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SERIES Q: SWITCHING AND SIGNALLING, AND ASSOCIATED MEASUREMENTS AND TESTS

Testing specifications – Testing specifications for next generation networks

The architecture and facilities of a model network for Internet of things testing

Recommendation ITU-T Q.3952

International Telecommunication Union

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Recommendation ITU-T Q.3952

The architecture and facilities of a model network for Internet of things testing

Summary

ITU-T has been discussing the concept of a model network since 2006.

The first Recommendation approved on this subject, ITU-T Q.3900 (2006) "Methods of testing and model network architecture for NGN technical means testing as applied to public telecommunication networks" became the basic standard for next generation network (NGN) testing.

Afterwards, there was a discussion on the global interoperability concept as the next step of the testing methodology for NGN networks. The global interoperability includes technical means interoperability, interoperability of services and interoperability of networks for providing the guaranteed level of QoS. The set of Recommendations, which are based on the model network and global interoperability concepts, were developed during study periods 2005-2008, 2009-2012 in collaboration with experts from Russia, Austria, China, Japan, Korea, Poland (e.g., Recommendations ITU-T Q.3900, ITU-T Q.3904, ITU-T Q.3906.1, ITU-T Q.3945, etc.).

The same concept can be used for IoT testing. Therefore, Recommendation ITU-T Q.3952 describes the architecture and facilities of a model network for Internet of things (IoT) testing.

History

Edition	Recommendation	Approval	Study Group	Unique ID*
1.0	ITU-T Q.3952	2018-01-13	11	11.1002/1000/13489

Keywords

IoT, model network, testing.

* 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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Recommendation ITU-T Q.3952

The architecture and facilities of a model network for Internet of things testing

1 Scope

Testing of Internet of things (IoT) technologies requires a specific model network that can simulate different scenarios of IoT implementations. This Recommendation defines the architecture of model networks to be used for IoT testing.

2 References

The following ITU-T Recommendations and other references contain provisions which, through references 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 Q.3900] Recommendation ITU-T Q.3900 (2006), *Methods of testing and model network architecture for NGN technical means testing as applied to public telecommunication networks*.

[ITU-T Q.3950] Recommendation ITU-T Q.3950 (2011), *Testing and model network architecture for tag-based identification systems and functions*.

[ITU-T X.1311] Recommendation ITU-T X.1311 (2011) | ISO/IEC 29180:2012, *Information technology – Security framework for ubiquitous sensor networks*.

[ITU-T Y.4000] Recommendation ITU-T Y.4000/Y.2060, *Overview of Internet of things*.

[ITU-T Y.4050] Recommendation ITU-T Y.4050/Y.2069, *Terms and definitions for the Internet of things*.

3 Definitions

None.

4 Abbreviations and acronyms

This Recommendation uses the following abbreviations and acronyms:

FUSN Flying Ubiquitous Sensor Network

IoT Internet of Things

QoS Quality of Service

SDN Software-Defined Networking

UWB Ultra Wide Band

5 Conventions

None.

6 Model network architecture

The model network is aimed at testing [ITU-T Q.3900], [ITU-T Q.3950]:

– prototypes of IoT-devices based on microcontrollers, as well as single-board computers based on proprietary and open hardware platforms;

– interoperability of IoT-based devices;

– wireless sensor networks (including mobile and fixed nodes);

– indoor location systems based on wireless technologies and ultra wide band (UWB) technology.

On the basis of an extensive list of sensors, actuators and devices, the model network enables to develop benches for testing applications of the Internet of things.

Stress testing and benchmarking of the IoT-devices both wired and wireless on the model network is performed using a software package for generating test network traffic for different scenarios. Specialized client software is installed in the software modules and communications, and is controlled by commands from the central console, which is installed on the web server.

NOTE – There are well-known:

– wireless specifications: WiFi, ZigBee, Z-Wave, 6LoWPAN, RPL, Bluetooth, Thread, GSM/GPRS/EDGE (2G), UMTS/HSPA (3G), LTE (4G, including LTE-M), NFC, Sigfox, LoRa, LoRaWAN, NB-IoT *et al*;

– wired specification: Ethernet.

The technical facilities (e.g., measurement equipment, core network, benchmarking systems, etc.) of the model network need to be used for simulating different sensor networks and performing different tests at all levels of OSI-model.

The model network may include different technical solutions and may be used for different types of measurement, e.g., subsequent analysis of the network traffic, etc. The common model network structure is shown in Figure 1.

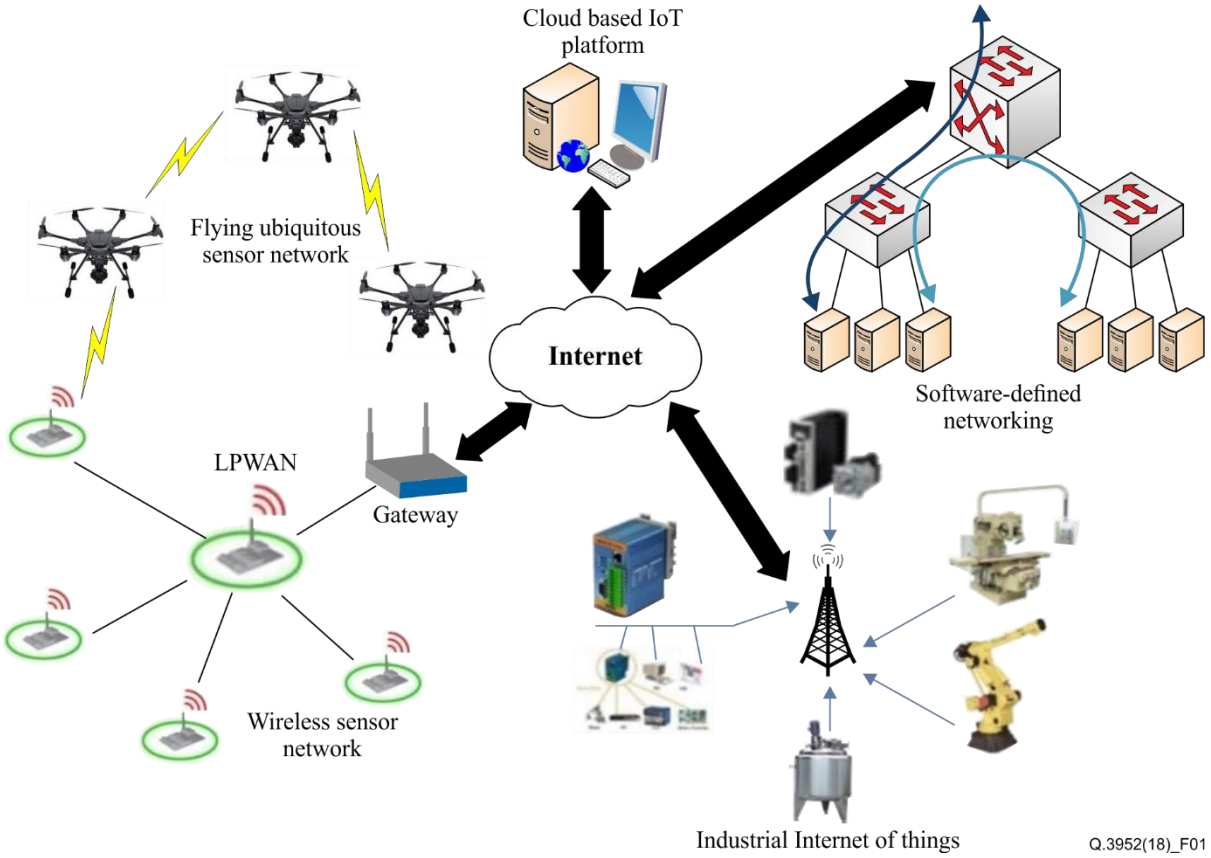

Figure 1 – The structure of the model network

According to Figure 1, the model network is based at least on five interconnected segments and enables the possibility to emulate scenarios of intersegment interconnection and D2D communication, considered within the concept of 5G network (IMT-2020), as follows:

– Segment 1: The architecture of a wireless sensor network is based on the self-organizing network using the chain endpoint–router–controller. The aim of this segment is to study the following issues: power saving of different objects, network security, clustering, administration of data exchange, to name a few.

– Segment 2: Flying ubiquitous sensor network (FUSN) is a floating segment of the model network (e.g., a quadrocopter-based network) that is used to collect and transfer data from floating sensors to the public communication network. The aim of the segment is to study the following issues: lifecycle of services, optimal routes/paths to gather data from different sensors and electromagnetic interference among different network nodes, to name a few.

– Segment 3: Industrial Internet of things is a segment of the model network that is used to test the interaction of industrial equipment via the Internet. The aim of this segment is to assess, analyse and study the following issues: network performance parameters (e.g., latency, packet loss, jitter, etc.), operation and management of cloud servers used for IoT devices, and failures and malfunctions of the industrial equipment.

– Segment 4: The SDN-based segment of the model network may be used for studying the interoperability of IoT-oriented protocols, interconnection of IoT-SDN-based networks with the public communication network, and benchmark testing of SDN-controller. SDN technology is one of the solutions to be used for resource management of IoT-based networks. According to the concept of SDN network virtualization the control plane of a network device is separated from the data plane. This provides the balance between the centralized control through SDN-controller and decentralized operations, such as routing

flow. SDN enables strict requirements for quality of service for the maximum possible number of threads (QoS requirements for the new thread without violating the requirements for existing streams) and ensures maximum utilization of the network.

– Segment 5: Cloud IoT-platform is used for providing IoT–based services (e.g., "IoT University Solution"). It aims to establish a user-friendly interface for giving access to a particular IoT-device. For example, the platform "IoT University" enables organization of interaction between devices and applications on basis of well-known IoT protocols. This segment may be used for developing different IoT-based applications and applications to be used for cloud analysis of big data.

The model network should allow to study and test wireless and wired technologies to be used in IoT-based networks.

The model network should at least include the following key elements:

– core network with at least two transit nodes, simulating architecture of the existing public telecommunication networks or the local area networks (preferably to use equipment provided by different vendors);

– communication network in the allocated model network with an ability to use different techniques, given the use of equipment from different manufacturers;

– servers simulating traffic of public telecommunication networks;

– toolkit for developing prototypes of IoT-devices based on different technologies (wired and wireless);

– a set of measuring equipment (e.g., traffic analyser, benchmarking system, payload simulator, etc.) connected to the core of the model network through the allocated channel;

– operation support system, which provides monitoring of technical facilities of model networks and overall network management;

– testing management system whose aim is to set up test scripts, generate traffic flows, create and store the intermediate testing results and develop test reports, to name a few;

– SDN-controller and relevant nodes providing integrated management model network segments.

The block diagram of the base part of the model network is shown in Figure 2.

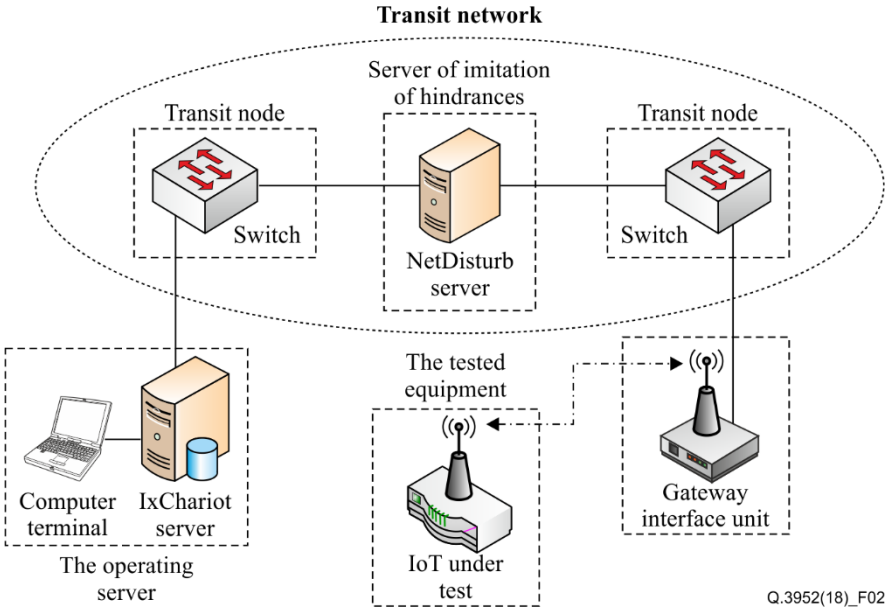

Figure 2 – Block diagram of the base part model network

It should be noted that this diagram shows only one of the possible options of the model network's basic part.

In order to ensure maximum reliability of the test or that the architecture of the model network is the architecture of the customer's network, it is possible to quickly reconfigure the network to include additional components of the composition of its elements, and redistributing traffic flows.

In the development of testing methods it is advisable to follow the reference model of the IoT-devices, the proposed [ITU-T Y.4000], [ITU-T Y.4050].

This model includes four layers:

– application layer;
– support services and application support layer;
– network layer;
– device layer.

7 Technologies and services to be tested on the model network

The model network should enable to test wireless and wired technologies uses in IoT devices.

The model network should enable testing of services and network performance parameters for the following applications of the Internet of things:

– Ubiquitous sensor networks;
– Medical network (Body area network);
– Flying ubiquitous sensor networks;
– Telemetry system;
– Smart home system.

8 Types of testing to be applied on the model networks

The following types of testing is to be applied on the model network for IoT tests:

– Conformance;
– Interoperability;
– Stress test;
– Benchmarking;
– Data analysis and IoT traffic management;
– Security testing [ITU-T X.1311].

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