardware module, service or other system resource that a crowdsourced system has been given access to by crowdsourcing participants.

3.1.2 crowdsourced systems [ITU-T Y.4205]: Systems that employ crowdsourcing in order to augment their constituent infrastructure and the set of provided services or collected information.

3.1.3 crowdsourcer [ITU-T Y.4205]: The initiator of a crowdsourcing task. It can refer to a single person, a group of people, a corporation, an organization, etc.

3.1.4 crowdsourcing [ITU-T Y.4205]: The practice of obtaining needed services, ideas, content or other system resources by soliciting contributions from a large, open and potentially undefined group of people, rather than from employees, suppliers or identified experts through an online open call by providing incentives (financial, social, or entertainment) to all or a subset of those crowd members who participate in the crowdsourcing activity.

3.1.5 crowdsourcing participant [ITU-T Y.4205]: The person contributing to a crowdsourced system by providing and potentially benefiting from ideas, content, or access to services, hardware or other system resources. In the general case, the participant is a member of a large, open and potentially undefined group of people.

3.1.6 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 term:

3.2.1 urban infrastructure: Physical facilities and systems related to local services in a city.

4 Abbreviations and acronyms

This Recommendation uses the following abbreviations and acronyms:

AI	Artificial Intelligence
FE	Functional Entity
HMI	Human/Machine Interface
ID	Identifier
IoT	Internet of Things
UE	User Equipment
UIM	Urban Infrastructure Monitoring

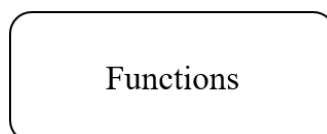
5 Conventions

In this Recommendation:

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

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

The word "functions" indicates a collection of functionalities, which is represented by the following symbol in this Recommendation:



The phrase "functional entity" (FE) indicates a representation of functionality, which is shown by the following symbol in this Recommendation:

6 Introduction to UIM based on crowdsourcing

Urban infrastructure includes the physical facilities and systems that a city must have for its operation and development. For example, urban infrastructure includes street lighting facilities, manhole covers, mailboxes, urban roads and dustbins.

Urban infrastructure has the characteristics of large quantity, wide distribution and high management difficulty. Usually, there are several ways to monitor urban infrastructure, such as manual inspection, installing sensors on the infrastructure, etc. However, the following issues still exist in the methods previously mentioned. First, the efficiency of manual inspection is relatively low because of the wide distribution of urban infrastructure and the limited number of inspectors. Second, the infrastructure can be monitored through installing sensors. However, there may be false reports or missing reports in the sensing data.

To overcome the above deficiencies in traditional urban infrastructure monitoring (UIM) methods and to realize efficient monitoring, this Recommendation addresses the framework of UIM based on crowdsourcing.

Crowdsourcing refers to the practice of obtaining needed goal by engaging a group of ordinary people, rather than from employees, suppliers or identified experts. Crowdsourced systems refer to the systems that employ crowdsourcing to augment their constituent infrastructure and the set of provided services or collected information. As mentioned in [ITU-T Y.4205], crowdsourced systems provide a method for opportunistically augmenting Internet of things (IoT) and sensing infrastructure in a scalable and financially viable way. Meanwhile, crowdsourced systems can be used to complement and extend the already available infrastructure for smart buildings, smart cities and communities. The crowdsourced system of UIM employs crowdsourcing to monitor urban infrastructure.

First, using crowdsourcing to monitor urban infrastructure can expand the scope of urban infrastructure information collection, improve the real-time data acquisition, and increase the flexibility of task execution. Second, UIM based on crowdsourcing has the advantage of expanding participants. There are no special requirements for participants' gender, age, data collection equipment and data format (e.g., image, video, text, audio, etc.), which supports almost all participants to involve in without threshold. Finally, with the rapid development of embedded devices, wireless sensor networks, IoT and cloud computing, pervasive IoT devices integrating sensing, computing and communication capabilities are being widely deployed, such as smartphones, wearable devices, etc. Those devices have strong sensing abilities and can help crowdsourcing participants achieve more efficient and convenient urban infrastructure data collection. Therefore, crowdsourcing is suitable for large-scale UIM applications.

As shown in Figure 1, the crowdsourced system of UIM consists of a UIM platform and user equipment (UE). A UIM platform will receive UIM requirements released by the crowdsourcer, uniformly manage and maintain the requirements and monitoring tasks, and distribute tasks to participants through UE. The crowdsourcer can refer to the management department of specific urban infrastructure. If the task is accepted, the participant uses UE to collect and report the urban infrastructure status data to the UIM platform in the context of the task. The UIM platform collects, aggregates and analyses the urban infrastructure status data from all participants, and finally gives feedback to the crowdsourcer.

NOTE – As mentioned in [ITU-T Y.4205], the crowdsourcer is the initiator of a crowdsourcing task. Considering the complexity of UIM and the platform's stronger capabilities of data processing, the crowdsourcer can release the UIM requirements to the UIM platform, and the platform generates performable tasks.