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Handbook on Network performance testing and control for guarantee required QoS for NGN services

Denis Andreev
Rapporteur of Q.10/11 & Q.11/11
ZNIIS, Moscow
Content

1. Explanation of QoS/QoE/NP Handbook creation in ITU
2. History of Handbook creation
3. The short overview of Handbook contents
4. The typical approach and common problems on QoS estimation
5. Innovation approach for estimation and QoS support
6. The Russia experience on International projects on QoS/QoE/NP testing
Further network deployment stages will be held in a systematic lack of available bandwidth and the backlog of technology development from traffic growth.
Future model of Telecom services

- Social segment (school, hospital, administrations)
- Small and medium business (SOHO, shop)
- Large business (banks, large production)

Internet

NGN

Data center

SaaS provider

Safe and reliable network (guaranteed in terms of QoS and Security required level)

Reliability Data center and SDP

e-governement  e-medicine  Distributed soft  ERP  ...

SaaS provider
Whose will be the customer?

Fixed operators networks

Mobile operators

Internet content provider
The common exist problematic on QoS support

- The network deployment based on packet switching technologies
- Service distribution without correspondence with telecommunication technologies
- The payload increase in transport network in consequence of increase broadband of access layer (on 50 % each of the year)
  Jakob Nielsen
- Heterogeneous network environment (TDM and IP)
- Reduce of reliability rate in case of usages different vendors solutions
The history of Handbook QoS/QoE/NP testing creation

1. ITTC project (joint project ITU-D – ZNIIS) CIS-008
2. Testing results on the ZNIIS Model network under ETSI project STF392
3. Creation the Handbook for CIS Region as Guide for QoS/QoE support for exist operators
4. The special reports of QoS/QoE/NP testing on the Model networks for CIS operators was published as a Annex of Handbook
5. Creation the ITU-T Handbook as a guide for international community as a global Guide for QoS/QoE/NP testing and monitoring (has just presented under SG11 October 2011 meeting) – was sent to All SG’s ITU-T as a reference document
6. It was sent to ETSI for comments and with proposal to prepare the special technical ETSI document which will content this Handbook as a guide for Europe
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Part 2. Network performance testing for supporting required values of QoS

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The common terminology of QoS and QoE

QoS

On the basis of the general concept of quality the basic terms of Quality of Service (QoS) have been defined in the Recommendation ITU-T E.800

The Recommendation ITU-T E.800 the following definition of QoS are given: «Totality of characteristics of a telecommunications service that bear on its ability to satisfy stated and implied needs of the user of the service»
The common terminology of QoS and QoE

QoE

At the present time in the world telecommunication community the quality of experience (QoE) term is used for estimation the quality of services as integrated indicator. In accordance with Recommendation ITU-T P. 10 (2-nd edition), the concept of QoE is defined as the admissibility of services or applications in general, subjectively perceived by the end-user.

QoE is integral index, which includes both an evaluation of the quality of the transfer of user payload, and with the experience of the user to the appropriate service.
QoE for telephonic services

In basic the media perception quality assessment from the end-user is common assessment of MOS (Mean Opinion Score – average of speech intelligibility rating), implemented in accordance with the ITU-T Recommendations.

Values of criteria such as connection establishment time and the waiting time of obtaining the acoustic signals depend on the correctness of the signaling protocols that provide services and, therefore, can be estimated by analyzing the delay of signaling protocols messages exchange.
The MOS estimation, as described in ITU-T Recommendation P.800, based on a five-point scale – from one (worst voice quality) to five (very good quality). In accordance with this algorithm, a group of people (experts) evaluate the sound quality of test patterns of speech transmitted over a network connection.

Typically, the largest score that can be obtained by this method are equal to 4.5. Score of 4.0 points and above is considered as very high, corresponding with the voice quality which common use on traditional phone networks.
# MOS/R-factor correspondence

<table>
<thead>
<tr>
<th>R Value</th>
<th>MOS CQEN Value</th>
<th>Categories of User Satisfaction</th>
</tr>
</thead>
<tbody>
<tr>
<td>94</td>
<td>4.42</td>
<td></td>
</tr>
<tr>
<td>93</td>
<td>4.40</td>
<td></td>
</tr>
<tr>
<td>92</td>
<td>4.38</td>
<td>Very satisfied (Best)</td>
</tr>
<tr>
<td>91</td>
<td>4.36</td>
<td></td>
</tr>
<tr>
<td>90</td>
<td>4.34</td>
<td></td>
</tr>
<tr>
<td>87</td>
<td>4.195</td>
<td></td>
</tr>
<tr>
<td>85</td>
<td>4.18</td>
<td></td>
</tr>
<tr>
<td>82</td>
<td>4.09</td>
<td>Satisfied (High)</td>
</tr>
<tr>
<td>81</td>
<td>4.06</td>
<td></td>
</tr>
<tr>
<td>80</td>
<td>4.03</td>
<td></td>
</tr>
<tr>
<td>77</td>
<td>3.85</td>
<td>Some users dissatisfied (Medium)</td>
</tr>
<tr>
<td>73</td>
<td>3.74</td>
<td></td>
</tr>
<tr>
<td>70</td>
<td>3.60</td>
<td></td>
</tr>
<tr>
<td>68</td>
<td>3.50</td>
<td>Many users dissatisfied (Low)</td>
</tr>
<tr>
<td>60</td>
<td>3.10</td>
<td></td>
</tr>
<tr>
<td>50</td>
<td>2.58</td>
<td>Nearly all users dissatisfied (Poor)</td>
</tr>
</tbody>
</table>

\[
\text{MOS} = 1 + (0.035) \times R + (000.007) \times R (R - 60) (100 - R)
\]

**NOTE 1:** Connections with R-values below 50 are not recommended.

**NOTE 2:** Although the trend in transmission planning is to use R-values, equations to convert R-values into other metrics e.g. MOS, % GoB, % PoW, can be found in ITU-T Recommendation G.107.
The problems with establishing correspondence between the subjective and objective assessments

The problem of vertical transparency (mapping) parameters and its values

QoS for multimedia services

Network performance
ITU-T Recommendation on QoS support

E-series


Terms and definitions related to quality of services: ITU-T Recommendations E.800, E.801, E.802

Models for telecommunication services: ITU-T Recommendations E.810, E.820, E.830

QoS parameters, associated with communication services: ITU-T Recommendations E.845, E.846, E.850, E.855

Using QoS parameters for the planning of communication networks: ITU-T Recommendations E.860, E.861, E.862

Data collection and quality assessment of the functioning of the equipment, networks and services: ITU-T Recommendations E.880
ITU-T Recommendation on QoS support

G-series


Services quality and technical characteristics - common and associated with the user aspects: ITU-T Recommendations G.1000, G.1010, G.1020, G.1030, G.1040, G.1050

General characteristics of the transmission medium: ITU-T Recommendations G.602


Quality and availability parameters: ITU-T Recommendations G.821-G.829

Digital Linear Systems: ITU-T Recommendations G.911
ITU-T Recommendation on QoS support
M-series

Introduction and general principles of maintenance and maintenance organization: ITU-T Recommendations M.34, M.160, M.495

International telephone lines: ITU-T Recommendations M.560, M.721

International leased circuits: ITU-T Recommendations M.1016, M.1020, M.1025

International data transmission systems: ITU-T Recommendations M.1030, M.1040, M.1340

International transport network: ITU-T Recommendations M.2100, M.2101, M.2101.1, M.2201

ISDN networks: ITU-T Recommendations M.3650
ITU-T Recommendation on QoS support O-series


Dictionary (terminology): ITU-T Recommendations P.10

The methods of objective and subjective quality assessment: ITU-T Recommendations P.82, P.85, P.800, P.800.1, P.830, P.831-834, P.862, P.863

Audiovisual quality in multimedia services: ITU-T Recommendations P.910, P.911
ITU-T Recommendation on QoS support
X/Y-series

ITU-T X-series Recommendations, those relating to QoS and NP, divide to the following categories:
• Network aspects: ITU-T Recommendations X.134-X.140 [137-143], X.144-146 [144-146];
• QoS: ITU-T Recommendations X.641-642 [147-148].

ITU-T Y-series Recommendations, those relating to QoS and NP, divide to the following categories:
Problems of Internet Protocol (IP):
• Architecture, access, networking opportunities and administrative management of resources: ITU-T Recommendations Y.1221 [149], Y.1291 [150];
• QoS and NP – transmission quality of user information: ITU-T Recommendations Y.1530 [151], Y.1540 [13], Y.1541 [152], Y.1542 [153], Y.1561 [154].
Next generation networks (NGN) – QoS and NP.
The Approach of QoS/QoE/NP support

Step 1: Formation

Step 2: Formation

Step 3: Support

Step 4: Satisfaction

Customer’s service requirements (QoE)

QoS parameters (QoS)

Network performance parameters (NP)
The typical approach of QoS estimation and common problems

At the moment the three basic approach are widely used for estimation quality of distributed media-information contents on the exist operators networks (Rec. ITU-T G.1011):

- active (intrusive, PESQ, POLQA)
- passive (non-intrusive, P.563)
- modeling (E-model)
Active - PESQ

PESQ (Perceptual Evaluation of Speech Quality) – the estimation on voice transfer quality

The PESQ is objective specification on parameters quality determination in telephonic networks, which give the forecast of the expected results of subjective estimation from experts

For determination of voice quality transfer PESQ include approach of comparing etalon signal (reference) with degraded signal on the outside point
Active - PESQ
The Future of PESQ - POLQA

POLQA (Perceptual Objective Listening Quality Assessment) – objective of appear voice quality *(Rec. ITU-T P.863)*

POLQA is technology for estimation voice quality next generation for fix, mobile and IP-networks

POLQA could be used for 3G, 4G/LTE and also for estimation HD voice/video
Passive (Rec. ITU-T P.563)

In principal the passive method include estimation of degraded without comparing with etalon signal (reference) (Rec. ITU-T P.563)
II.II.A. Active and passive comparison

Correlation rate between MOS on P.563 and real expert estimation varied form 0.85 till 0.9
E-model


This approach initially created with purpose of network designing simplify for NGN and suppose to calculate of call sessions quality on mathematics methodology under initial data of network characteristics.

Sometimes the measurement equipment vendors updated E-model and used it for passive monitoring.
Methods implementation

On the exist operators network these approaches are used for following tasks

• for network designing – E-model
• for testing network sites (segment) before providing it for operation mode – active (PESQ, POLQA)
• for monitoring exist networks – all these approaches
The common problems

Active (intrusive, PESQ, POLQA)
the auxiliary test service traffic QoS estimation on the exist network does not give the objective situation on speech quality on the hole network

Passive (non-intrusive, P.563)
Comparison with the standardized model of the traffic/service (the various services and their profiles complicates process of control – model standardization is required)

E-model
The mathematical model having a divergence with real technical telecom solutions, applied on an operator network
Necessary to create alternative integrated systems for managing network resources to ensure quality of service during the transformation to NGN and under implementation concept "All over IP" *

*The paper. Electrosvyaz Russia, 2009. V.Shalaginov and D.Andreev Resource admission control for ensure the quality of ICT services in NGN networks
Modeling and services benchmarking

There is only one light source that illuminates my way – it’s the light of experience.
I know only one way to judge the future – it’s based on the past.

Patrick Henry Pearse. Irish playwright, poet.
Measurement and finding the limit values for Network performance and network productivity for each network segment for distributing service sessions (Model network – common instrument for this task)

Implementation probes on real networks which can simulate services like distributed on exist operators network and which can monitoring/control quality of service
THE ARCHITECTURE OF MODEL NETWORK FOR NETWORK PERFORMANCE, QoS, QoE AND LIMIT VALUES OF NETWORK PRODUCTIVITY TESTING

Marking:
- Voice information
- Signaling information
- Fix parameters
- Variable parameters
- Measurement parameters

- Control point (CP)
- Network
- Network element
The etalon Model network provided by ETSI TR 102 717 V1.1.1

- User segment A/C
- UNI A/C - sending/receiving side
- Access segment A/C
- Segment-connection Point
- Total transit segment
The results of ETSI benchmarking

End-to-End delay in ms and R value between
DSL line 128 kbit/s uplink; 128 kbit/s downlink PSTN/ISDN to PSTN/ISDN are provided with G.711, DSL Access with G.729A with wired terminals

<table>
<thead>
<tr>
<th></th>
<th>PSTN/ISDN Delay (ms)/R</th>
<th>DSL Delay (ms)/R</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>PSTN/ISDN</td>
<td></td>
</tr>
<tr>
<td>PSTN/ISDN</td>
<td>68 ms / R=91 (20 ms Packet size)</td>
<td>102 ms - 144 ms / R=79 (20 ms Packet size)</td>
</tr>
<tr>
<td></td>
<td>48 ms / R=92 (10 ms Packet size)</td>
<td>(le = 11)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>DSL</td>
<td></td>
</tr>
<tr>
<td>DSL</td>
<td>108 ms - 153 ms / R=79 (20 ms Packet size)</td>
<td>160 ms - 207 ms / R=74 (20 ms Packet size)</td>
</tr>
<tr>
<td></td>
<td>(le = 11)</td>
<td>(le = 11)</td>
</tr>
</tbody>
</table>
### The results of ETSI benchmarking

<table>
<thead>
<tr>
<th>Initiated Registrations Per Second [events]</th>
<th>Maximum</th>
<th>Minimum</th>
<th>Average</th>
<th>Variance</th>
<th>Standard Deviation</th>
<th>Median</th>
<th>Mode</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>98,00</td>
<td>18,00</td>
<td>66,68</td>
<td>225,80</td>
<td>15,03</td>
<td>66,00</td>
<td>63,00</td>
</tr>
</tbody>
</table>
The results of testing under innovation approach (joint project ITU-ZNIIS CIS-08)

Service G.711 512 кбит/с Eth-Eth

MOS distribution channels at a value of bandwidth 512 kbit/s

The results of testing under innovation approach (joint project ITU-ZNIIS CIS-08)
The results of testing under innovation approach (joint project ITU-ZNIIS CIS-08)

Service G.711 512 кбит/с Eth-ADSL
Rec. ITU-T Q.3900 Methods of testing and model network architecture for NGN technical means testing as applied to public telecommunication networks
The typical approach on estimation QoS/QoE/NP by operators

✓ The QoS/NP norms on the network segment determination for different telecom technologies and services
✓ Service modeling with determination QoE model (etalon model of service)
✓ Benchmarking services and networks
✓ Interoperability testing
✓ Testing on RFP conformance
✓ Determination of optimal functionality of QoS support system before implementation on network
✓ Realization the special QoS/QoE/NP monitoring system based on the service emulation method
The common approach on QoS/QoE/NP monitoring (joint project ITU-ZNIIS CIS-08)
The Russia key results in International project in QoS area

**Joint ITU-ZNIIS project**
International telecommunication testing center creation (ITTC) 2008-2011

**Common results**
- Training courses
- Testing equipment and network solutions on conformance and interoperability
- International workshop on testing
- Preparation methodical materials (test specifications, test reports, handbooks, and etc.)
- Launched the rus/eng Knowledge database (in accord. with Rec. ITU-T Q.3983)

**Traffic Engineering and QoS Control in Multimedia-enabled Wireless Networks**
FP6 E-NEXT Network of Excellence
COST 290

**Joint ITU-ZNIIS project on creation virtual laboratory**
WTDC-10

**Expected results**
- Remote equipment testing
- Portal on remote testing creation
- Remote training on testing process
- Virtual testing zone creation

**Test specification development**
IMS NNI under WG INT ETSI STF #394
Extension of IMS NNI interoperability test descriptions

**Test specification development**
IMS NNI for RCS v.9 under WG INT ETSI STF #414

**Perceptual Impact of End-to-End Delay and End-to-End Delay Variation on Fax-over-IP (FoIP) and Modem-over-IP (MoIP)**
STQ ETSI STF #392

**Joint ITU-ZNIIS & ETSI-ZNIIS research activity in testing area**

**4-th ETSI IMS Plugtests**
ZNIIS are going to participate as a remote test site for Plugtests event
Conclusions

The QoS/QoE/NP testing are begun one of the central topic for research by International standardization organizations (ITU, ETSI)

The previous mechanism which was standardized based on subjective and mathematical estimation which contradict with expected QoS

The innovation approach of QoS/QoE/NP testing have to be realized on the real networks

ITU has to provide help for developing countries on testing/monitoring QoS/QoE/NP
Denis Andreev

Director of Technopark ZNIIS, Rapporteur of Q.10/11 SG11 ITU-T

tel: +7-495-368-8745
Tel: +7-495-368-8745
mobile: +7-495-647-9603
Fax: +7-495-368-9105
skype: davwilly77
sipnet: 2811971@sipnet.ru
E-mail: andreevd@zniis.ru
cc: andreevd@ties.itu.int

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Russia, 111141, Moscow, 1-st Proezd Perova polya, 8