International Telecommunication Union

ITU-T

TELECOMMUNICATION
STANDARDIZATION SECTOR
OF ITU

Q.4060

(10/2018)

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

Testing specifications – Testing specifications for IMT-2020 and IoT

The structure of the testing of heterogeneous Internet of things gateways in a laboratory environment

Recommendation ITU-T Q.4060

ITU-T Q-SERIES RECOMMENDATIONS

SWITCHING AND SIGNALLING, AND ASSOCIATED MEASUREMENTS AND TESTS

SIGNALLING IN THE INTERNATIONAL MANUAL SERVICE	Q.1–Q.3
INTERNATIONAL AUTOMATIC AND SEMI-AUTOMATIC WORKING	Q.4–Q.59
FUNCTIONS AND INFORMATION FLOWS FOR SERVICES IN THE ISDN	Q.60–Q.99
CLAUSES APPLICABLE TO ITU-T STANDARD SYSTEMS	Q.100–Q.119
SPECIFICATIONS OF SIGNALLING SYSTEMS No. 4, 5, 6, R1 AND R2	Q.120–Q.499
DIGITAL EXCHANGES	Q.500–Q.599
INTERWORKING OF SIGNALLING SYSTEMS	Q.600–Q.699
SPECIFICATIONS OF SIGNALLING SYSTEM No. 7	Q.700–Q.799
Q3 INTERFACE	Q.800–Q.849
DIGITAL SUBSCRIBER SIGNALLING SYSTEM No. 1	Q.850–Q.999
PUBLIC LAND MOBILE NETWORK	Q.1000–Q.1099
INTERWORKING WITH SATELLITE MOBILE SYSTEMS	Q.1100–Q.1199
INTELLIGENT NETWORK	Q.1200–Q.1699
SIGNALLING REQUIREMENTS AND PROTOCOLS FOR IMT-2000	Q.1700–Q.1799
SPECIFICATIONS OF SIGNALLING RELATED TO BEARER INDEPENDENT CALL CONTROL (BICC)	Q.1900–Q.1999
BROADBAND ISDN	Q.2000–Q.2999
SIGNALLING REQUIREMENTS AND PROTOCOLS FOR THE NGN	Q.3000–Q.3709
SIGNALLING REQUIREMENTS AND PROTOCOLS FOR SDN	Q.3710–Q.3899
TESTING SPECIFICATIONS	Q.3900–Q.4099
Testing specifications for next generation networks	Q.3900–Q.3999
Testing specifications for SIP-IMS	Q.4000–Q.4039
Testing specifications for Cloud computing	Q.4040–Q.4059
Testing specifications for IMT-2020 and IoT	**Q.4060–Q.4099**
SIGNALLING REQUIREMENTS AND PROTOCOLS FOR IMT-2020	Q.5000–Q.5049
COMBATING COUNTERFEITING AND STOLEN ICT DEVICES	Q.5050–Q.5069

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

Recommendation ITU-T Q.4060

The structure of the testing of heterogeneous Internet of things gateways in a laboratory environment

Summary

The architecture of new networks is mostly based on a heterogeneous structure. One of the key issues of such networks is the integration of various network technologies into one Internet protocol (IP) environment.

In this regard, there is a need to use a gateway (Recommendation ITU-T Y.4000/Y.2060) which may be located between different technological segments of the network. The gateway will be used as an intermediary point which transfers messages from one network segment to another. In general, this gateway may be used as a point of traffic aggregation among Internet of things (IoT) devices to be used to interconnect different segments of a network.

This Recommendation describes the testing methodology of the heterogeneous network gateway which is to be used for communication among IoT devices. The tests will include the following, but not limited to:

- checking the gateway to verify stress load (benchmarking)
- checking the gateway to determine the possibility for the transmission of various types and sizes of frames and (or) packages;
- verifying joint conversions from different protocols and multiple interfaces;
- checking the gateway operation settings (CPU, RAM, etc.); and
- checking the network parameters (delay, data loss, etc.).

History

Edition	Recommendation	Approval	Study Group	Unique ID*
1.0	ITU-T Q.4060	2018-10-14	11	11.1002/1000/13700

Keywords

Gateway, heterogeneous, Internet of things, 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.

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, 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 TSB patent database at http://www.itu.int/ITU-T/ipr/.

Table of Contents

Recommendation ITU-T Q.4060

The structure of the testing of heterogeneous Internet of things gateways in a laboratory environment

1 Scope

This Recommendation describes the testing methodology of the heterogeneous network gateway which is to be used for communication among IoT devices. The tests will include the following, but not limited to:

- checking the gateway to verify stress load (benchmarking);
- checking the gateway to determine the possibility for the transmission of various types and sizes of frames and (or) packages;
- verifying joint conversions from different protocols and multiple interfaces;
- checking the gateway operation settings (CPU, RAM, etc.); and
- checking the network parameters (delay, data loss, etc.).

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 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), *Information technology – Security framework for ubiquitous sensor networks*.

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

[ITU-T Y.4050] Recommendation Y.4050/Y.2069 (2012), *Terms and definitions for 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.4101] Recommendation ITU-T Y.4101/Y.2067 (2017), *Common requirements and capabilities of the gateway for Internet of things applications*.

[ITU-T Y.4400] Recommendation ITU-T Y.4400/Y.2063 (2012), *Framework of the web of things*.

3 Definitions

3.1 Terms defined elsewhere

This Recommendation uses the following terms defined elsewhere:

3.1.1 device [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 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.

3.2 Terms defined in this Recommendation

This Recommendation defines the following terms:

3.2.1 heterogeneous gateway (HG): A computer appliance system used for the communication of IoT devices between each other and with remote IoT servers.

3.2.2 IoT gateway infrastructure (IoT GI): A computer appliance system used for the provision of network technology compatibility, and which consists of a hardware computing system, network interfaces, an operational system and an emulation/virtualization system.

3.2.3 semantic IoT gateway (SIoTG): A software system that is used for conversion between various IoT protocols, applications and services and is included in heterogeneous gateway systems.

4 Abbreviations and acronyms

This Recommendation uses the following abbreviations and acronyms:

6LoWPAN	IPv6 over Low power Wireless Personal Area Networks
AMQP	Advanced Message Queuing Protocol
CoAP	Constrained Application Protocol
CPU	Central Processor Unit
DDS	Data Distribution Service
GI	Gateway Infrastructure
HG	Heterogeneous Gateway
HTTP	Hypertext Transfer Protocol
IoT	Internet of things
IP	Internet Protocol
MQTT	Message Queue Telemetry Transport
NI	Network Interface
OS	Operation System
RAM	Random Access Memory
RF	Radio Frequency
SCTP	Stream Control Transmission Protocol
SIoTG	Semantic Internet of Things Gateway
UDP	User Datagram Protocol

TCP	Transport Control Protocol
XMPP	Extensible Messaging and Presence Protocol
WSN	Wireless Sensor Network

5 Conventions

None.

6 Gateway structure

Gateways in heterogeneous networks are a key element that allow the combination of different network topologies and technologies in a single network. An example of such a gateway in a heterogeneous network is shown in Figure 1.

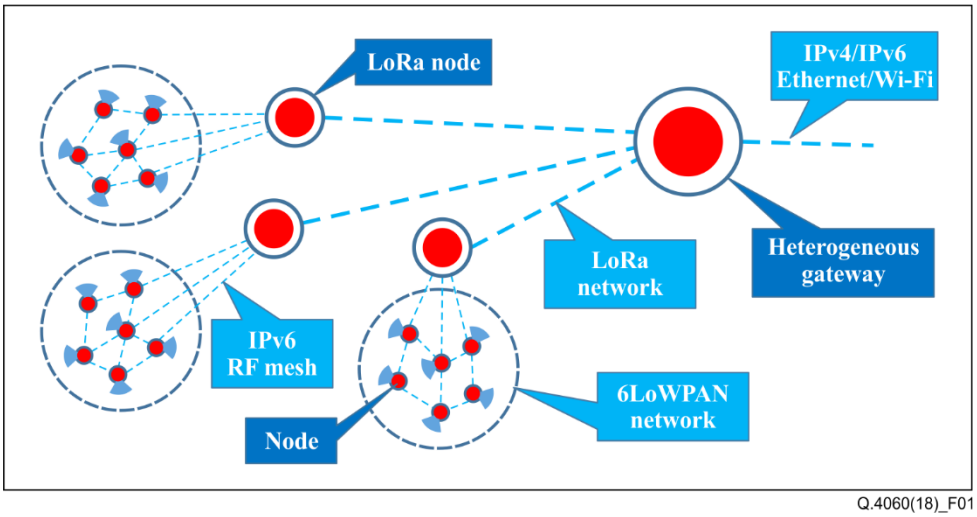

Figure 1 − Example of a gateway in a heterogeneous network

IoT gateways include support for various IoT services operating in the application layer. Such devices are called semantic IoT gateways (SIoTGs).

Semantic IoT gateways are software systems intended to ensure network connectivity of various IoT services in the application layer. The main purpose of a semantic gateway is to effect conversion between applied IoT protocols and allow interoperability with external IoT services (e.g., priority services, private services).

An example of a network model for the heterogeneous gateway using a semantic IoT gateway is shown in Figure 2.

The heterogeneous gateway uses emulation or virtualization systems for additional protocols, applications, and services management. The structure of the heterogeneous gateway is shown in Figure 3.

Emulation/virtualization and network interface control systems are used for communication between IoT protocols, applications, services in the semantic IoT gateway part and an operation system (OS), and hardware in the IoT infrastructure part.

An IoT gateway architecture using a semantic IoT gateway is shown in Figure 2.

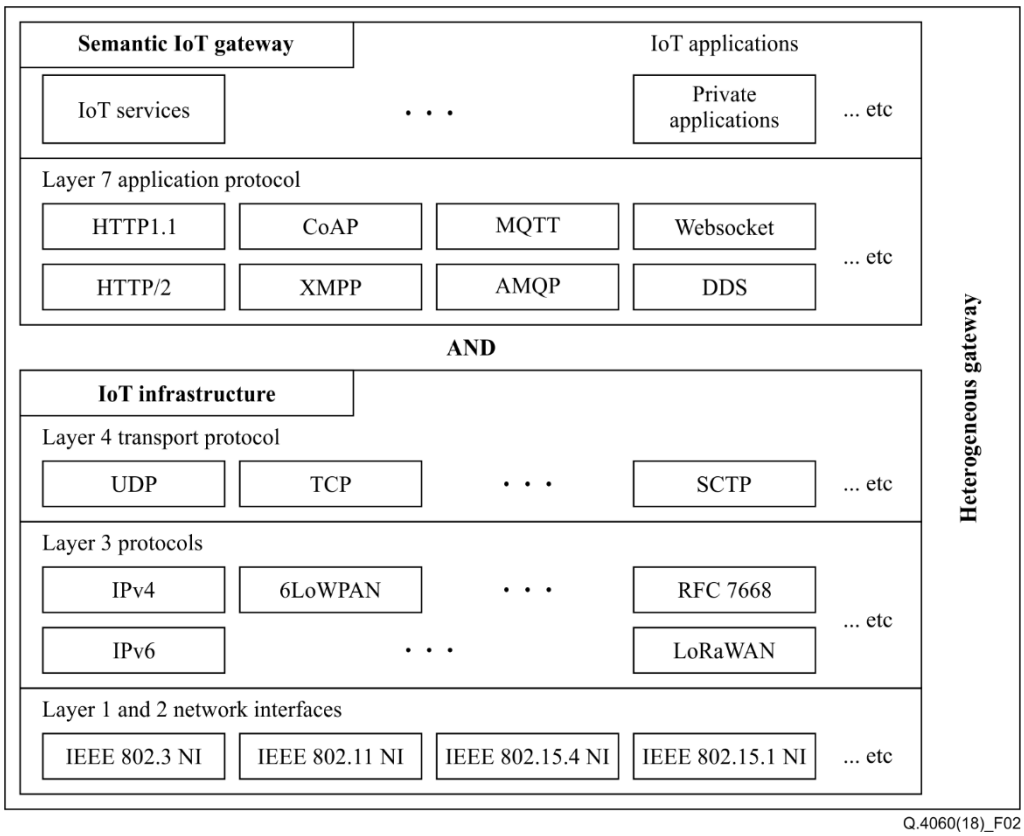

Figure 2 – Functional architecture of an IoT gateway using a semantic IoT gateway

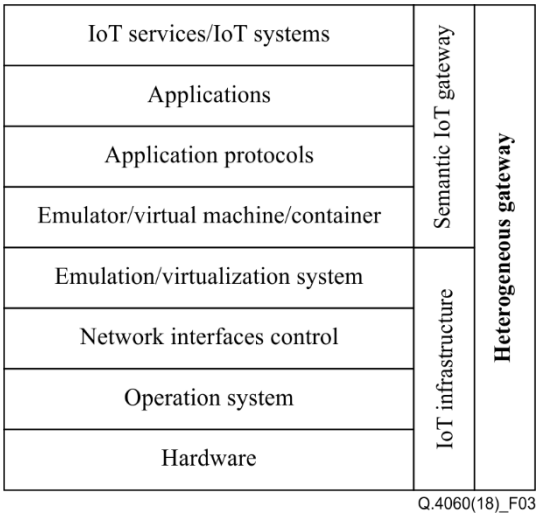

Figure 3 − Structure of heterogeneous gateway

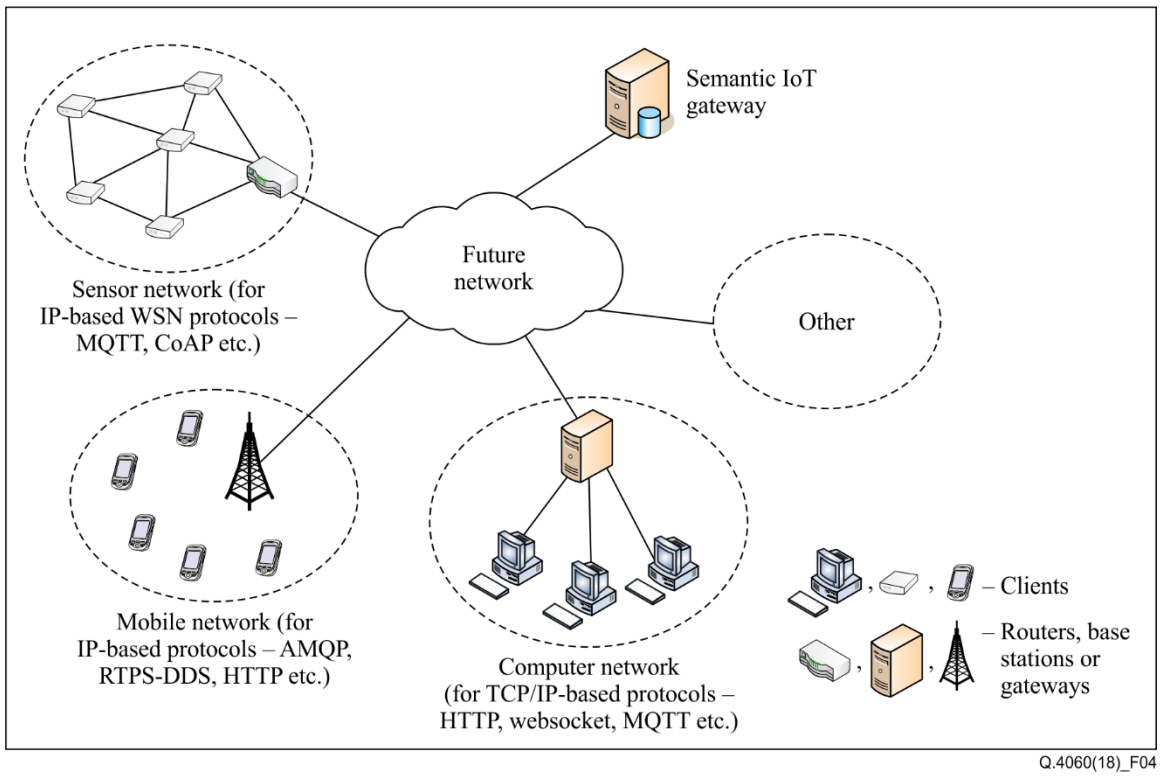

Figure 4 – Example of inter-protocol communication via future network using semantic gateways

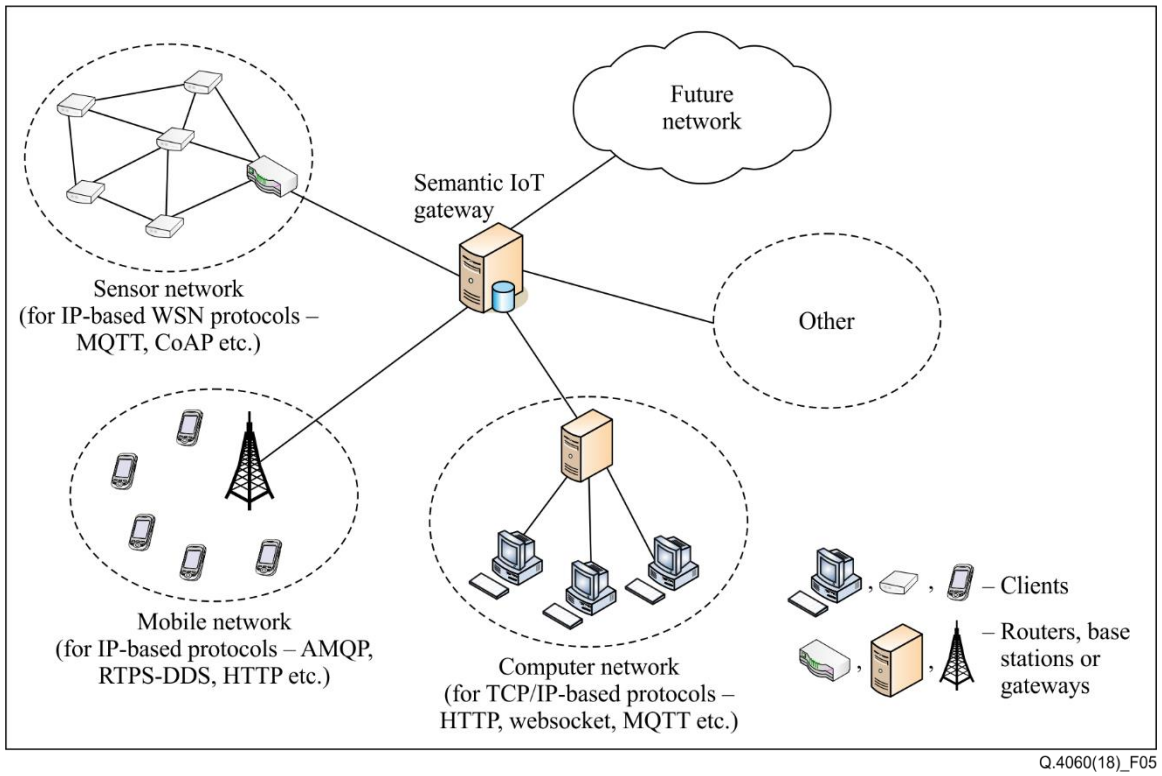

Figure 5 – Example using a semantic gateways scheme to construct local networks

Semantic IoT gateways can be used to organize various types of communication networks:

- to connect various IoT Internet services based on different application protocols (Figure 4);

- to connect devices based on different application protocols located in the local network (Figure 3).

7 Testing procedure

The testing procedure consists of several sequential steps:

- checking the gateway to verify stress load (benchmarking);
- checking the gateway to determine the possibility for the transmission of various types and sizes of frames and (or) packages;
- verifying joint conversions from different protocols and multiple interfaces [ITU-T Y.4000];
- checking gateway operation settings (CPU, RAM, etc.); and
- checking the network parameters (delay, data loss, etc.).

8 General description of the gateway testing

Gateway testing consists of measuring the performance of each protocol conversion process. The criteria to measure performance are basically:

- time of conversion (ms);
- losses (%);
- CPU load (%);
- RAM load (%);
- confirmation of technological compatibility; and
- failover and recovery testing (failures per time/recovery time).

Variable parameters of testing are:

- different protocols;
- packet size;
- packets rate; and
- the amount of streams.

A typical gateway test configuration is shown in Figure 6.

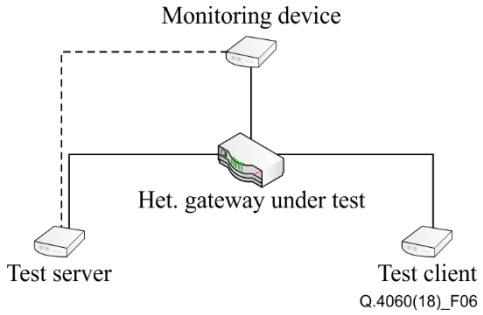

Figure 6 – Typical gateway test configuration

As shown in Figure 6, the gateway test is to connect the device, creating a test flow of network traffic and device analysis. An analysis device (monitoring) is connected to the gateway through the interface and monitors gateway operation settings. Optionally, the analysis device may have a connection to the test server feedback.

9 Assessment criteria for a heterogeneous gateway

The heterogeneous gateway has to satisfy the requirements described in [ITU-T Y.4101] based on the following assessment criteria:

– scalability;
– addressing;
– Openness to functional extensions;
– quality of service;
– communication aspects;
– protocol diversity support;
– uniformity of interactions;
– device and service discovery;
– service management;
– device identifier management;
– storage;
– security and confidentiality;
– self-management and remote maintenance.

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

Printed in Switzerland
Geneva, 2018