International Telecommunication Union

ITU-T

TELECOMMUNICATION
STANDARDIZATION SECTOR
OF ITU

Y.4217
(08/2022)

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

Service requirements and capability framework for Internet of things-related crowdsourced systems

Recommendation ITU-T Y.4217

ITU-T Y-SERIES RECOMMENDATIONS

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

GLOBAL INFORMATION INFRASTRUCTURE	
General	Y.100–Y.199
Services, applications and middleware	Y.200–Y.299
Network aspects	Y.300–Y.399
Interfaces and protocols	Y.400–Y.499
Numbering, addressing and naming	Y.500–Y.599
Operation, administration and maintenance	Y.600–Y.699
Security	Y.700–Y.799
Performances	Y.800–Y.899
INTERNET PROTOCOL ASPECTS	
General	Y.1000–Y.1099
Services and applications	Y.1100–Y.1199
Architecture, access, network capabilities and resource management	Y.1200–Y.1299
Transport	Y.1300–Y.1399
Interworking	Y.1400–Y.1499
Quality of service and network performance	Y.1500–Y.1599
Signalling	Y.1600–Y.1699
Operation, administration and maintenance	Y.1700–Y.1799
Charging	Y.1800–Y.1899
IPTV over NGN	Y.1900–Y.1999
NEXT GENERATION NETWORKS	
Frameworks and functional architecture models	Y.2000–Y.2099
Quality of Service and performance	Y.2100–Y.2199
Service aspects: Service capabilities and service architecture	Y.2200–Y.2249
Service aspects: Interoperability of services and networks in NGN	Y.2250–Y.2299
Enhancements to NGN	Y.2300–Y.2399
Network management	Y.2400–Y.2499
Computing power networks	Y.2500–Y.2599
Packet-based Networks	Y.2600–Y.2699
Security	Y.2700–Y.2799
Generalized mobility	Y.2800–Y.2899
Carrier grade open environment	Y.2900–Y.2999
FUTURE NETWORKS	Y.3000–Y.3499
CLOUD COMPUTING	Y.3500–Y.3599
BIG DATA	Y.3600–Y.3799
QUANTUM KEY DISTRIBUTION NETWORKS	Y.3800–Y.3999
INTERNET OF THINGS AND SMART CITIES AND COMMUNITIES	
General	Y.4000–Y.4049
Definitions and terminologies	Y.4050–Y.4099
Requirements and use cases	**Y.4100–Y.4249**
Infrastructure, connectivity and networks	Y.4250–Y.4399
Frameworks, architectures and protocols	Y.4400–Y.4549
Services, applications, computation and data processing	Y.4550–Y.4699
Management, control and performance	Y.4700–Y.4799
Identification and security	Y.4800–Y.4899
Evaluation and assessment	Y.4900–Y.4999

For further details, please refer to the list of ITU-T Recommendations.

Recommendation ITU-T Y.4217

Service requirements and capability framework for Internet of things-related crowdsourced systems

Summary

Recommendation ITU-T Y.4217 specifies service requirements of Internet of things (IoT)-related crowdsourced systems, in addition to the requirements of IoT-related crowdsourced systems (Recommendation ITU-T Y.4205); and the common requirements of IoT (Recommendation ITU-T Y.4100). Based on these requirements, a capability framework of IoT-related crowdsourced systems is developed. With this, service requirements and capability framework for IoT-related crowdsourced systems can help with the implementation of IoT-related crowdsourced systems.

---

[*] 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.

INTELLECTUAL PROPERTY RIGHTS

ITU draws attention to the possibility that the practice or implementation of this Recommendation may involve the use of a claimed Intellectual Property Right. ITU takes no position concerning the evidence, validity or applicability of claimed Intellectual Property Rights, whether asserted by ITU members or others outside of the Recommendation development process.

As of the date of approval of this Recommendation, ITU had not received notice of intellectual property, protected by patents/software copyrights, which may be required to implement this Recommendation. However, implementers are cautioned that this may not represent the latest information and are therefore strongly urged to consult the appropriate ITU-T databases available via the ITU-T website at http://www.itu.int/ITU-T/ipr/.

Table of Contents

Recommendation ITU-T Y.4217

Service requirements and capability frameworks for Internet of things-related crowdsourced systems

1 Scope

Internet of things (IoT)-related crowdsourced systems need to provide appropriate capabilities to support the requirements of IoT-related crowdsourced systems. This Recommendation specifies the service requirements and capability frameworks for IoT-related crowdsourced systems.

The scope of this Recommendation includes:

– Service requirements of IoT-related crowdsourced systems;

– Capability framework of IoT-related crowdsourced systems.

These service requirements and capability frameworks build on the requirements of IoT-related crowdsourced systems [ITU-T Y.4205] and the common requirements of IoT [ITU-T Y.4100]. Service requirements and capability framework address aspects of crowdsourcing platforms and crowdsourced resources in IoT-related crowdsourced systems.

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

[ITU-T Y.4100]   Recommendation ITU-T Y.4100/Y.2066 (2014)*, Common requirements of the Internet of things.*

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

3 Definitions

3.1 Terms defined elsewhere

This Recommendation uses the following terms defined elsewhere:

3.1.1 crowd [ITU-T Y.4205]: The term is used to collectively refer to the contributors (crowdsources) of a crowdsourced system, as well as the resources that are provided to a crowdsourced system.

3.1.2 crowdsourcing participant [ITU-T Y.4205]: The person contributing to a crowdsourced system by providing and potentially benefitting 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.

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

3.1.4 **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.

3.1.5 **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.

3.1.6 **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.

3.2 Terms defined in this Recommendation

None.

4 Abbreviations and acronyms

This Recommendation uses the following abbreviations and acronyms:

AGV Automated Guided Vehicle

IoT   Internet of Things

PM 2.5 Particulate Matter 2.5

UAV Unmanned Aerial Vehicle

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 expressions "can optionally" and "may" indicate 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 Introduction of IoT-related crowdsourced systems

6.1 Concept of IoT-related crowdsourced systems

Crowdsourcing is 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 (financial, social, or entertainment) incentives to all or a subset of those crowd members who participate in the crowdsourcing activity, as defined in [ITU-T Y.4205].

The IoT-related crowdsourced system is an IoT system that employs crowdsourcing in order to augment its constituent infrastructure and the set of provided services or the collected information. It can employ IoT devices via crowdsourcing and orchestrate their operation in the context of carrying out a task. In return, the crowdsourcing platform provides the owners of the devices with incentives. The IoT-related crowdsourced system leverages human intelligence, which has a deeper context understanding than traditional IoT networks [ITU-T Y.4205].

6.2 Reference model of IoT-related crowdsourced systems

The reference model of IoT related crowdsourced systems, as shown in Figure 1, has been defined in [ITU-T Y.4205]. It is a reference model, where there is no limitation on how it can be implemented in the context of a particular crowdsourced system.
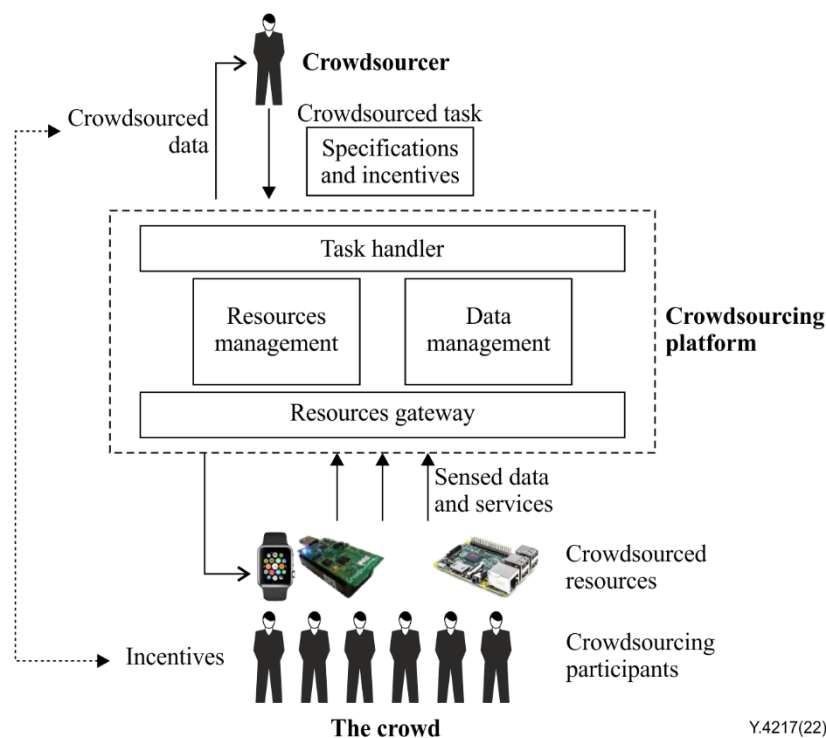
Figure 1 – The reference model for IoT-related crowdsourced systems [ITU-T Y.4205]

A crowdsourced system consists of three layers (the crowdsourcer, the crowdsourcing platform and the crowd) arranged in a vertical manner.

The crowdsourcer is the initiator of a crowdsourcing task. It can be referred to as a single person, a group of people, a corporation, an organization, etc.

The crowdsourcing platform is the intermediary medium that connects the crowdsourcer and the crowd. This includes the task handler functions (interfacing the crowdsourcer), the resources management and data management functions, and the resources gateway functions (interfacing the crowd).

The crowd represents the contributors of a crowdsourced system, providing sensed data and/or services and in return receiving incentives.

7 Service requirements of IoT-related crowdsourced systems

7.1 Service requirements of the crowdsourcing platform

7.1.1 Efficiency-related requirements

1) Depending on the service requirements, the crowdsourcing platform may support time-sensitive tasks.

NOTE 1 – In order to complete each sensitive task in a short time, it is necessary to distribute these tasks to the participants with the shortest task completion time.

2) Depending on the service requirements, the crowdsourcing platform may support tasks that are sensitive to the number of participants.

NOTE 2 – Some crowdsourcing platforms have few participants and a large number of tasks. It is necessary to mobilize as many participants as possible to match the tasks in the platform.

3) Depending on the service requirements, the crowdsourcing platform may support tasks that are sensitive to the activity of the participants.

4) Depending on the service requirements, the crowdsourcing platform may support tasks that are sensitive to the historical task completion records of the participants.

NOTE 3 – Taking violation records as an example, some participants have a record of manipulating data or personal information to receive more incentives, which leads to leaving violation records in the platform. The crowdsourcing platform may use the historical data of the participants' violation records and take the information into account for task distribution.

5) Depending on the service requirements, the crowdsourcing platform may support tasks that are sensitive to data quality.

NOTE 4 – Taking the detection of a road crack as an example, the crowdsourcing platform is required to judge whether the photos uploaded by the participants have sufficient quality based on the image quality assessment.

7.1.2 Incentive-related requirements

1) Depending on the service requirements, the crowdsourcing platform may support incentives that can be paid to participants, which may include monetary rewards, virtual credits, honours, entertainment and gamification, etc.

2) Depending on the service requirements and the supply-demand factors, the crowdsourcing platform may employ different task distribution methods.

NOTE – Examples of such methods include but are not limited to task-snatching, task-auction and fixed partnership.

7.1.3 Anonymity-related requirements

1) The crowdsourcing platform is required to ensure data minimization of the crowd.

2) The crowdsourcing platform is required to ensure the data retention limits of the crowd.

NOTE – Examples of such requirements include, but are not limited to, the support of periodical data purging.

3) The crowdsourcing platform is required to ensure data desensitization and de-identification of the crowd information.

7.1.4 Other requirements

1)   Depending on the service requirements, the crowdsourcing platform may support applications with different technical requirements, such as bandwidth and/or storage size and/or computing power.

NOTE – These requirements relate to the four functional components of the reference model for IoT-related crowdsourcing platforms, i.e., task handler, resources management, data management and resources gateway [ITU-T Y.4205]. Depending on the service requirements, the crowdsourcing platform may support multiple application interfaces in order to support an undefined, open group of crowdsources (crowds having good health, elderly people with poor mobility, people with visual disabilities, etc.).

7.2 Service requirements of the crowdsourced resources

7.2.1 Efficiency-related requirements

1)   Depending on the service requirements, the crowdsourced resources may support energy consumption sensitive tasks.

NOTE 1 – Taking unmanned aerial vehicles (UAV) as an example, they are sensitive to the travelled distance. The load of each task may need to be minimized so that each UAV can fulfil the task with the shortest distance travelled.

2)   Depending on the service requirements, the crowdsourced resources may support intelligent data quality assessment to reduce the redundancy in the process of data acquisition, transmission and communication interaction.

NOTE 2 – Taking the image task as an example, due to the uncertainty of crowdsourcing data acquisition, the data packets contain redundant data or low-quality invalid data. The crowdsourced resources may detect the redundancy according to the image similarity and remove the redundant sensed data based on the quality evaluation.

7.2.2 Anonymity-related requirements

1)   Depending on the service requirements, the crowdsourced resources are required to support data desensitization and de-identification processing (such as video mosaic, masking and filtering), in order to minimize the information transmitted to the platform.

2)   Depending on the service requirements, the crowdsourced resources are required to obtain an opt-in consent from crowdsourcing participants before collecting any data.

7.2.3 Other requirements

1)   Depending on the service requirements, the crowdsourced resources may provide the crowdsourcing platform with the locations of the IoT devices.

8 Capability framework of IoT-related crowdsourced systems

8.1 Overview

Figure 2 illustrates the capability framework of IoT-related crowdsourced systems, including the mapping of the reference model for IoT-related crowdsourced systems [ITU-T Y.4205] to the IoT reference model [ITU-T Y.4000].
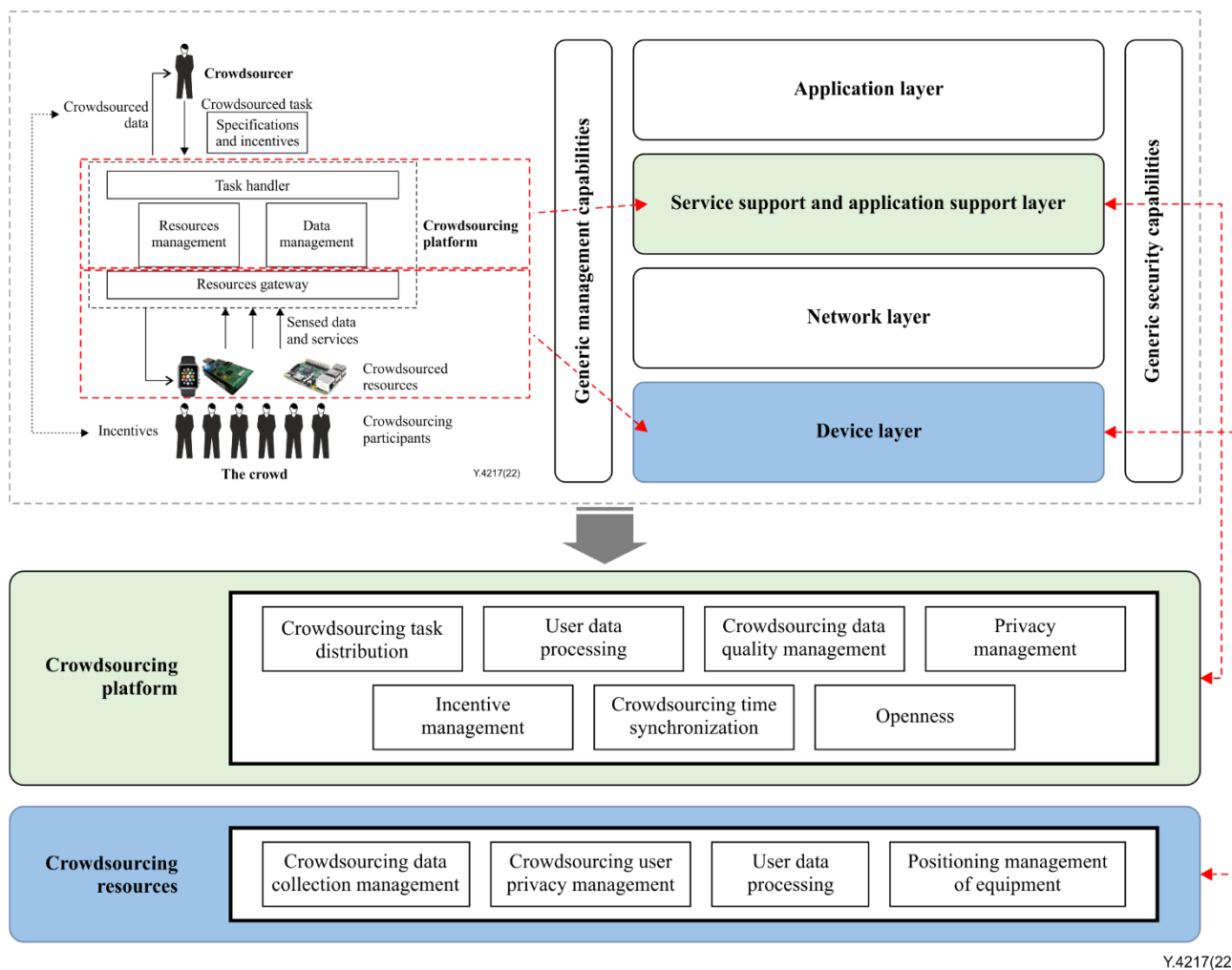
Figure 2 – Capability framework of IoT-related crowdsourced systems

The reference model for IoT-related crowdsourced systems [ITU-T Y.4205] consists of a crowdsourcer, crowdsourcing platform and a crowd.

The IoT reference model [ITU-T Y.4000] consists of an application layer, service support and application support layer, network layer, a device layer, as well as a cross-layer management and security capabilities.

With regard to mapping the reference model for IoT-related crowdsourced systems [ITU-T Y.4205] to the IoT reference model [ITU-T Y.4000], the following applies: the crowdsourcing platform, which includes task handler, resources management and data management, is mapped to the service support and application support layer capabilities; the crowdsourced devices and the resources gateway of the crowdsourcing platform are mapped to the device layer.

8.2 Capabilities of the crowdsourcing platform

8.2.1 Crowdsourcing task distribution capability

In line with the requirements identified in clause 7.1, the following abilities are identified:

1) The crowdsourcing platform enables task distribution by utilizing results from the platform's data analysis capability as the basis.

2)   The crowdsourcing platform enables the management model and related algorithm to count the income and cost of crowdsourcing tasks and coordinates the crowdsourcing resources for participation in the tasks.

3)   The crowdsourcing platform enables the configuration and optimization of crowdsourcing task allocation and decomposition.

8.2.2   Crowdsourcing user data processing capability

In line with the requirements identified in clause 7.1, the following abilities are identified:

1)   The crowdsourcing platform enables the analysis of dynamic and static tasks to improve system performance, including but not limited to the generation of evaluation reports of crowdsourcing services before, during, and after the execution of the crowdsourcing tasks.

2)   The crowdsourcing platform enables the classification of crowdsourcing resources.

NOTE 1 – For example, a vehicle may receive tasks regard to a user experience, and the user experience sub-tasks may include safety, entertainment and driving experience. Therefore, it is necessary to classify crowdsourcing resources into different classes to distribute tasks processing as appropriate.

3)   The crowdsourcing platform enables network topology-based management of the crowdsourcing resources in relation to the data forwarding path.

NOTE 2 – For example, the crowdsourcing platform distributes crowdsourcing tasks through a distributed network. The data may be forwarded several times in a multi-hop network. Therefore, it is necessary to analyse the network topology (star topology, reticular topology, tree topology, etc.), and select the optimal path for task distribution.

4)   The crowdsourcing platform enables the partitioning of the crowdsourcing resources into resource groups or subtasks for task scheduling.

5)   The crowdsourcing platform enables the usage of algorithms for improvement of the computational efficiency of data pre-processing and reduction of the execution time of the crowdsourcing tasks such as authentication and authorization, identity coding, identifier management and data format adaptation.

8.2.3   Crowdsourcing data quality management capability

In line with the requirements identified in clause 7.1, the following abilities are identified:

1)   The crowdsourcing platform enables the evaluation of data quality of crowdsourcing tasks, including but not limited to data volume, data accuracy and data timeliness.

NOTE – The crowdsourcing platform might support applications that are able to evaluate the quality of data uploaded by the participants and reward participants accordingly based on the quality of the data. For example, in the crowdsourcing task of urban particulate matter (PM) 2.5 monitoring, the crowdsourcing participants who provide a more accurate location, time and PM 2.5 concentration data, may receive a higher reward.

2)   The crowdsourcing platform enables the analysis of the impact of the quality of the crowdsourcing tasks execution and provides early warning of crowdsourcing abnormal events, such as false data and task management exceptions.

8.2.4   Privacy management capability

In line with the requirements identified in clause 7.1, the following abilities are identified:

1)   The crowdsourcing platform enables the anonymization of the data uploaded by users to protect the privacy of their users.

NOTE – The crowdsourcing platform may support location-sensitive applications. When completing the crowdsourcing tasks, the user location information may be uploaded to the crowdsourcing platform. After the tasks are completed, the platform deletes the location data immediately.

2) The crowdsourcing platform enables the analysis and verification of the data uploaded by the crowdsourcing resources by data analysis capability in order to avoid a potential risk to the system, such as user privacy data theft.

8.2.5 Crowdsourcing time synchronization capability

In line with the requirements identified in clause 7.1, the following abilities are identified:

1) The crowdsourcing platform enables a crowdsourcing platform to employ a global clock to execute various time synchronization-related tasks.

NOTE 1 – The clock can optionally employ the clock generated by the platform or can be aligned with an external clock.

2) The crowdsourcing platform enables sorting the order of the times of the tasks' completion for tasks with time sequence requirements.

NOTE 2 – For example, the application of an automated guided vehicle (AGV) collaborative control requires multiple AGVs to communicate with a high-precision clock in order to realize collaborative transportation.

8.2.6 Incentive management capability

In line with the requirements identified in clause 7.1, the following abilities are identified:

1) The crowdsourcing platform enables incentive mechanisms to encourage participants to participate in the tasks. These incentives may include different types of rewards.

2) The crowdsourcing platform enables the incentive of direct payment (without a third party) for crowdsourcing participants.

3) The crowdsourcing platform enables the various types of payment for different time-wise participation options, including but not limited to real-time payment for short-term participants, periodic payment for long term or periodic participants and stage payment for contract participants.

4) The crowdsourcing platform enables the utilization of incentive mechanisms to improve the crowdsourcing participation rate within a given payment budget.

8.2.7 Openness capability

In line with the requirements identified in clause 7.1, the following abilities are identified:

1) The crowdsourcing platform enables the crowdsourcing resources to support multiple interfaces, which extend the access to all populations, including people with disabilities, people with age related disabilities and those with specific needs.

2) The crowdsourcing platform enables crowdsourcing tasks to support different types of device terminals, such as mobile phones, tablets and handheld terminals.

3) The crowdsourcing platform supports the interfaces which are compatible with different crowdsourcing resource access methods or different types of devices.

8.3 Capabilities of the crowdsourced resources

8.3.1 Crowdsourcing data collection capability

In line with the requirements identified in clause 7.2, the following abilities are identified:

1) The crowdsourced resources support the obtention of information related to task requirements according to the configuration or the operation of crowdsourcing participants, thus supporting active participation in crowdsourcing tasks.

2) On the premise of user authorization, the crowdsourcing resources collect the IoT-related terminal's information, including identification information, and analyse the information according to the task's requirements automatically.

8.3.2 User privacy management capability

In line with the requirements identified in clause 7.2, the following abilities are identified:

1) The crowdsourced resources support anonymity management for the privacy of users participating in crowdsourcing tasks.

2) The crowdsourced resources support the analysis and verification of the authenticity of the resources from the resources' data processing capability, thus avoiding potential safety issues to the system.

8.3.3 Data processing capability

In line with the requirements identified in clause 7.2, the following abilities are identified:

1) The crowdsourced resources used by crowdsourcing participants support computing, storage, and communication functionalities, including for support of direct processing of the collected data.

2) The crowdsourcing resources support low-power consumption processing capabilities in order to support applications that are sensitive to the energy consumption of data sensing and uploading.

8.3.4 Positioning management capability

In line with the requirements identified in clause 7.2, the following abilities are identified:

1) The crowdsourcing resources support location positioning and tracking, in order to support the acquisition of location information to meet the requirements of applications' accuracy.

NOTE – These abilities should be restricted to devices that are not associated with any individuals (e.g., personal devices), and/or which could be used to identify an individual.

SERIES OF ITU-T RECOMMENDATIONS

Series A	Organization of the work of ITU-T
Series D	Tariff and accounting principles and international telecommunication/ICT economic and policy issues
Series E	Overall network operation, telephone service, service operation and human factors
Series F	Non-telephone telecommunication services
Series G	Transmission systems and media, digital systems and networks
Series H	Audiovisual and multimedia systems
Series I	Integrated services digital network
Series J	Cable networks and transmission of television, sound programme and other multimedia signals
Series K	Protection against interference
Series L	Environment and ICTs, climate change, e-waste, energy efficiency; construction, installation and protection of cables and other elements of outside plant
Series M	Telecommunication management, including TMN and network maintenance
Series N	Maintenance: international sound programme and television transmission circuits
Series O	Specifications of measuring equipment
Series P	Telephone transmission quality, telephone installations, local line networks
Series Q	Switching and signalling, and associated measurements and tests
Series R	Telegraph transmission
Series S	Telegraph services terminal equipment
Series T	Terminals for telematic services
Series U	Telegraph switching
Series V	Data communication over the telephone network
Series X	Data networks, open system communications and security
Series Y	**Global information infrastructure, Internet protocol aspects, next-generation networks, Internet of Things and smart cities**
Series Z	Languages and general software aspects for telecommunication systems