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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

Use cases, requirements and capabilities of unmanned aircraft systems for the Internet of things

Recommendation ITU-T Y.4215

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Recommendation ITU-T Y.4215

Use cases, requirements and capabilities of unmanned aircraft systems for the Internet of things

Summary

Recommendation ITU-T Y.4215 describes the use cases, requirements and capabilities of unmanned aircraft systems (UASs) for the Internet of things (IoT).

According to different wireless communication scenarios, the use cases are classified into four categories: UAS-aided offloading, UAS-aided emergency response, UAS-aided relaying and UAS-aided information dissemination and data collection.

Common and specific requirements and capabilities of UASs for IoT support of the different use cases are described in this Recommendation.

History

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Recommendation ITU-T Y.4215

Use cases, requirements and capabilities of unmanned aircraft systems for the Internet of things

1 Scope

This Recommendation describes the use cases, requirements and capabilities of unmanned aircraft systems (UASs) for the Internet of things (IoT). UASs can act as a key part of IoT as wireless communication platforms in IoT. The use cases are specified according to different communication scenarios. The requirements and capabilities are also specified based on the different use cases.

This Recommendation covers the following:

– Classification of the use cases of UAS-aided communication;

– Common and specific requirements of UASs for IoT;

– Common and specific capabilities of UASs for IoT.

Use cases of UAS for IoT are provided in the appendix.

Regulation and supervision of UASs are out of the scope of this Recommendation.

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 device [b-ITU-T Y.4000]: With regard to the Internet of things, this is a piece of equipment with the mandatory capabilities of communication and the optional capabilities of sensing, actuation, data capture, data storage and data processing.

3.1.2 gateway [b-ITU-T Y.4101]: A unit in the Internet of things which interconnects the devices with the communication networks. It performs the necessary translation between the protocols used in the communication networks and those used by devices.

3.1.3 Internet of things [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.

3.1.4 service [b-ITU-T Y.2091]: A set of functions and facilities offered to a user by a provider.

3.1.5 unmanned aircraft system (UAS) [b-ICAO]: An aircraft and its associated elements which are operated with no pilot on board.

3.2 Terms defined in this Recommendation

None.

4 Abbreviations and acronyms

This Recommendation uses the following abbreviations and acronyms:

IoT Internet of Things

UAS Unmanned Aircraft System

5 Conventions

In this Recommendation:

– The keywords "is required to" indicate a requirement that must be strictly followed and from which no deviation is permitted if conformance to this document is to be claimed.

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

– The keywords "can optionally" and "may" indicate an optional requirement that is permissible, without implying any sense of being recommended. These terms are 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 the specification.

6 Introduction of UAS for IoT

The IoT is a global infrastructure that interconnects (physical and virtual) things and has the fundamental characteristics of interconnectivity and on an enormous scale [b-ITU-T Y.4000]. UASs can act as a key part in wireless communication platforms to support the interconnection in IoT with the advantage of high mobility, easy deployment, and low cost.

This Recommendation describes the requirements and capabilities of UAS for IoT.

The use cases of UAS for IoT, according to which the requirements and capabilities are identified, are provided in the appendix. UASs can be used for computing offloading, emergency response, communication relaying, information dissemination and data collection for IoT.

7 Requirements of UASs for IoT

In this clause, the requirements of UASs for IoT are described taking into consideration the use cases described in the appendix. Clause 7.1 and clause 7.2 respectively provide common requirements of UASs for IoT as well as specific requirements of UASs in different use cases for IoT.

7.1 Common requirements of UASs for IoT

The common requirements of UASs for IoT are as follows.

– The UASs are required to provide wireless communication links for IoT devices and IoT networks. For example, in some delay constraint scenarios, the UASs must keep real-time communication with IoT devices.

– The UASs are recommended to locate itself accurately, e.g., during flight altitude and geographic position.
– The UASs are required to support energy-efficiency management strategies to guarantee flight endurance, including for, but not limited to, communication purposes.
– The UASs are recommended to support the capability to store, process and compress data.
– The UASs are required to take into account the confidentiality, integrity and availability of the data, including during the period that UASs provide communication links for IoT devices. The data includes the transmission data between UASs and IoT devices, and the stored data carried by the UASs.
– The UASs are required to mitigate communication interference from other UASs which are deployed in the same frequency band.

7.2 Specific requirements of UASs for IoT

7.2.1 Requirements of UASs for IoT in UAS-aided offloading

The following are specific requirements of UASs for IoT in UAS-aided offloading.

– The UASs are required to support high bandwidth communication for data receiving and transmitting.
– The UASs are recommended to support capabilities to plan optimal trajectory.

NOTE – The UASs should maintain good communication links, e.g., line of sight communications by planning its trajectory intelligently.

7.2.2 Requirements of UASs for IoT in UAS-aided emergency response

The following are specific requirements of UASs for IoT in UAS-aided emergency response.

– The UASs are required to provide low-latency and high reliable communications.
– The UASs are required to support rapid configuration in emergency situations.

7.2.3 Requirements of UASs for IoT in UAS-aided relaying

The following are specific requirements of UASs for IoT in UAS-aided relaying.

– The UASs are recommended to keep reliable communications with specific IoT devices.

NOTE – In UAS-aided relaying, the UASs provide communication links for two devices or device groups that have no direct communication links between each other. Thus, it is necessary for the UASs to provide reliable communications for these specific devices. The UASs must also be equipped with an equipment, such as a directional antenna to provide reliable links for specific devices.

7.2.4 Requirements of UASs for IoT in UAS-aided information dissemination and data collection

The following are specific requirements of UASs for IoT in UAS-aided information dissemination and data collection.

– The UASs are required to receive and forward the data between the nodes.

8 Capabilities of UASs for IoT

8.1 Common capabilities of UASs for IoT

The common capabilities of UASs for IoT are as follows.

– Wireless communication capability: Wireless communication capability provides the communication links between IoT devices and UASs and the communication links between UASs and IoT networks.

– Locating capability: Locating capability enables UASs to locate themselves accurately. Locating capability helps the UASs to find an appropriate position to provide communication links with maximum allowable quality.
– Energy-efficient management capability: Energy-efficient management capability enables UASs to perform the communications tasks with energy-efficient communication schemes under flight constraints.
– Data management capability: Data management capability enables UASs to take actions such as processing, compressing, storing, and enabling confidentiality, availability and integrity of the data that is received from the IoT devices.
– Interference mitigation capability: Interference mitigation capability enables UASs to receive the data from the IoT devices in their coverage with little interference from non-associated IoT devices. Interference mitigation capability also provides the ability for the UASs to distinguish the signals from different devices.

8.2 Specific capabilities of UASs for IoT

8.2.1 Capabilities of UASs for IoT in UAS-aided offloading

– High bandwidth transmission capability: High bandwidth transmission capability enables UASs to support the receiving and transmission of large volumes of data between UASs and IoT networks.
– Trajectory planning capability: Trajectory planning capability enables UASs to adaptively optimize the flight path in order to maintain the communication links between UASs and IoT devices.

8.2.2 Capabilities of UASs for IoT in UAS-aided emergency response

– Fast connection establishment capability: Fast connection establishment capability enables the UASs to establish communication links between IoT devices and IoT network in real-time. Fast connection establishment capability guarantees communication efficiency and reliability.

8.2.3 Capabilities of UASs for IoT in UAS-aided relaying

– Dynamic routing capability: Dynamic routing capability enables UASs to maintain a wireless connection between two or more IoT devices without direct communication links.

8.2.4 Capabilities of UASs for IoT in UAS-aided information dissemination and data collection

– Data receiving capability: Data receiving capability enables the data acquisition from IoT devices. Data receiving capability guarantees the delivery of information.
– Data forwarding capability: Data forwarding capability enables UASs to transmit data to other nodes (including UASs and IoT devices). Data forwarding capability also provides the ability to collect data from IoT devices to IoT network.

Appendix I

Use cases of UAS for IoT

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

I.1 UAS-aided offloading

When the existing communication infrastructures cannot provide qualified services, the communication requirements cannot be satisfied. For example, when massive IoT devices attempt to access the IoT network (e.g., reboot after a power outage), the burden of terrestrial access infrastructures (e.g., base stations in a cellular network) are so high that the access attempts cannot be handled in a timely manner. UASs can provide communication capability between IoT devices and the IoT network to realize offloading. The use case of UAS-aided offloading is shown in Figure I.1.

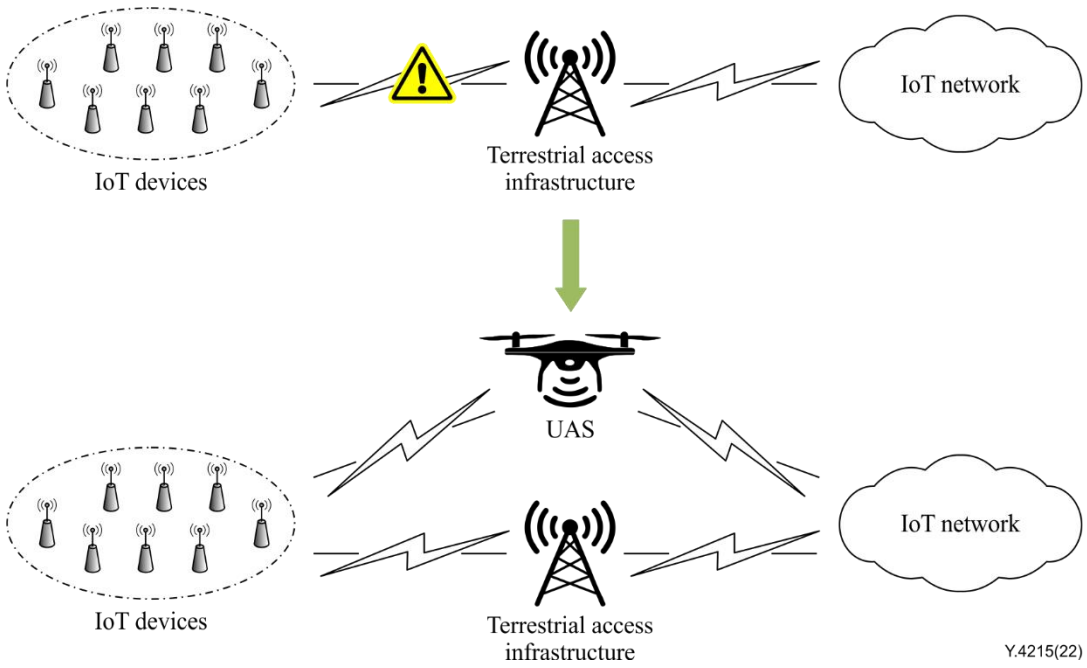

Figure I.1 – UAS-aided offloading

I.2 UAS-aided emergency response

After disasters, terrestrial access infrastructures encounter malfunctions or damages. Under these circumstances, the IoT devices have no available paths to access the IoT network. This is when UASs provide temporary communication links between IoT devices and the IoT network. The use case of UAS-aided emergency response is shown in Figure I.2.

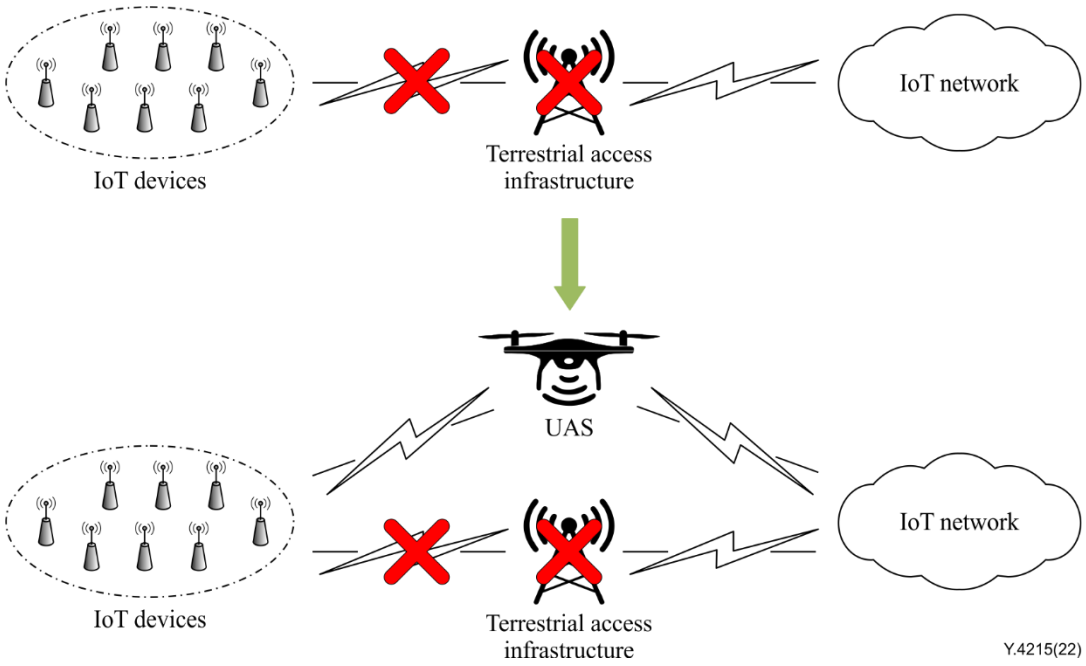

Figure I.2 – UAS-aided emergency response

I.3 UAS-aided relaying

Due to the impact from some obstacles (e.g., high mountains), reliable direct communication links between some IoT devices cannot be established. In this case, UASs can be used to provide wireless connectivity between two or more devices or between device groups. The use case of UAS-aided relaying is shown in Figure I.3.

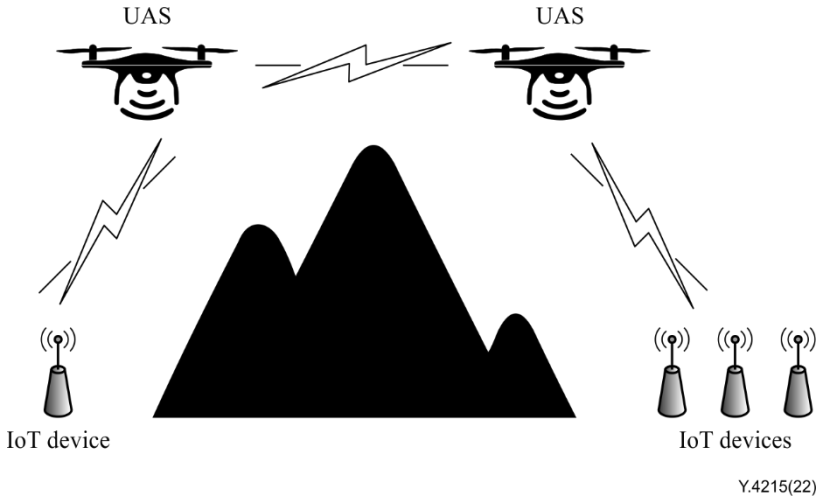

Figure I.3 – UAS-aided relaying

I.4 UAS-aided information dissemination and data collection

IoT devices are widely used and densely deployed in various industries. Some IoT devices cannot be covered by the IoT network due to some constraints (e.g., geographic factors or costs). Under these circumstances, the information from the IoT network can be disseminated to the IoT devices located under constraints by UASs. The data that is collected from these IoT devices can also be sent later to the IoT network by the UASs. The use case of information dissemination and data collection can be realised via a sequence of UAS repeaters as shown in Figure I.4.

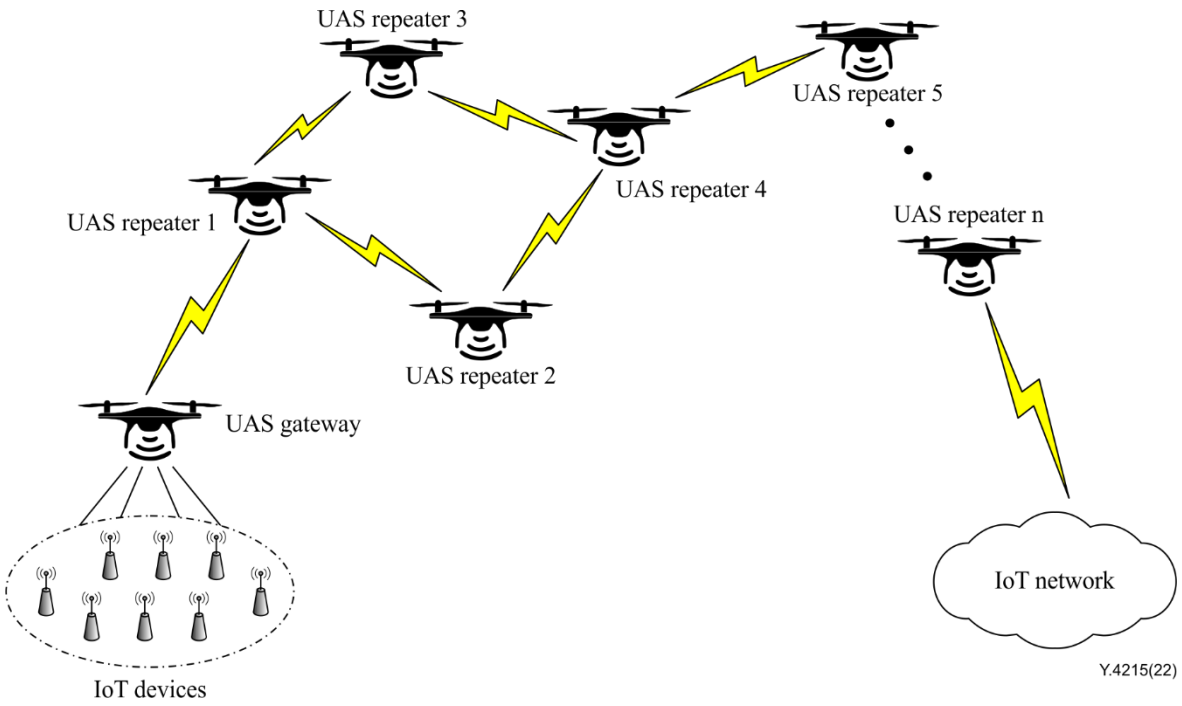

Figure I.4 – UAS-aided information dissemination and data collection

NOTE – This use case implies the management of location information of the various UAS repeaters for patch communication management.

Depending on the IoT devices type and the data generated by them, the connection between IoT devices and the IoT network can be classified as a real-time or a delay-tolerant data transmission network [b-Fall]. The data transfer from the IoT device to the IoT network is considered to happen via multi-hop routing. UASs work as repeater nodes which provide the capability of effective information transmission. The use of such a transmission method may assist data to be transmitted over long distances. Depending on the requirements for QoS, e.g., latency and throughput, the number of intermediate nodes may vary.

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