International Telecommunication Union

# ITU-T

TELECOMMUNICATION
STANDARDIZATION SECTOR
OF ITU

# Q.3925

(03/2012)

SERIES Q: SWITCHING AND SIGNALLING

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

## Traffic flow types for testing quality of service parameters on model networks

Recommendation ITU-T Q.3925

International
Telecommunication
Union

ITU-T Q-SERIES RECOMMENDATIONS

**SWITCHING AND SIGNALLING**

| | |
|---|---|
| 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.3999 |
| General | Q.3000–Q.3029 |
| Network signalling and control functional architecture | Q.3030–Q.3099 |
| Network data organization within the NGN | Q.3100–Q.3129 |
| Bearer control signalling | Q.3130–Q.3179 |
| Signalling and control requirements and protocols to support attachment in NGN environments | Q.3200–Q.3249 |
| Resource control protocols | Q.3300–Q.3369 |
| Service and session control protocols | Q.3400–Q.3499 |
| Service and session control protocols – supplementary services | Q.3600–Q.3649 |
| NGN applications | Q.3700–Q.3849 |
| **Testing for next generation networks** | **Q.3900–Q.3999** |

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

## Recommendation ITU-T Q.3925

# Traffic flow types for testing quality of service parameters on model networks


### Summary

Recommendation ITU-T Q.3925 describes the types of traffic flows which should be generated for testing QoS parameters for voice, data, and video on the model network. The characteristics of traffic flows are determined for different types of services, content, and networks (voice, voice over Internet Protocol (VoIP), Web surfing, file transfer, e-mail, peer-to-peer, video, and ubiquitous sensor networks conditions).



### History

| Edition | Recommendation | Approval | Study Group |
|---|---|---|---|
| 1.0 | ITU-T Q.3925 | 2012-03-29 | 11 |

## 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.3925

# Traffic flow types for testing quality of service parameters on model networks

### 1 Scope

The Q.39xx-series of Recommendations relates to testing methods and specifications for model networks. The model network concept was created in 2006 due to the complexity of next generation network (NGN) equipment over digital networks, the unlimited services set in principle, the level of guaranteed quality of service (QoS) for separated QoS classes, and so on. The global interoperability concept was also created as a next step in testing methodology. Global interoperability includes the interoperability of technical means, of services, and of QoS classes and parameters.

The modern type of traffic is required to realize the testing of global interoperability on the model network. In general, voice traffic flow has been digital network traffic flow. Over a long period of time, voice traffic flow characteristics were obtained in the real networks and these characteristics are standardized in [ITU-T Q.543], in accordance with statistical data.

The NGN traffic contains voice traffic, data traffic, and video traffic. As a rule, data and video traffic have different characteristics than voice traffic in the circuit switched network. Data and video traffic in the NGN are self-similar. Consequently, the new methods for traffic generation and modelling should be used in the testing procedure for global interoperability.

This Recommendation describes the voice, data, and video traffic flow characteristics which should be generated for testing global interoperability parameters on the model network. Traffic characteristics of the ubiquitous sensor network (USN) are also described in 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 P.59] Recommendation ITU-T P.59 (1993), *Artificial conversational speech.*

[ITU-T Q.543] Recommendation ITU-T Q.543 (1993), *Digital exchange performance design objectives.*

[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 Y.1541] Recommendation ITU-T Y.1541 (2011), *Network performance objectives for IP-based services.*

[ITU-T Y.1901] Recommendation ITU-T Y.1901 (2009), *Requirements for the support of IPTV services.*

### 3 Definitions

None.

## 4 Abbreviations and acronyms

This Recommendation uses the following abbreviations and acronyms:

BHCA Busy Hour Call Attempts

IPTV Internet Protocol Television

ISDN Integrated Services Digital Network

NGN Next Generation Network

VoIP Voice over Internet Protocol

USN Ubiquitous Sensor Network

## 5 Conventions

None.

## 6 Traffic flow types in the public telecommunication networks

### 6.1 Poisson traffic

The voice traffic arrival process for circuit switched public telecommunication networks is the Poisson process based on long-term observation.

The fundamental properties of the Poisson process are stationary, independent at all time instants (epochs), and simple. The following two most important Poisson process properties could be considered [b-Iversen]:

– the number of events within a time interval of fixed length is Poisson distributed,

– the time distance between consecutive events is exponentially distributed.

The Poisson flow is fully determined by its own parameter.

The Poisson arrival process is adequate for submission of other arrival processes, for example the dial-up Internet access arrival process [b-Iversen].

### 6.2 Self-similar traffic

Both the data and video traffic creating the new types of arrival traffic flows in NGNs are self-similar traffic flows.

The arrival traffic process is considered as self-similar if the distribution function for the original and the aggregated processes are equal. The aggregated arrival process is created by the averaging of the original process in *m* size series blocks (the block is part of the original process) [b-Willinger].

The most important feature of the self-similar arrival process is the Hurst parameter [b-Sheluhin]. Knowledge of the Hurst parameter value gives the possibility to generate the self-similar flow with specified characteristics.

The Hurst parameter, H, could be determined as follows:

$$D(X^{(m)}) = m^{2(H-1)} D(X)$$

Where $D(X^{(m)})$ is the aggregated flow variance and *D(X)* is the original flow variance.

The next equation is frequently used:

$$\ln\left(\frac{D(X^{(m)})}{D(X)}\right) = (2H-2)\ln(m)$$

The expression (2H–2) is a next geometrical sense. This is the line slope coefficient. This line is approximated by the following function:

$$\ln\left(\frac{D(X^{(m)})}{D(X)}\right) = f\left(\ln(m)\right)$$

## 7 Voice traffic flow characteristics

### 7.1 Voice traffic flow characteristics in accordance with Recommendation ITU-T Q.543

The originating voice traffic flow characteristics are shown in Table 1, based on Table 1a of [ITU-T Q.543]. The originating traffic flow for ISDN subscribers is not considered since there are significantly fewer ISDN subscribers than PSTN subscribers. The intensity of traffic flow in Erlangs and busy hour call attempts (BHCA) are shown in Table 1 for normal level load type A. For testing the QoS parameters on the model network for overload conditions, the values from Table 1 should be increased up to 25% in Erlangs and 35% in busy hour call attempts (level load type B), in accordance with clause 2.1.2.2 of [ITU-T Q.543].

**Table 1 – Originating voice traffic flow characteristics**

| Traffic flow class | Flow type | Average traffic intensity (Erlang) | Average number of busy hour call attempts (BHCA) |
|---|---|---|---|
| 1 | Poisson | 0.03 | 1.2 |
| 2 | Poisson | 0.06 | 2.4 |
| 3 | Poisson | 0.10 | 4 |
| 4 | Poisson | 0.17 | 6.8 |

The superposition of traffic flow classes should be used during testing on the model network. The superposition of N independent Poisson processes will be the Poisson process in accordance with the Poisson superposition theorem [b-Iversen]. The shares of traffic flow classes in the superposition flow are determined by the concrete characteristics of the network or network part which should be tested. If the incoming traffic flow should be generated, its characteristics are to be taken as for originating traffic.

### 7.2 Voice traffic flow features in NGNs

The voice traffic flow features in NGNs are determined by the voice traffic transfer over IP Protocols (VoIP). The VoIP user share is constantly increased, but the voice traffic characteristics from Table 1a of [ITU-T Q.543] are very stable and could be used for VoIP average traffic intensity and the average number of busy hour call attempts (BHCA).

The statistical observation of VoIP traffic flows on the real networks proved that the arriving VoIP traffic flow could be described by the Poisson process. Furthermore, the Poisson traffic flow model could be used for VoIP traffic, even for all-IP networks [b-Birke].

The silence suppression methods could be used during VoIP traffic processing. Methods used in [ITU-T P.59] can be considered for the VoIP traffic generation for the model network. The talk-spurt duration and pause duration submit the exponential distribution in accordance with [ITU-T P.59]. In conversation, the pause share duration is 61.47% and the mutual silence share duration is 22.48%.

# 8 Data traffic flow characteristics

## 8.1 "www" traffic flow characteristics

The "www" traffic is self-similar with the Hurst parameter H = 0.7-0.9 [b-Crovella] and [b-Ho].

## 8.2 File transfer traffic flow characteristics

File transfer traffic is self-similar with the Hurst parameter H = 0.85-0.95 [b-Norros] and [b-Jena].

## 8.3 E-mail traffic flow characteristics

E-mail traffic is self-similar with the Hurst parameter H = 0.75 [b-Ho].

## 8.4 Peer-to-peer traffic flow characteristic

Peer-to-peer traffic is self-similar. The Skype traffic as P2P traffic example is self-similar with H = 0.6 for inter-arrival time and H = 0.7 for packet lengths [b-Markovich].

# 9 Video traffic flow characteristic

The IPTV traffic flow statistical observation proved that the traffic flows are self-similar both for multicast and unicast traffic [b-Janevski], [b-Tarasov] and [b-Mellia]. The Hurst parameter values are H = 0.55-0.6 for multicast traffic and H = 0.75-0.8 for unicast traffic. The traffic flow characteristics for video traffic generation on the model network are shown in Table 2.

**Table 2 – IPTV traffic flow characteristics**

| Traffic types | Flow types | H values |
|---|---|---|
| Multicast | Self-similar | 0.55-0.6 |
| Unicast | Self-similar | 0.75-0.8 |

The self-similar unicast traffic flow characteristics could be recommended for the aggregated IPTV traffic flow [b-Janevski]. The ON/OFF method [b-Willinger] could be recommended for IPTV traffic generation on the model network

# 10 Characteristics of the traffic flow on ubiquitous sensor networks

In the near future, the ubiquitous sensor network (USN) will be a large traffic generator for public networks. Research into the USN traffic flow proved that traffic flow at the USN networks could be self-similar. The traffic flows are self-similar with H=0.67-0.69 for the USN, with stationary telemetry sensor nodes as well as mixed stationary and mobility sensor nodes [b-Koucheryavy]. Classification of the traffic classes for USN is proposed in Table 3.

**Table 3 – Characteristics of USN traffic flow**

| USN traffic classes | Flow type | H values |
|---|---|---|
| Voice | For further study | For further study |
| Signalling | Self-similar | 0.83 |
| Telemetry<br>Stationary sensors | Self-similar | 0.67 |
| Telemetry<br>Mixed sensors | Self-similar | 0.69 |
| Pictures (photo) | For further study | For further study |
| Reconfiguration | Self-similar | 0.83 |
| Local positioning | For further study | For further study |

## 11 Security considerations

None.

# Bibliography


[b-Birke] Birke, R., Mellia, M., Petracca, M., and Rossi, D. (2010), *Experience of VoIP Traffic Monitoring in a Commercial ISP*, International Journal of Network Management, vol. 20, Issue 5, pp. 339-359.

[b-Crovella] Crovella, M.E., and Bestavros, A. (1997), *Self-Similarity in Wide Web Traffic: Evidence and Possible Causes*. IEEE/ACM Transaction on Networking, v.5, No. 6, December 1997.

[b-Ho] Ho, J., Y. Zhu, and Madhavapaddy, S. (1999), *Throughput and buffer analysis for GSM general packet radio service*, Proceedings WCNC'99, New Orleans, USA, September 1999.

[b-Iversen] Iversen, V.B. (2010), *Teletraffic Engineering and Network Planning,* Technical University of Denmark. <http://www.osti.gov/eprints/topicpages/documents/record/982/1473132.html>

[b-Janevski] Janevski, T., and Vanevski, Z. (2008), *Statistical Analysis of Multicast versus Instant Channel Changing Unicast IPTV Provisioning*, 16th Telecommunications Forum TELFOR 2008, Belgrade, Serbia, 25-27 November 2008, pp. 96-99.

[b-Jena] Jena, A.K., Pruthi, P., and Popesku, A. (2011), *Modelling and Evaluation of Network Applications and Services*, Blekinge Institute of Technology, Karlskrona, Sweden. <www.bth.se>

[b-Koucheryavy] Koucheryavy, A., and Prokopiev, A. (2011), *Ubiquitous Sensor Networks Traffic Models for Telemetry Applications, Smart Spaces and Next Generation Wired/Wireless Networking*, 11th International Conference, NEW2AN 2011, and 4th Conference on Smart Spaces, ruSMART 2011. St.Petersburg, Russia, August 2011, Proceedings, LNCS 6869. Springer, 2011.

[b-Markovich] Markovich, N.M., and Krieger, U.R. (2011), *Statistical Analysis and Modeling of Peer-to-Peer Multimedia Traffic*, LNCS 5233, Next Generation Internet (Ed. D.Kouvatsos), 2011.

[b-Mellia] Mellia, M., and Meo, M. (2009), *Measurement of IPTV Traffic from an Operative Network*, European Transactions on Telecommunications.

[b-Norros] Norros, I. (1995), *The Management of Large Flows of Connectionless Traffic on the Basis of Self-similar Modeling*, International Conference on Communications ICC'95. Proceedings, 18-22 June 1995, Seattle, USA.

[b-Sheluhin] Sheluhin, O., Smolskiy, S., and Osin, A. (2007), *Self-Similar Processes in Telecommunications*. Wiley

[b-Tarasov] Tarasov, D., Paramonov, A., and Koucheryavy, A. (2010), *The Video Streaming Monitoring in the Next Generation Network. LNCS*, Springer, volume 5764 Smart Spaces and Next Generation Wired/Wireless Networking, pp. 191-205.

[b-Willinger] Willinger, W., Taqqu, M., Sherman, R., and Wilson, D. (1997), *Self-similarity through high-variability*. IEEE/ACM Transaction on Networking, vol. 5, No. 1, 1997, pp. 71-86.

## 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 |

Printed in Switzerland
Geneva, 2012