International Telecommunication Union

ITU-T

TELECOMMUNICATION
STANDARDIZATION SECTOR
OF ITU

Q.3912
(08/2012)

SERIES Q: SWITCHING AND SIGNALLING

Signalling requirements and protocols for the NGN –
Testing for next generation networks

Set of parameters for monitoring next generation network streaming services

Recommendation ITU-T Q.3912

ITU-T Q-SERIES RECOMMENDATIONS

SWITCHING AND SIGNALLING

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

Recommendation ITU-T Q.3912

Set of parameters for monitoring next generation network streaming services

Summary

Recommendation ITU-T Q.3912 provides the measurement metrics of stream service monitoring and defines a set of parameters that will impact the quality of streaming services in the next generation network (NGN). These parameters are generated by network elements, such as terminal elements, connection elements or transmission elements. The definitions provided here are dependent on NGN, which uses IP as the bearer protocol. This Recommendation defines the approach of measurement of NGN streaming services parameters. The procedures on how to monitor these parameters are out of the scope of this Recommendation.

Keywords

Monitoring parameters, network performance, NGN, QoS, streaming services.

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.3912

Set of parameters for monitoring next generation network streaming services

1   Scope

This Recommendation provides the measurement metrics of stream service monitoring and defines a set of parameters that will impact the quality of streaming services in the next generation network (NGN). These parameters are generated by network elements, such as terminal elements, connection elements or transmission elements. The definitions provided here are dependent on the NGN, which uses IP as the bearer protocol. This recommendation defines the approach of measurement of NGN streaming services parameters. The procedures on how to monitor these parameters 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.

[ITU-T G.1050]	Recommendation ITU-T G.1050 (2011), *Network model for evaluating multimedia transmission performance over Internet Protocol*.
[ITU-T G.1080]	Recommendation ITU-T G.1080 (2008), *Quality of experience requirements for IPTV services*.
[ITU-T H.222.0]	Recommendation ITU-T H.222.0 (2006), *Information technology – Generic coding of moving pictures and associated audio information: Systems*.
[ITU-T J.144]	Recommendation ITU-T J.144 (2004), *Objective perceptual video quality measurement techniques for digital cable television in the presence of a full reference*.
[ITU-T J.246]	Recommendation ITU-T J.246 (2008), *Perceptual visual quality measurement techniques for multimedia services over digital cable television networks in the presence of a reduced bandwidth reference*.
[ITU-T J.247]	Recommendation ITU-T J.247 (2008), *Objective perceptual multimedia video quality measurement in the presence of a full reference*.
[ITU-T J.341]	Recommendation ITU-T J.341 (2011), *Objective perceptual multimedia video quality measurement of HDTV for digital cable television in the presence of a full reference*.
[ITU-T P.800]	Recommendation ITU-T P.800 (1996), *Methods for subjective determination of transmission quality*.
[ITU-T P.800.1]	Recommendation ITU-T P.800.1 (2006), *Mean Opinion Score (MOS) terminology*.
[ITU-T P.862]	Recommendation ITU-T P.862 (2001), *Perceptual evaluation of speech quality (PESQ): An objective method for end-to-end speech quality assessment of narrow-band telephone networks and speech codecs*.

[ITU-T P.863]   Recommendation ITU-T P.863 (2011), *Perceptual objective listening quality assessment*.

[ITU-T Q.3911]   Recommendation ITU-T Q.3911 (2010), *Parameters for monitoring voice services in NGN*.

[ITU-R BT.500-13] Recommendation ITU-R BT.500-13 (2012), *Methodology for the subjective assessment of the quality of television pictures*.

[ITU-R BT.1359-1] Recommendation ITU-R BT.1359-1 (1998), *Relative timing of sound and vision for broadcasting*.

3   Definitions

3.1   Terms defined elsewhere

This Recommendation uses the following term defined elsewhere:

3.1.1   channel zapping [ITU-T G.1080]: The act of quickly changing from one channel to another.

3.2   Terms defined in this Recommendation

None.

4   Abbreviations and acronyms

This Recommendation uses the following abbreviations and acronyms:

3G   3rd-Generation

4G   4th-Generation

BAT   Bouquet Association Table

CAT   Conditional Access Table

CRC   Cyclic Redundancy Check

DF   Delay Factor

EB   Elementary Buffer

EIT   Event Information Table

HD   High-Definition

IGMP   Internet Group Management Protocol

IP   Internet Protocol

ISMA   Internet Streaming Media Alliance

LTE   Long Term Evolution

MB   Multiplex Buffer

MDI   Media Delivery Index

MLR   Media Loss Rate

MOS   Mean Opinion Score

MPEG   Moving Picture Experts Group

NGN   Next Generation Networks

NIT   Network Information Table

PAT   Program Association Table

PCR   Program Clock Reference

PESQ   Perceptual Evaluation of Speech Quality

PID   Packet Identifier

PMT   Program Map Table

POLQA   Perceptual Objective Listening Quality Analysis

PTS   Presentation Time Stamp

RST   Running Status Table

RTP   Real-time Transport Protocol

SI   Service Information

SDT   Service Description Table

TB   Transport Buffer

TDT   Time and Date Table

TOT   Time Offset Table

TS   Transport Stream

TSTD   Transport Stream System Target Decoder

5   Conventions

None.

6   Measurement metrics

6.1   Objective measurement

Objective measurement is used to obtain the value of measurement parameters by injecting a test stream or input signals into the network. The test stream or input signals are sent from one endpoint of the network, and received by the remote answering machine located at another endpoint. Objective measurements are based on criteria and metrics that can be measured objectively and be evaluated automatically. The analysis of the measurement parameters value can be used to determine the performance or behaviour of the system.

6.2   Subjective measurement

Subjective measurement is used to evaluate the audio or video quality by some viewers. The audio or video sequences are shown to the group of viewers and then their opinions are recorded and averaged to evaluate the quality of each audio or video sequence.

7   Monitoring parameters

7.1   Physical level parameters

7.1.1   Network node equipment status

Network node equipment status is defined as the physical status (e.g., Power On/Off) of the network node. The network node status in the monitoring platform can show the real-time network status.

7.1.2 Terminal status

Terminal status is defined as the physical status (e.g., Power On/Off) of the terminal. The terminal status in the monitoring platform can show the real-time terminal status.

7.1.3 Physical link status

Physical link status is defined as the status (e.g., Up/Down) of the link between network nodes or terminals (e.g., the link between two network nodes, or the link between a network node and a terminal).

7.1.4 Link effective bandwidth

Link effective bandwidth is defined as the actual speed at which data can be transmitted as compared with the theoretical maximum speed that the specific link can transmit.

7.2 Network level parameters

The performance of an IP network has an important impact on streaming services. Network level performance parameters such as packet loss, burst loss, sequential packet loss, count of reordered packets, latency, jitter, peak jitter and peak-to-peak jitter defined in [ITU-T G.1050] can reflect a network's performance and should be monitored.

Media delivery index (MDI) which is defined in [b-IETF RFC 4445] can be used as a diagnostic tool or a quality indicator for monitoring a network intended to deliver applications such as streaming media, MPEG video, voice over IP (VoIP), or other information which is sensitive to arrival time and packet loss. MDI provides a readily scalable per-stream measure focusing on loss and the cumulative effects of jitter.

The MDI consists of two components: the delay factor (DF) and the media loss rate (MLR). DF and MLR are defined in [b-IETF RFC 4445].

7.3 Transport level parameters

7.3.1 MPEG-2 TS parameters

If the multimedia stream is multiplexed by MPEG-2 transport stream (TS) as defined in [ITU-T H.222.0], then the MPEG-2 TS parameters in Table 7-1 should be monitored. The MPEG-2 TS parameters in Table 7-1 are defined in [b-ETSI TR 101 290].

Table 7-1 – MPEG-2 TS monitoring parameters

No.	Parameters	Definition
First priority: necessary for de-codability (basic monitoring)		
1.1	TS_sync_loss	Loss of synchronization with consideration of hysteresis parameters
1.2	Sync_byte_error	Sync_byte not equal 0x47
1.3	PAT_error	PID 0x0000 does not occur at least every 0.5 s A PID 0x0000 does not contain a table_id 0x00 (i.e., a PAT) Scrambling_control_field is not 00 for PID 0x0000
1.4	Continuity_count_error	Incorrect packet order A packet occurs more than twice Lost packet

Table 7-1 – MPEG-2 TS monitoring parameters

No.	Parameters	Definition
1.5	PMT_error	Sections with table_id 0x02 (i.e., a PMT), do not occur at least every 0.5 s on the PID which is referred to in the PAT Scrambling_control_field is not 00 for all PIDs containing sections with table_id 0x02 (i.e., a PMT)
1.6	PID_error	Referenced PID does not occur for a user-specified period
Second priority: recommended for continuous or periodic monitoring		
2.1	Transport_error	Transport_error_indicator in the TS-Header is set to "1"
2.2	CRC_error	CRC error occurred in CAT, PAT, PMT, NIT, EIT, BAT, SDT or TOT table
2.3	PCR_error	PCR discontinuity of more than 100 ms occurring without specific indication. Time interval between two consecutive PCR values more than 40 ms
2.4	PCR_accuracy_error	PCR accuracy of selected programme is not within ±500 ns
2.5	PTS_error	PTS repetition period more than 700 ms
2.6	CAT_error	Packets with transport_scrambling_control not 00 present, but no section with table_id = 0x01 (i.e., a CAT) present Section with table_id other than 0x01 (i.e., not a CAT) found on PID 0x0001
Third priority: application dependant monitoring		
3.1	NIT_error	Section with table_id other than 0x40 or 0x41 or 0x72 (i.e., not an NIT or ST) found on PID 0x0010 No section with table_id 0x40 or 0x41 (i.e., an NIT) in PID value 0x0010 for more than 10 s
3.2	SI_repetition_error	Repetition rate of SI tables outside of specified limits
3.3	Buffer_error	**TB_buffering_error** Overflow of transport buffer (TBn) **TBsys_buffering_error** Overflow of transport buffer for system information (Tbsys) **MB_buffering_error** Overflow of multiplexing buffer (MBn), or if the *vbv_delay method* is used: Underflow of multiplexing buffer (Mbn) **EB_buffering_error** Overflow of elementary stream buffer (EBn), or, if the *leak method* is used: Underflow of elementary stream buffer (EBn) though low_delay_flag and DSM_trick_mode_flag are set to 0, and if the *vbv_delay method* is used: Underflow of elementary stream buffer (EBn) **B_buffering_error** Overflow or underflow of main buffer (Bn) **Bsys_buffering_error** Overflow of PSI input buffer (Bsys)

Table 7-1 – MPEG-2 TS monitoring parameters

No.	Parameters	Definition
3.4	Unreferenced_PID	PID (other than PAT, CAT, CAT_PIDs, PMT_PIDs, NIT_PID, SDT_PID, TDT_PID, EIT_PID, RST_PID, reserved_for_future_use PIDs, or PIDs user defined as private data streams) not referred to by a PMT within 0.5 s
3.5	SDT_error	Sections with table_id = 0x42 (SDT, actual TS) not present on PID 0x0011 for more than 2 s Sections with table_ids other than 0x42, 0x46, 0x4A or 0x72 found on PID 0x0011
3.6	EIT_error	Sections with table_id = 0x4E (EIT-P/F, actual TS) not present on PID 0x0012 for more than 2 s Sections with table_ids other than in the range 0x4E – 0x6F or 0x72 found on PID 0x0012
3.7	RST_error	Sections with table_id other than 0x71 or 0x72 found on PID 0x0013. Any two sections with table_id = 0x71 (RST) occur on PID 0x0013 within a specified value (25 ms or lower).
3.8	TDT_error	Sections with table_id = 0x70 (TDT) not present on PID 0x0014 for more than 30 s Sections with table_id other than 0x70, 0x72 (ST) or 0x73 (TOT) found on PID 0x0014 Any two sections with table_id = 0x70 (TDT) occur on PID 0x0014 within a specified value (25 ms or lower).
3.9	Empty_buffer_error	Transport buffer (TBn) not empty at least once per second or transport buffer for system information (TBsys) not empty at least once per second or if the *leak method* is used multiplexing buffer (MBn) not empty at least once per second.
3.10	Data_delay_error	Delay of data (except still picture video data) through the TSTD buffers superior to 1 s; or delay of still picture video data through the TSTD buffers superior to 60 s.

7.3.2   RTP parameters

If the streaming services use RTP as the transport layer protocol, some of the RTP parameters as identified in [ITU-T Q.3911] should be monitored for voice services. There is no fundamental difference in RTP between voice services and streaming services. These parameters include RTP packet delay, RTP packet loss rate and RTP packet jitter.

7.4 Service level parameters

7.4.1 Video quality

Video quality is a characteristic of a video passed through a video transmission/processing system, can be a formal or informal measure of perceived video degradation (typically, compared to the original video). In video streaming services, video quality is important to the user experience. Video quality can be assessed by objective measurement and subjective measurement.

Objective measurement methods are classified based on the availability of the original video signal, which is considered to be of high quality (generally not compressed). Therefore, they can be classified as full reference methods, reduced reference methods or no-reference methods. The reduced reference methods measurements refer to [ITU-T J.246] and the full reference methods measurements refer to [ITU-T J.144], [ITU-T J.247] and [ITU-T J.341].

The primary goal of many objective measurement video quality metrics is to automatically estimate average user (viewer) opinion on the quality of video processed by the system. However, the measurement of subjective video quality can also be challenging because it may require the judgement of a trained expert. Some "subjective video quality measurements" are described in [ITU-R BT.500-13].

7.4.2 Audio quality

Audio quality is the quality of the audio output from various electronic devices. Audio quality is important to the user experience in audio or video streaming services. Audio quality can be assessed by mean opinion score (MOS) and perceptual evaluation of speech quality (PESQ) parameters.

MOS parameters are described in [ITU-T P.800.1] and [ITU-T P.800]. As defined in [ITU-T P.800.1], MOS is the mean of opinion scores, i.e., of the values on a predefined scale that subjects assign to their opinion of the performance of the telephone transmission system used either for conversation or for listening to spoken material. MOS is an audio quality assessment of voice service by subjective measurement.

PESQ is an end-to-end speech quality assessment of voice service by objective measurement. PESQ parameters are defined in [ITU-T P.862].

Perceptual objective listening quality analysis (POLQA) is the next-generation voice quality testing technology for fixed, mobile and IP based networks. POLQA is also an end-to-end speech quality assessment by objective measurement. POLQA parameters are defined in [ITU-T P.863], and can be applied for voice quality analysis of HD Voice, 3G and 4G/LTE networks.

7.4.3 Audio/Video synchronization

Audio/Video synchronization refers to the relative timing of audio and video parts during creation, post-production (mixing), transmission, reception and play-back processing. When audio and video have a timing-related deviation, Audio/Video synchronization can be an issue in video streaming services, and thus, Audio/Video synchronization is important to the user experience. In the terminal device, Audio/Video synchronization should be monitored. The Audio/Video synchronization requirements in video conferencing and analogue broadcast systems are described in [ITU-R BT.1359-1].

7.4.4 Correct contents rate

Correct contents rate is defined as the rate of the number of correct contents (expected contents) presentation in the total number of stream attempts. The output value of this parameter is numerical and should be reported in a percentage format. This parameter is important to the user experience. The parameter is calculated by using the following formula:

$$\text{Correct contents rate} = (Nc/N) \times 100\%$$

Nc is the number of correct contents (expected contents) presentation and *N* is the total number of stream attempts.

7.4.5 Successful stream connection rate

Successful stream connection rate is defined as the rate of the successful stream connection number in the total number of stream attempts. The output value of this parameter is numerical and should be reported in a percentage format. The parameter is calculated by using the following formula:

$$\text{Successful stream connection rate} = (Ns/N) \times 100\%$$

Ns is the successful stream connection number and *N* is the total number of stream attempts.

7.4.6 Stream connecting delay

Stream connecting delay is defined as the time period from the moment when the user sends the stream request to the moment when the content is displayed.

7.4.7 Stream play buffering rate

Stream play buffering rate is defined as the ratio between buffering time and the whole played time. The whole played time is the period from the "stream connected" moment to the "statistic moment", i.e., the moment that this parameter is computed, and includes the buffered time and multimedia contents played time. This parameter reflects the stream play fluency and is important to the user experience. The output value of this parameter is numerical and should be reported in a percentage format. The parameter is calculated by using the following formula:

$$\text{Stream play buffering rate} = (Tb/Tw) \times 100\%$$

Tb is the buffering time in seconds of this playing stream and *Tw* is the whole played time in seconds of this playing stream.

7.4.8 Channel zapping time

In the broadcasting stream service, channel zapping time is the changing time from one channel to another. As is defined in [ITU-T G.1080], the channel zapping time includes the Internet group management protocol (IGMP) delay, buffering delay and decoding delay, as shown in Figure 7-1 (Figure 8-1 of [ITU-T G.1080]). The definition of IGMP delay, buffering delay and decoding delay are described in [ITU-T G.1080].
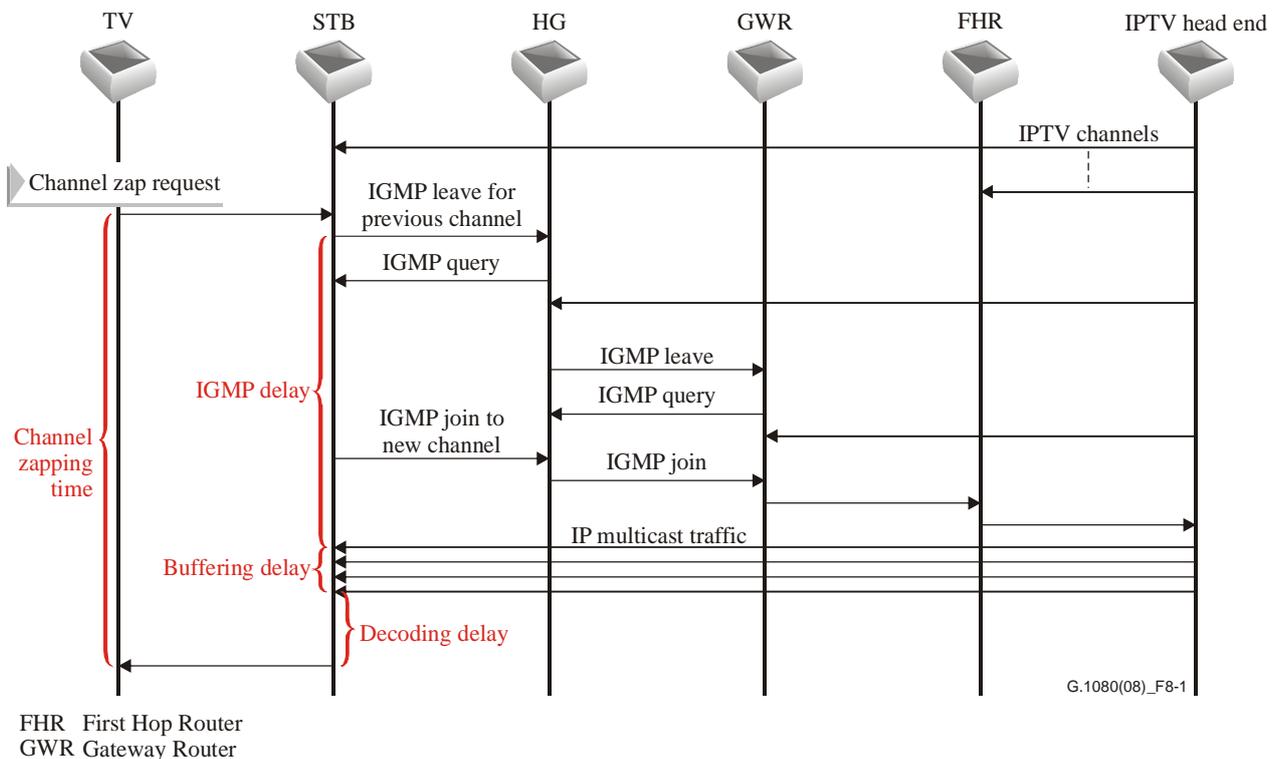
TV   STB   HG   GWR   FHR   IPTV head end

IPTV channels

Channel zap request

IGMP leave for previous channel

IGMP query

IGMP delay

IGMP leave

IGMP query

IGMP join to new channel

IGMP join

Channel zapping time

IP multicast traffic

Buffering delay

Decoding delay

G.1080(08)_F8-1

FHR First Hop Router
GWR Gateway Router

Figure 7-1 – Components that contribute to channel zapping time

7.4.9 Trick latency

In the stream trick mode, stream control function (stream selection, play, pause, rewind, fast forward and stop) has its own delay. These delays are defined as follows:

– Stream selection process delay: Time lag between when the stream is selected and when the content is displayed.

– Play delay: Time lag between when the play entry is selected and when the content is displayed.

– Stop delay: Time lag between the stop play video entry is selected and the content is stopped playing as indicated by video content display.

– Rewind delay: Time lag between when the rewind video entry is selected and when the rewind action is executed as indicated on the display device.

– Pause delay: Time lag between when the pause video entry is selected and when the pause action is executed as indicated on the display device.

– Fast forward delay: Time lag between when the fast forward video entry is selected and when the fast forward action is executed as indicated on the display device.

Bibliography

[b-ETSI TR 101 290]   ETSI TR 101 290 (2001-05), *Digital Video Broadcasting (DVB); Measurement guidelines for DVB systems*.

[b-IETF RFC 4445]   IETF RFC 4445 (2006), *A Proposed Media Delivery Index (MDI)*.

SERIES OF ITU-T RECOMMENDATIONS

Series A	Organization of the work of ITU-T
Series D	General tariff principles
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	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	Terminals and subjective and objective assessment methods
Series Q	**Switching and signalling**
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 and next-generation networks
Series Z	Languages and general software aspects for telecommunication systems