International Telecommunication Union

ITU-T

TELECOMMUNICATION
STANDARDIZATION SECTOR
OF ITU

Y.4456

(03/2018)

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

Requirements and functional architecture for smart parking lots in smart cities

Recommendation ITU-T Y.4456

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
Network control architectures and protocols	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.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.4456

Requirements and functional architecture for smart parking lots in smart cities

Summary

Smart parking lots can provide various parking services for different parking lot scenarios, including parking guidance, parking space reservation, vehicle reverse search, vehicle automatic access control and self-service payment.

Recommendation ITU-T Y.4456 specifies the requirements and functional architecture for smart parking lots.

History

Edition	Recommendation	Approval	Study Group	Unique ID*
1.0	ITU-T Y.4456	2018-03-01	20	11.1002/1000/13498

Keywords

Architecture, requirement, smart parking lot, use case.

* 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 Y4456

Requirements and functional architecture for smart parking lots in smart cities

1 Scope

Smart parking lots (SPLs) integrate parking information to enable the coordination of parking facilities within smart cities. SPLs work with other systems to provide various parking services. This Recommendation specifies the requirements and functional architecture for SPLs.

The scope of this Recommendation includes:

– introduction of SPLs

– requirements for SPL

– Functional architecture of SPL

NOTE – For use cases of SPL see Appendix I.

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.101] Recommendation ITU-T Y.101 (2000), *Global Information Infrastructure terminology: Terms and definitions*.

[ITU-T Y.2012] ITU-T Recommendation Y.2012 (2010), *Functional requirements and architecture of next generation networks.*

[ITU-T Y.2261] ITU-T Recommendation Y.2261 (2006), *PSTN/ISDN evolution to NGN*.

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

3 Definitions

3.1 Terms defined elsewhere

This Recommendation uses the following terms defined elsewhere:

3.1.1 application [ITU-T Y.2261]: A structured set of capabilities, which provide value-added functionality supported by one or more services, which may be supported by an API interface.

3.1.2 functional entity [ITU-T Y.2012]: An entity that comprises an indivisible set of specific functions. Functional entities are logical concepts, while groupings of functional entities are used to describe practical, physical implementations.

3.1.3 service [ITU-T Y.101]: A structure set of capabilities intended to support applications.

3.2 Terms defined in this Recommendation

This Recommendation defines the following term:

3.2.1 smart parking lot: An application that integrates citywide parking information and provides various parking services to produce an enhanced parking experience.

4 Abbreviations and acronyms

This Recommendation uses the following abbreviations and acronyms:

APP	Application
AAFE	Access and Authentication Functional Entity
DAFE	Data Analytics Functional Entity
FE	Functional Entity
OOPL	Off-street and On-street Parking Lots
PGFE	Parking Guidance Functional Entity
POMFE	Platform Operation and Management Functional Entity
SCMFE	SPL Ctrl. and Mgmt. Functional Entity
SPL	Smart Parking Lot
SPNP	Smart Parking Networking Platform
VAACFE	Vehicle Automatic Access Control Functional Entity
WEB	World Wide Web

5 Conventions

In this Recommendation:

The keywords "is required to" indicate a requirement which 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 which 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 which 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 this Recommendation.

6 Introduction to SPL

The number of vehicles in cities has increased sharply and finding parking spaces has become increasingly difficult. Furthermore, the lack of parking guidance and parking space booking services makes it difficult for drivers to find parking spaces.

A smart parking lot (SPL) brings the efficient integration of parking resources and coordinated parking facilities together with other systems (e.g., external payment systems, WEB/APP-parking systems, urban parking guidance systems, traffic systems, etc.).

SPLs can provide various parking services to meet the particular requirements of different scenarios. Typical services may include parking guidance, parking space reservation, vehicle reverse search, vehicle automatic access control and self-service payment.

– Parking guidance: An SPL publishes information about unoccupied parking spaces with parking guidance information.
– Parking space reservation: An SPL can help search for available parking spaces and reserve parking spaces in advance.
– Vehicle automatic access control: An SPL may support vehicle parking without the need for stopping at entries and exits.
– Self-service payment: An SPL supports payment through self-service terminals, hand-held devices, WEB/APP-based parking systems or fully-automatic charging, etc.
– Vehicle reverse search: An SPL could help vehicle users to identify where their vehicles are parked, should they forget where they have left them.

The overview of the SPL environment is depicted in Figure 1.

– Off-street parking lots may have controlled entries and exits and on-street parking lots usually do not have controlled entries and exits. Both off-street and on-street parking lots (OOPL) may use sensors and actuators to monitor and control the use of parking spaces.
– Communication networks provide communication capabilities between off-street and on-street parking lots, smart parking network platforms (SPNPs) and external systems.
– An SPL platform provides capabilities (operation and management, access and authentication, data analytics, etc.) for the integration of parking information via interfaces.
– External systems are relatively independent of the SPL. They include WEB/APP-based parking systems, urban parking guidance systems, external payment systems and traffic systems. The SPL supports external interfaces for external systems to provide various parking services.

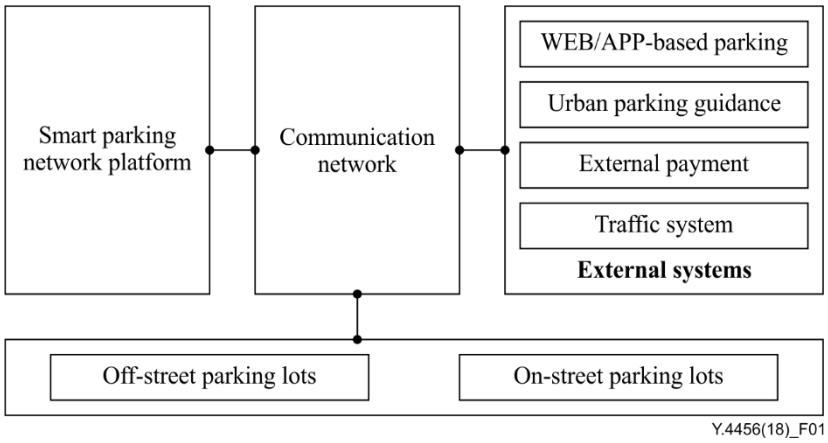

Figure 1 – Overview of the SPL environment

7 Requirements for SPLs

7.1 Parking guidance

OOPL are required to collect parking space information and report it to the SPNP.

The SPNP is required to provide interfaces to external systems to support parking guidance.

OOPL are recommended to use parking space lights, electronic guide screens to indicate parking space information to drivers.

7.2 Parking space reservation

The SPNP is recommended to receive requests for parking space reservations from external systems.

OOPL may reserve parking spaces according to requests from the SPNP.

The SPNP is recommended to provide interfaces to external systems to support parking space reservations.

7.3 Vehicle automatic access control

OOPL may control vehicle automatic access.

The SPNP is recommended to update vehicle information from OOPL.

7.4 Self-service payment

OOPL are required to support a method of self-service payment.

NOTE – Self-service payment can be supported through self-service terminals, hand-held terminals, WEB/APP-based parking systems and fully-automatic collection.

OOPL are required to collect payment information and may report the information to the SPNP.

The SPNP may support interfaces to external systems for self-service payment.

NOTE – Payment information is required to enable self-service payment. The payment information may include vehicle identification (licence plate number, e-tag, RFID, etc.), payment amount, payment time and payment status (paid, unpaid) and rate.

7.5 Vehicle reverse search

An SPNP may check vehicle identification and request the parking space location of the vehicle with the corresponding parking lot.

OOPL may provide a response of the parking space location to the SPNP.

The SPNP may provide the interface to external systems for vehicle reverse search.

7.6 Information management

OOPL are recommended to provide parking lot information and parking space information, and they may provide vehicle information.

An SPNP is required to manage parking lot information and parking space information, and may manage vehicle information.

OOPL and SPNPs are recommended to exchange parking lot information and parking space information, and they may exchange vehicle information.

NOTE 1 – Parking lot information: parking lot ID, parking lot type and parking lot location.

NOTE 2 – Parking space information: parking space ID, parking space status (occupied, vacant, temporarily reserved, long-time reserved).

NOTE 3 – Vehicle information: vehicle identification (licence plate number, e-tag, RFID, etc.), vehicle status (long-term, temporary, etc.), vehicle arrival time, vehicle departure time, vehicle arrival and departure and parking images.

8 Functional architecture of SPLs

8.1 Functional architecture overview

The SPL environment, as shown in Figure 1, consists of four components. From the requirements in clause 7, this Recommendation mainly focuses on OOPL and SPNPs. Communication networks and external systems are out of the scope of this Recommendation in terms of functional architecture.

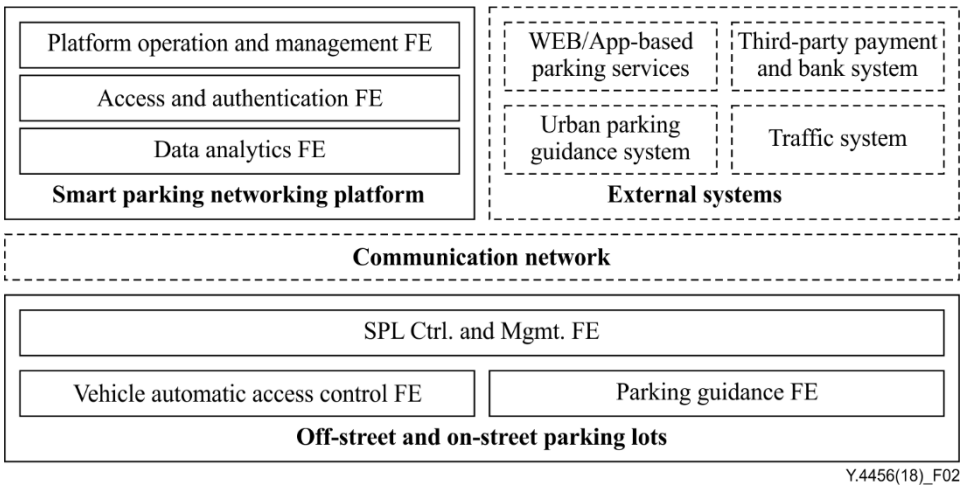

Figure 2 – Functional architecture of an SPL

8.2 Off-street and on-street parking lots (OOPL)

OOPL includes the vehicle automatic access control functional entity (VAACFE), parking guidance functional entity (PGFE) and SPL Ctrl. and Mgmt. functional entity (SCMFE). The main functions of these functional entities are described below:

Vehicle automatic access control functional entity (VAACFE):

– identifies vehicles;

– sends arrival and departure information to the SCMFE;

– controls vehicle access automatically, according to responses received from the SCMFE.

NOTE – This last function is applicable only for off-street parking lots.

Parking guidance functional entity (PGFE):

– detects parking spaces inside parking lots;

– sends parking space information to the SCMFE;

– updates parking space lights and electronic guide screens to indicate parking space information to drivers.

SPL Ctrl. and Mgmt. functional entity (SCMFE):

– collects payment information and reports payment information to the SPNP;

– manages parking lot information including parking lot configuration, parking space information and vehicle information;

– sends alarm messages (vehicle block alarm, equipment abnormal alarm and vehicle arrearage alarm, etc.) to parking lot staff;

– communicates with the platform operation and management functional entity (POMFE) of the SPNP to report information and receive messages.

8.3 Smart parking networking platform (SPNP)

The smart parking networking platform (SPNP) includes the access and authentication functional entity (AAFE), platform operation and management functional entity (POMFE) and data analytics functional entity (DAFE). The main functions of these functional entities are described below:

Access and authentication functional entity (AAFE):

– authenticates parking lot information stored in the POMFE;

– provides interfaces for authenticated users from external systems to access information to which they have rights.

Platform operation and management functional entity (POMFE):

– manages and stores information including parking lot configuration, parking space information, vehicle information and payment information;
– provides service execution for smart parking operation with relevant capabilities;
– communicates with OOPL to get the information and sends the messages to support various parking lot services.

Data analytics functional entity (DAFE):

– supports data analytics and reporting for getting statistical information from the SPNP and OOPL;
– supports data mining to optimize the operation of the SPL.

Appendix I

Use cases of SPL

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

I.1 Parking guidance

Without guidance drivers may cause congestion while looking for parking spaces. The location of parking lots and real-time information of parking spaces is provided to drivers to allow them to park conveniently.

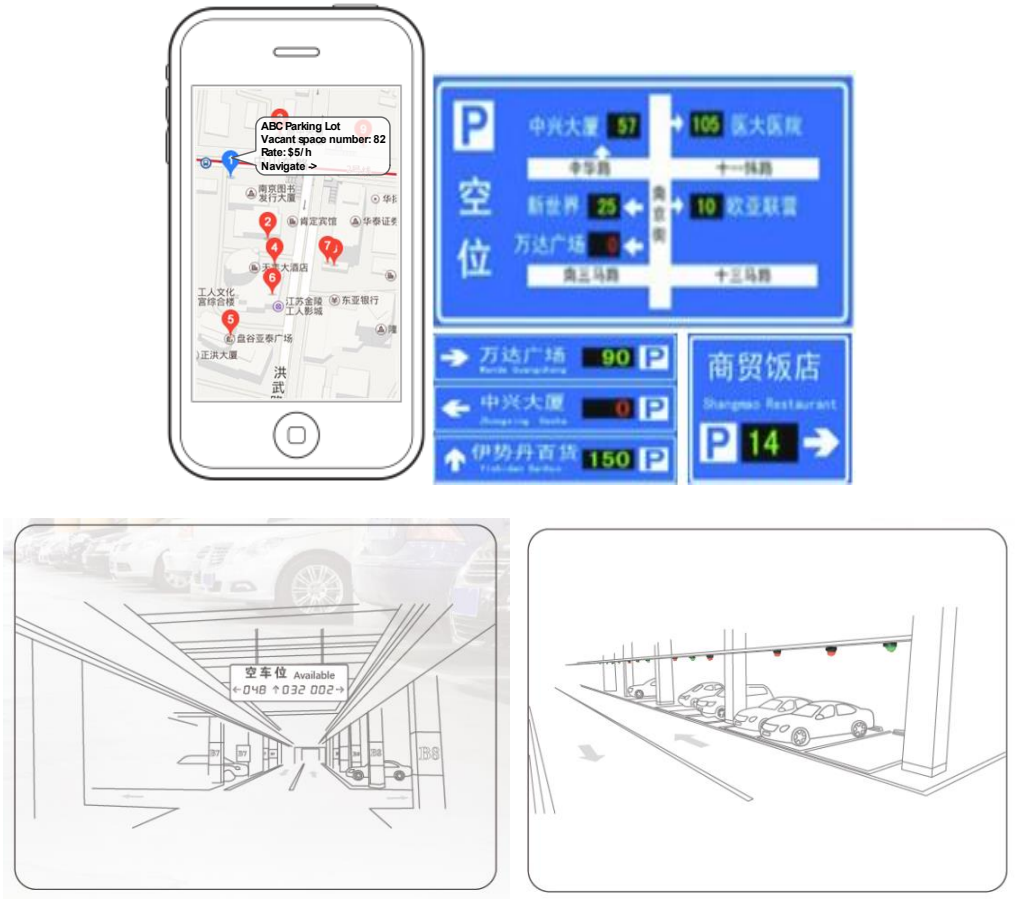

Figure I.1 – Parking guidance

I.2 Parking space reservation

SPLs can help drivers search for information on available parking spaces and to reserve parking spaces in advance. Drivers check electronic road maps with general information about the parking lots around a particular area and they can select the parking lot where they would like to make a parking space reservation, via a WEB/APP-based parking system.

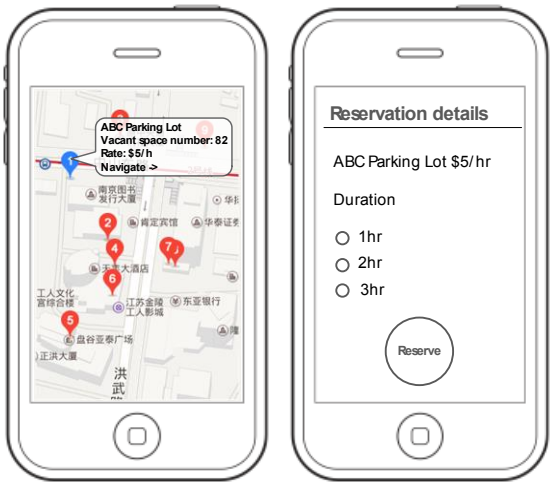

Figure I.2 – Parking space reservation

I.3 Vehicle automatic access control

An SPL supports vehicle access to parking lots without the need to stop at entries and exits.

When a vehicle enters or leaves a parking lot an SPL automatically senses and identifies the vehicle; it then makes subsequent operations according to defined policies, such as:

– for long-term vehicles the SPL will directly release them;

– for overdue vehicles the SPL will stop them or provide an alarm;

– for paid vehicles the SPL will release them;

– for unpaid vehicles the SPL will release the vehicle following payment or a record of payment.

I.4 Self-service payment

Drivers can check information about parking fees and pay the fees through the WEB/APP-based parking system, handheld terminals, self-service terminals or automatic collection.

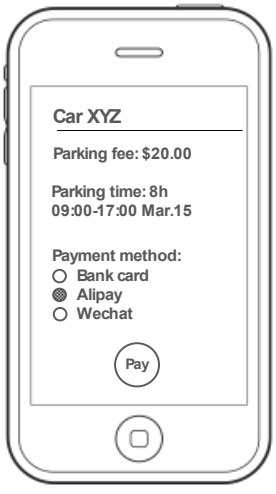

Figure I.3 – Self-service payment

I.5 Vehicle reverse search

It is easy to forget the parking space location when there are many parking spaces and several floors inside parking lots. SPLs could help drivers to identify where their vehicles are parked, should they

forget where they have left them. The drivers can input the licence plate numbers on the interface of the WEB/APP-based parking system and get the detailed location of where their vehicles are parked.

Figure I.4 – Vehicle reverse search

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