

**ITU Forum on Conformance and Interoperability  
Testing in CIS and Europe Regions  
(Moscow, Russia, 9-11 November 2011 )**

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

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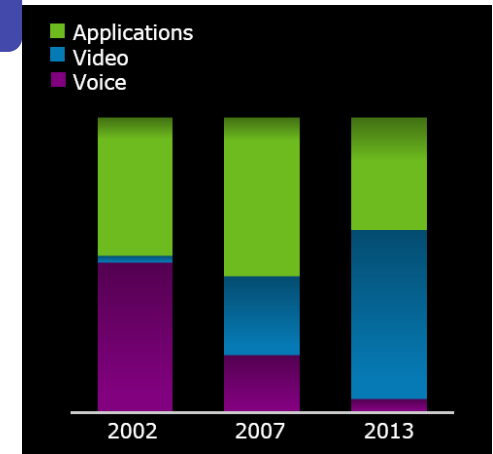
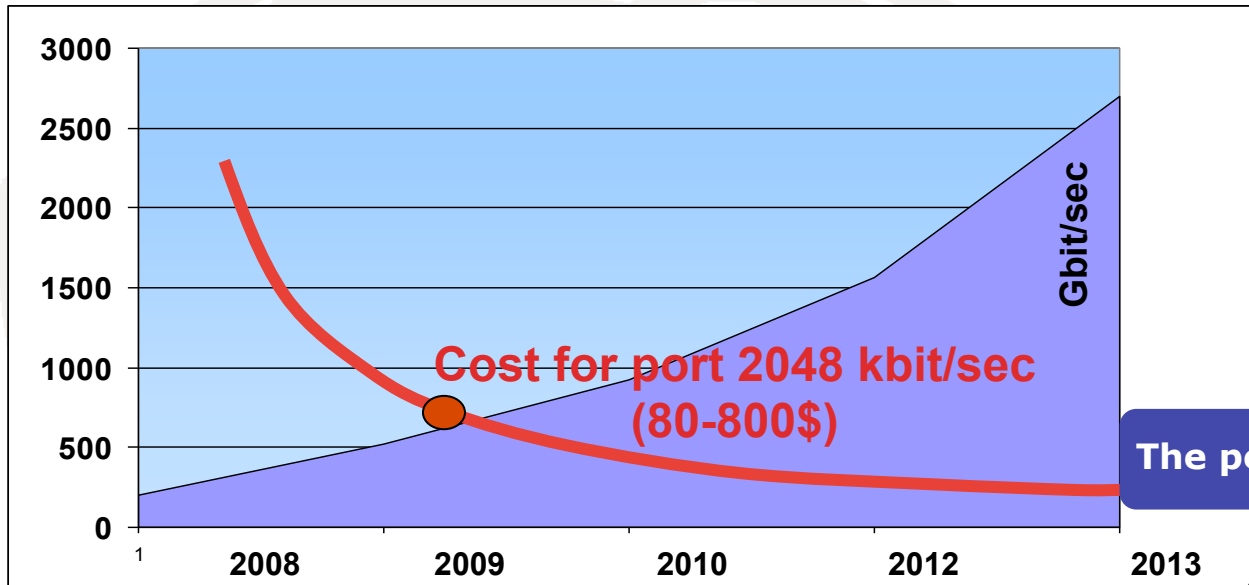
**ZNIIS, Moscow**

# Content

- 1. Explanation of QoS/QoE/NP Handbook creation in ITU**
- 2. History of Handbook creation**
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- 4. The typical approach and common problems on QoS estimation**
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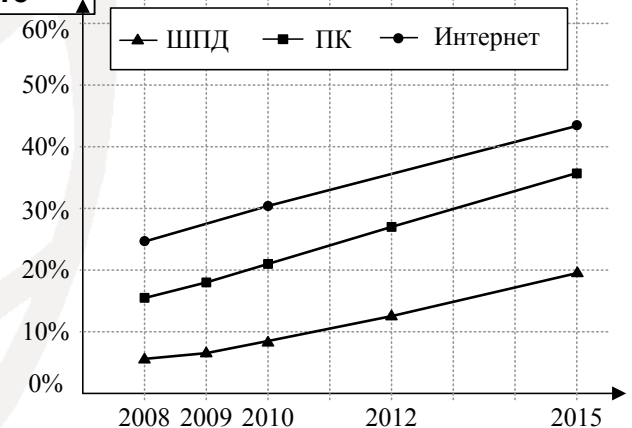
# Exist situation and dynamics of global telecom market in services

## The total network performance on transport layer

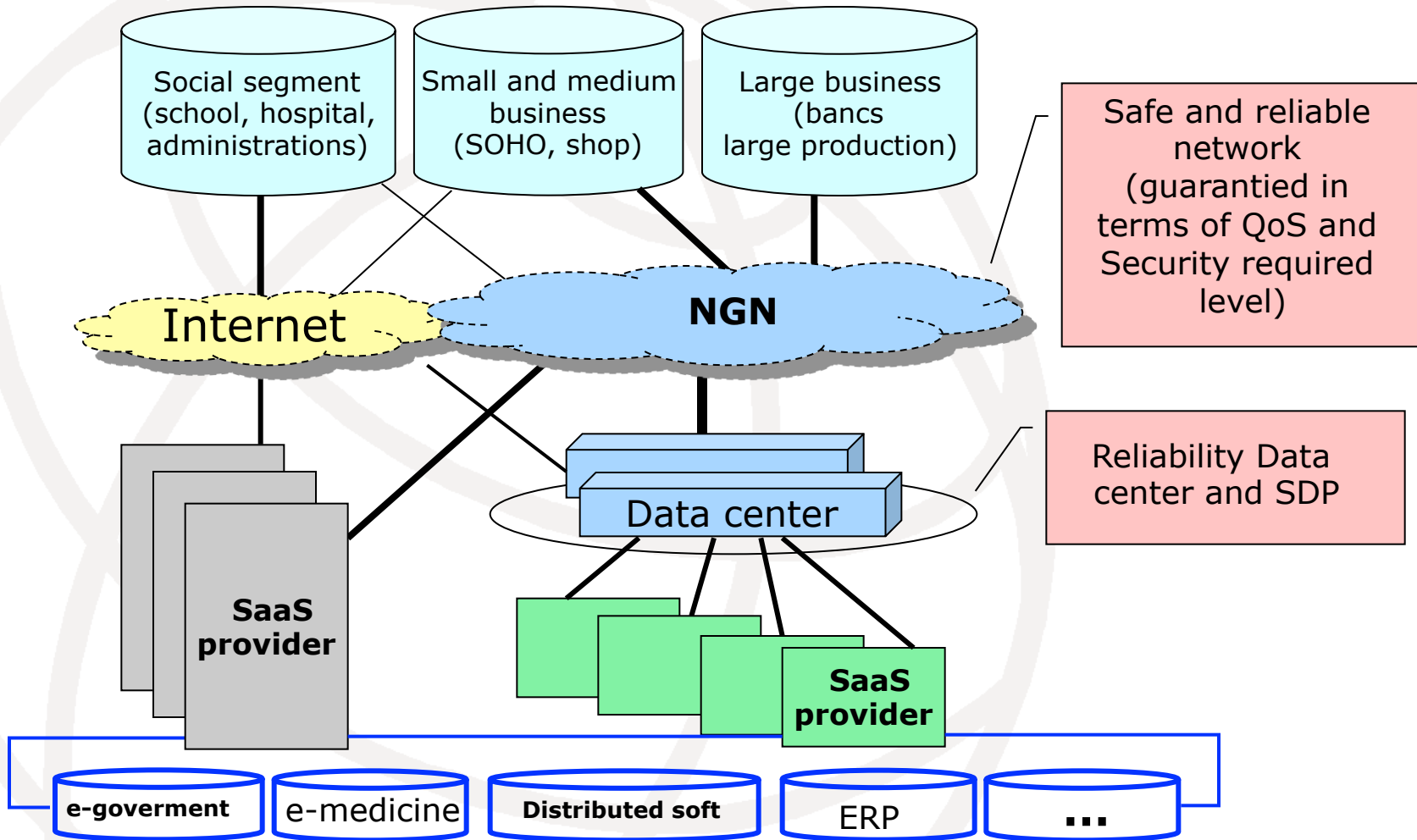


## The penetration rate of BBA in Russia

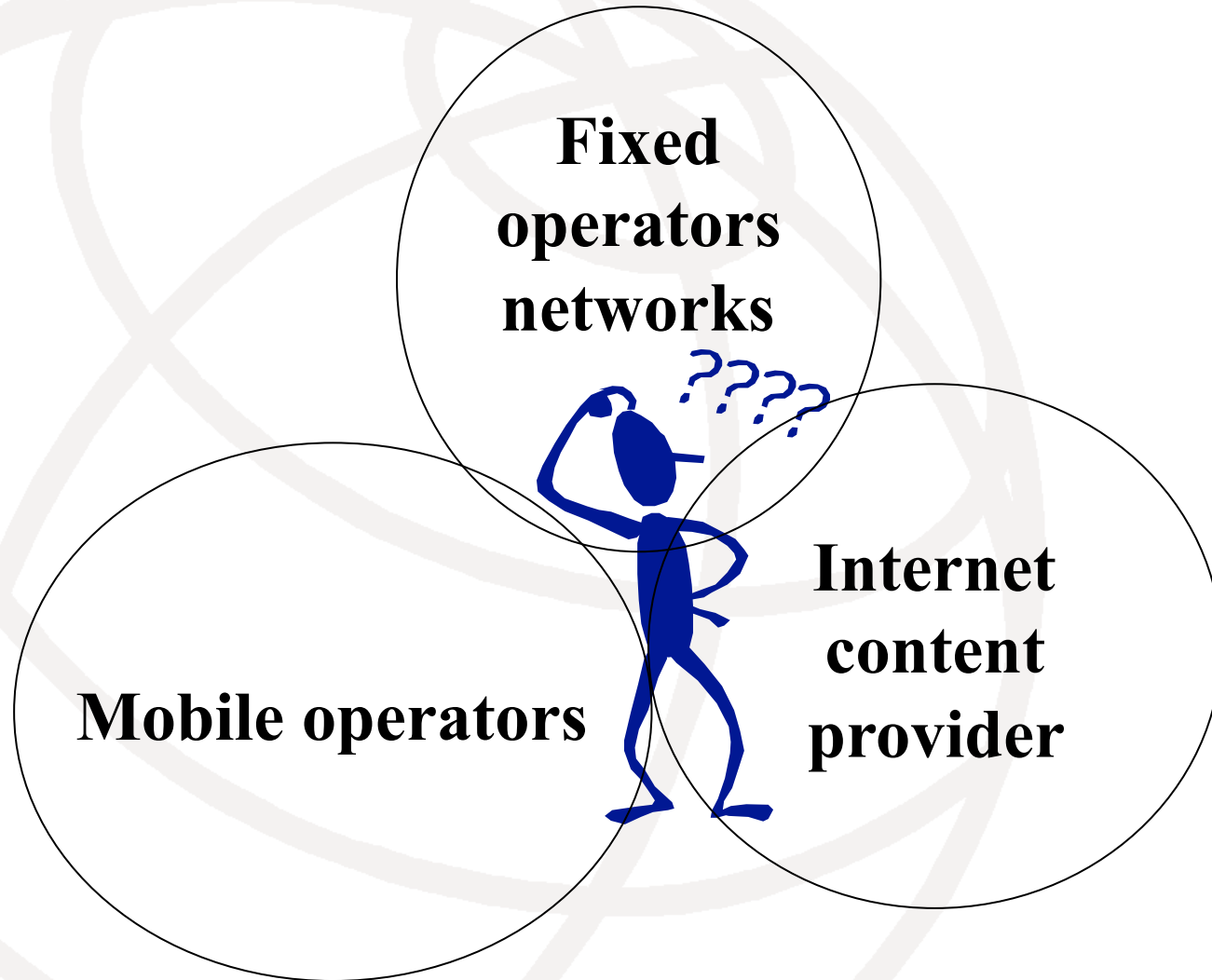
Further network deployment stages will be held in a systematic lack of available bandwidth and the backlog of technology development from traffic growth



# Future model of Telecom services



# Whose will be the customer?



# 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**

# Contents of Handbook

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**Annex B. Signaling timers for SIP-IMS protocol**

**Annex C. NP/QoS testing results on Model networks**

# 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**

# MOS definition

**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.**



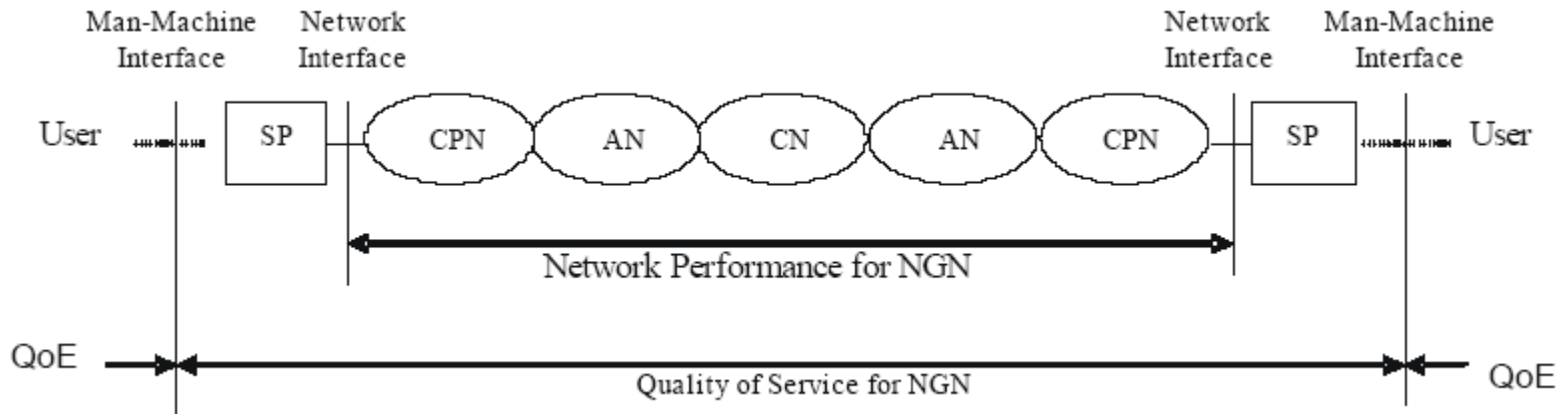
# MOS/R-factor correspondence

R Value	MOS CQEN Value	Categories of User Satisfaction
94	4,42	Very satisfied (Best)
93	4,40	
92	4,38	
91	4,36	
90	4,34	
87	4,195	Satisfied (High)
85	4,18	
82	4,09	
81	4,06	
80	4,03	
77	3,85	Some users dissatisfied (Medium)
73	3,74	
70	3,60	
68	3,50	Many users dissatisfied (Low)
60	3,10	
50	2,58	Nearly all users dissatisfied (Poor)

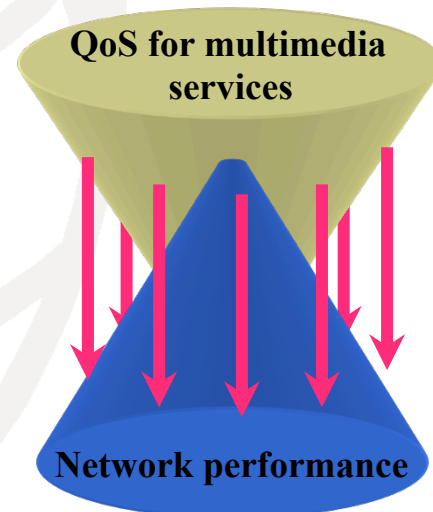
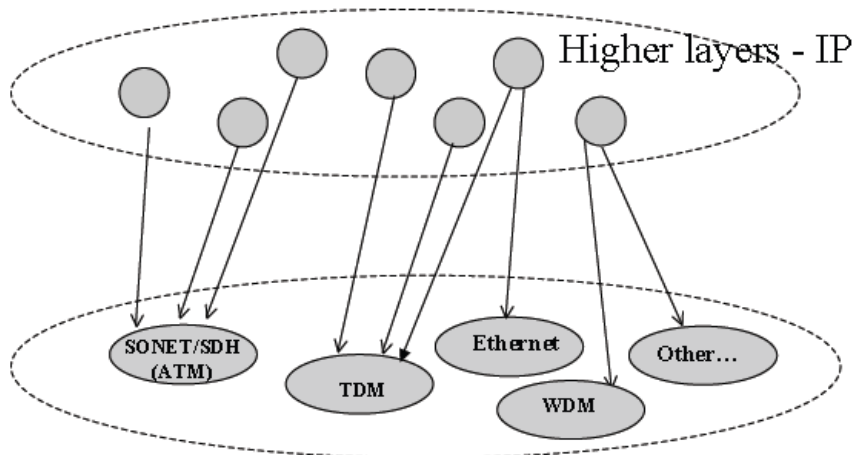
$MOS = 1 + (0,035) \times R + (000\ 007) \times R (R - 60) (100 - R)$

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 it values



# ITU-T Recommendation on QoS support

## E-series

**Checking the quality of international telephone service: ITU-T Recommendations E.420, E.421, E.422, E.427, E.428, E.430, E.431, E.432, E.437, E.440, E.450, E.451, E.453, E.470**

**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

**General Guidelines for quality of transmission (for international telephone connection): ITU-T Recommendations G.100, G.100.1, G.107, G.108, G.108.1, G.109, G.101, G.111, G.114, G.116, G.131**

**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**

**Digital Transmission Systems: ITU-T Recommendations G.711 Annex I, G.728 Annex II**

**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

**Measurement parameters of analog transmission systems: ITU-T Recommendations O.42, O.61, O.62, O.71, O.81, O.82, O.91, O.95, O.111, O.131**

**Measurement equipment parameters of digital transmission systems and the parameters of the analog / digital transmission systems: ITU-T Recommendations O.132, O.133, O.151, O.152, O.171, O.172, O.181, O.191**

# ITU-T Recommendation on QoS support P-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:**

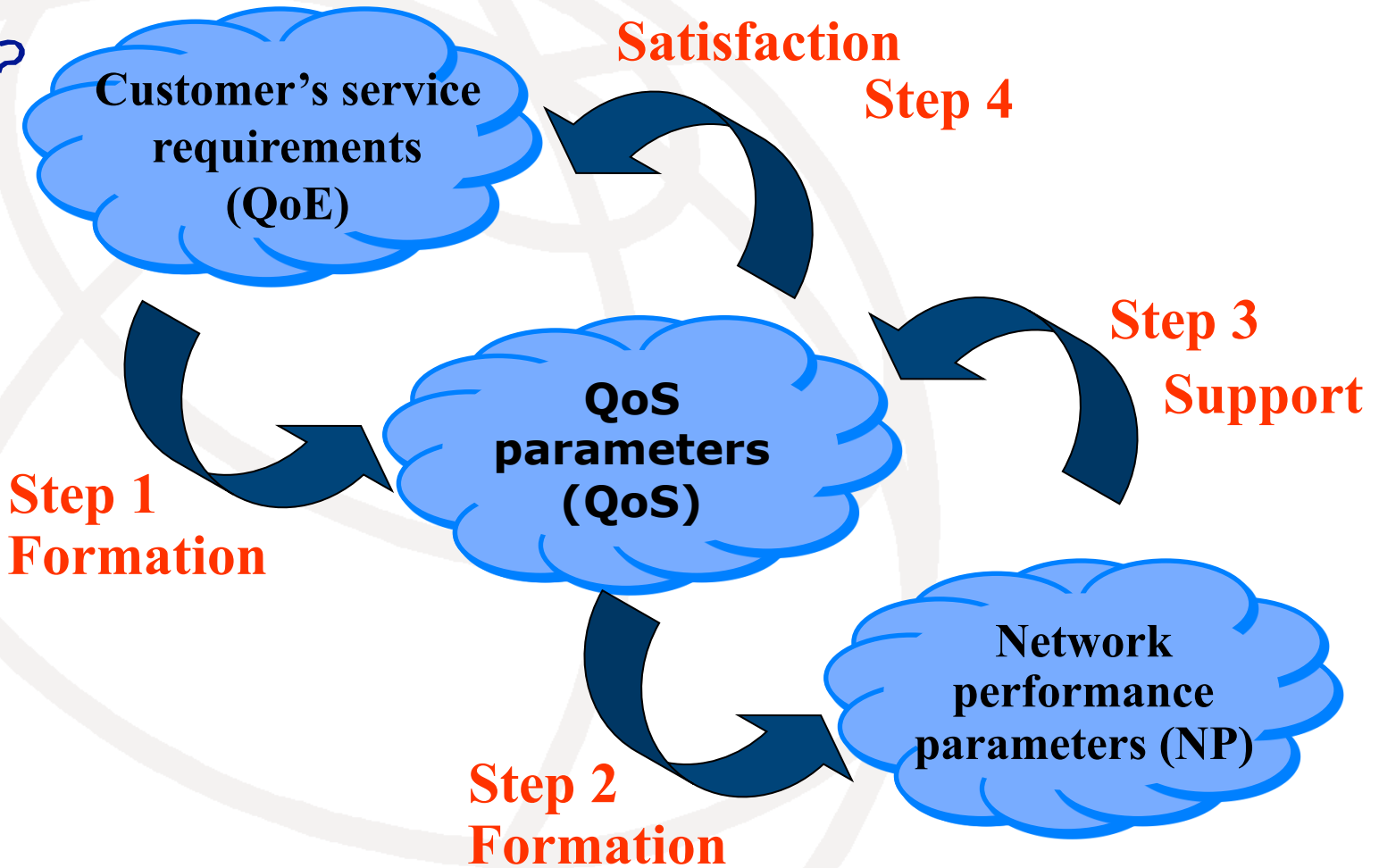
**Problems of Internet Protocol (IP):**

- **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



# 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)**

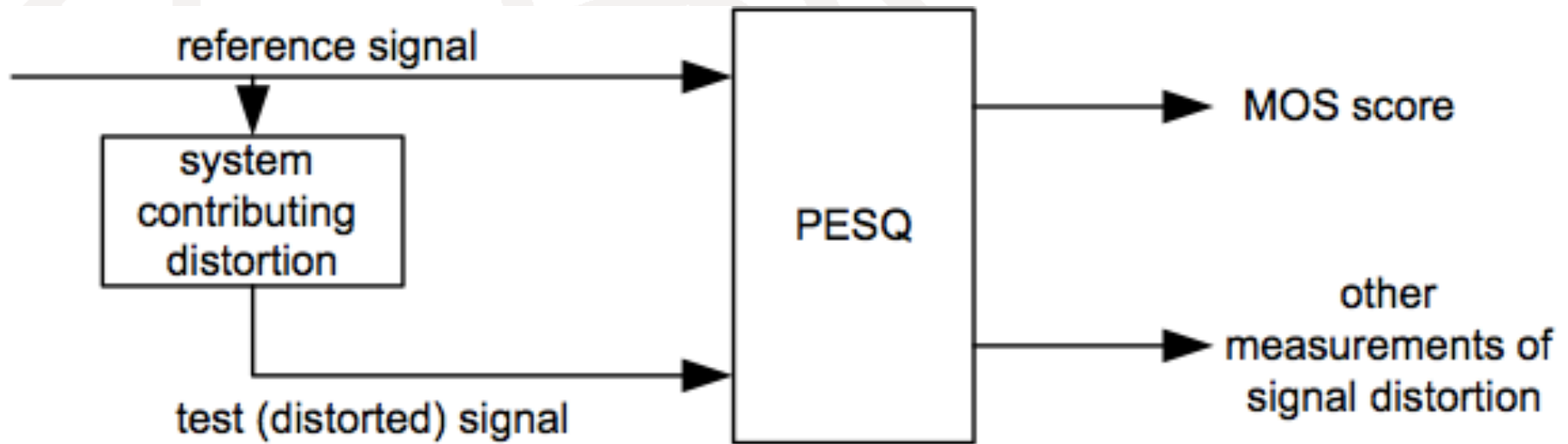
## Active - PESQ

**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



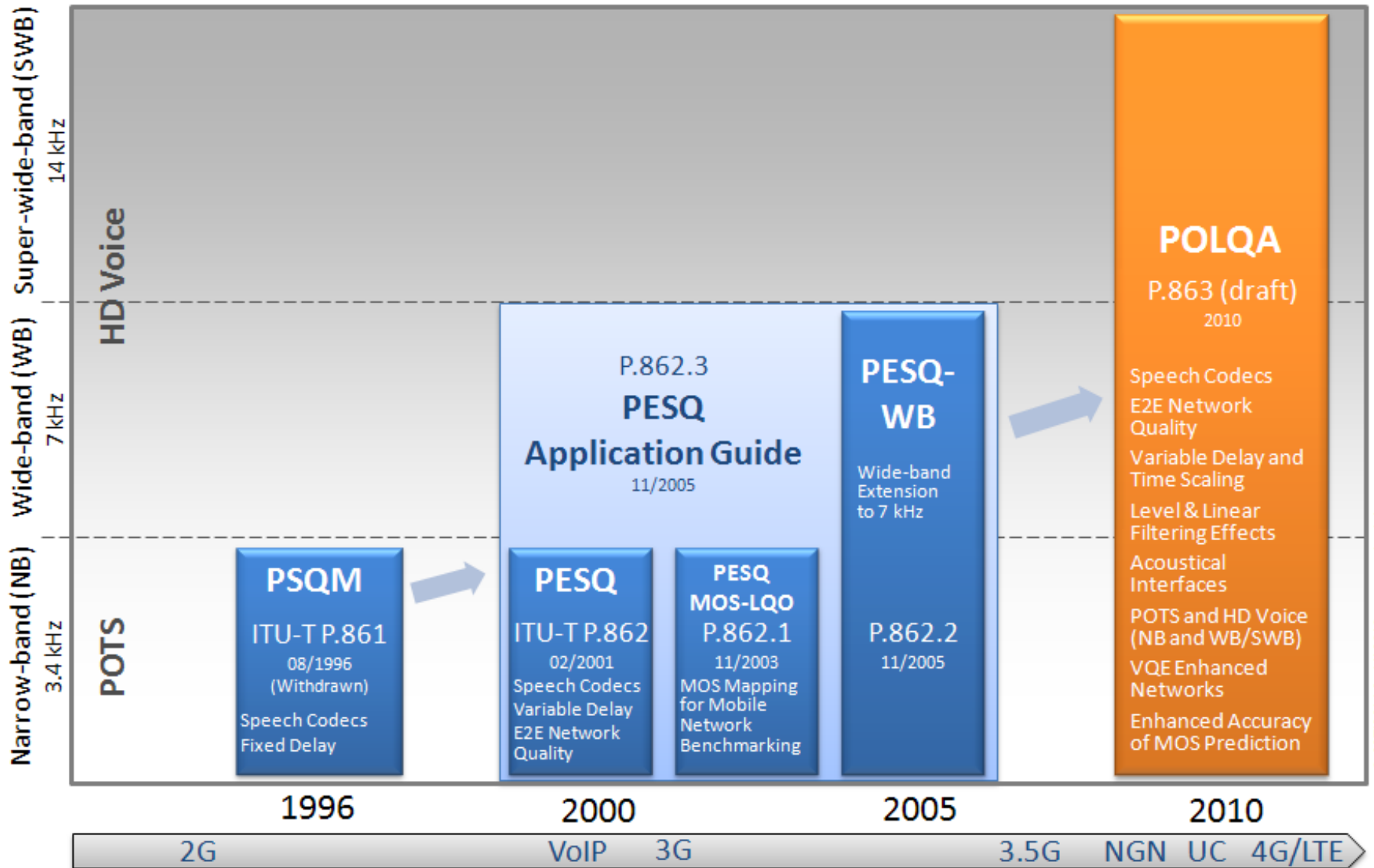
## The Future of PESQ - POLQA

**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**

# POLQA

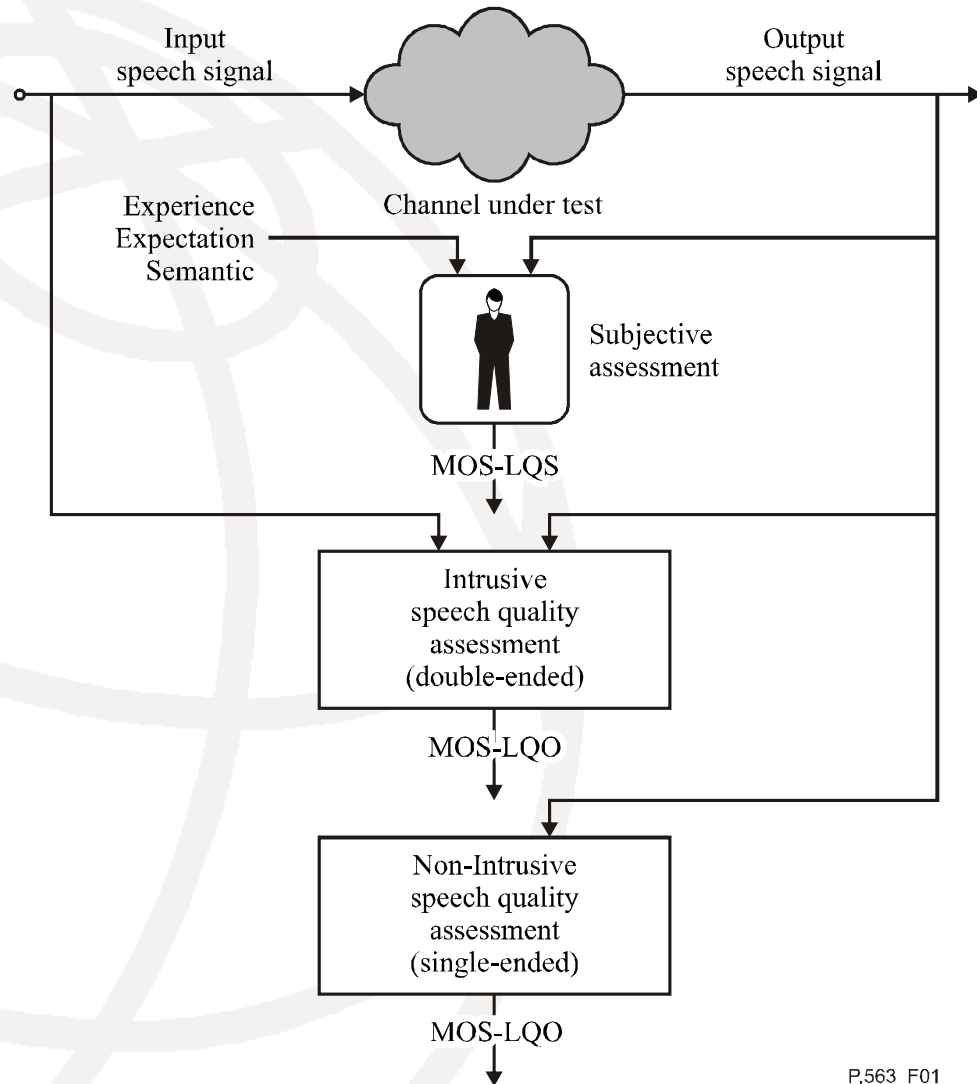


## **Passive (Rec. ITU-T P.563)**

**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 from  
0,85 till 0,9**





# E-model

**The Modeling method based on E-model algorithm (Rec. ITU-T G.107).**

**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**

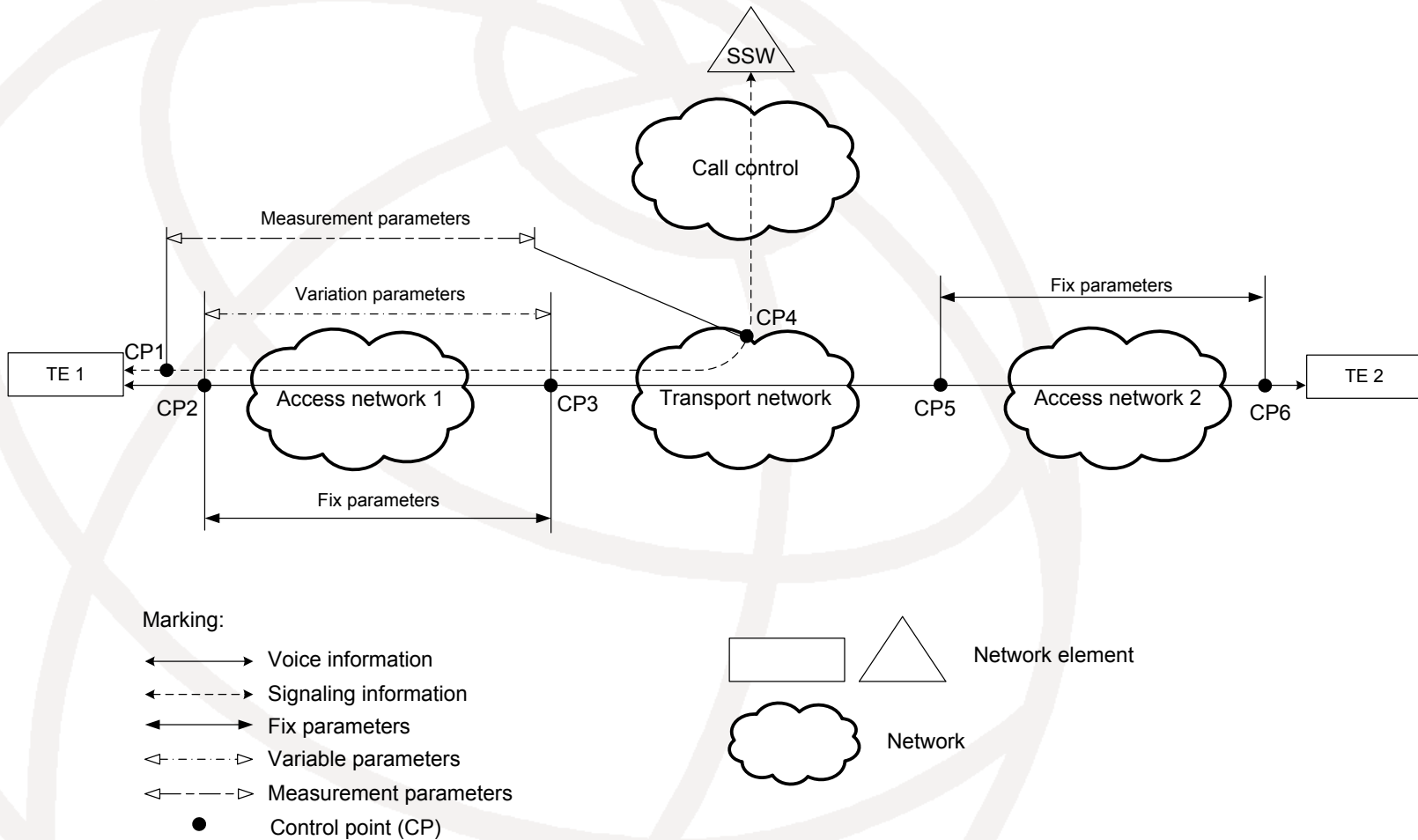
**I know only one way to judge the future –  
it's based on the past**

**Patrick Henry Pearse. Irish playwright, poet**

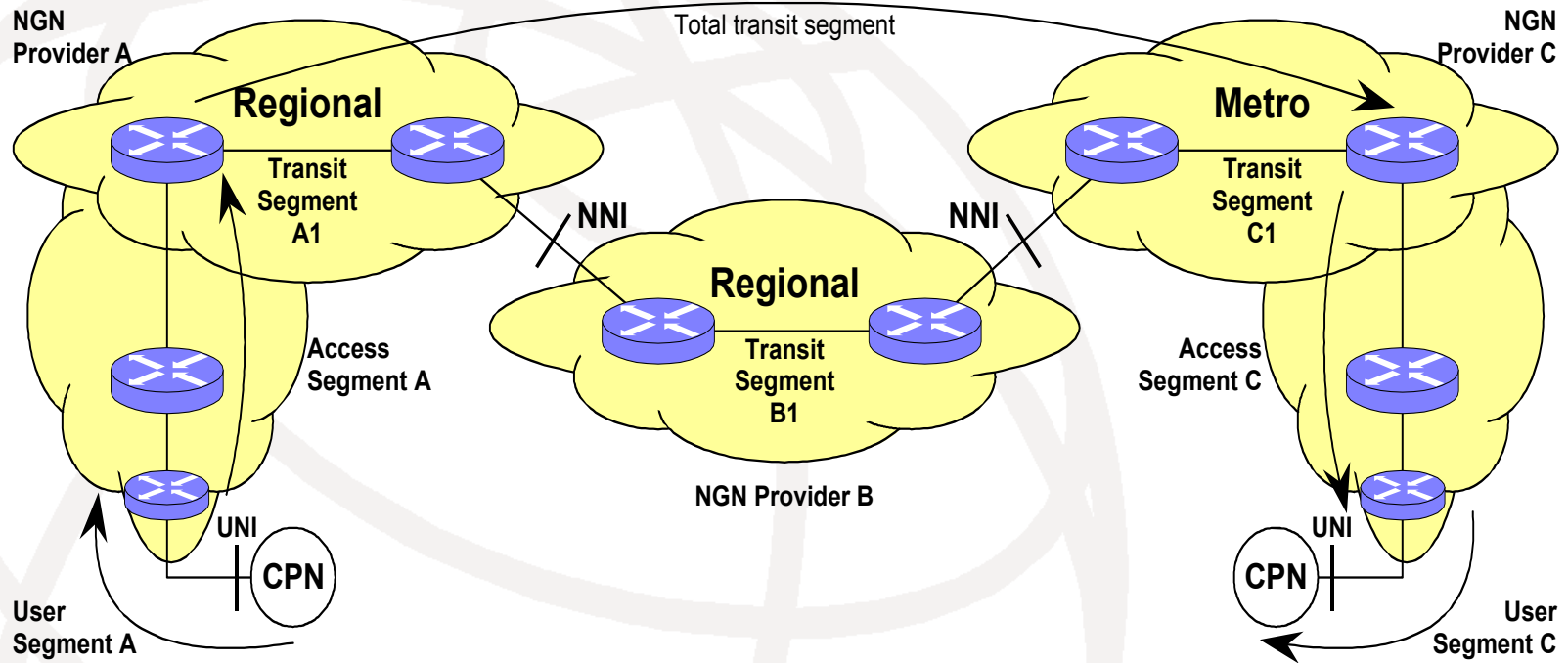
## INNOVATION APPROACH ON ESTIMATION AND QoS/QoE/NP MONITORING

- ❑ **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



# 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

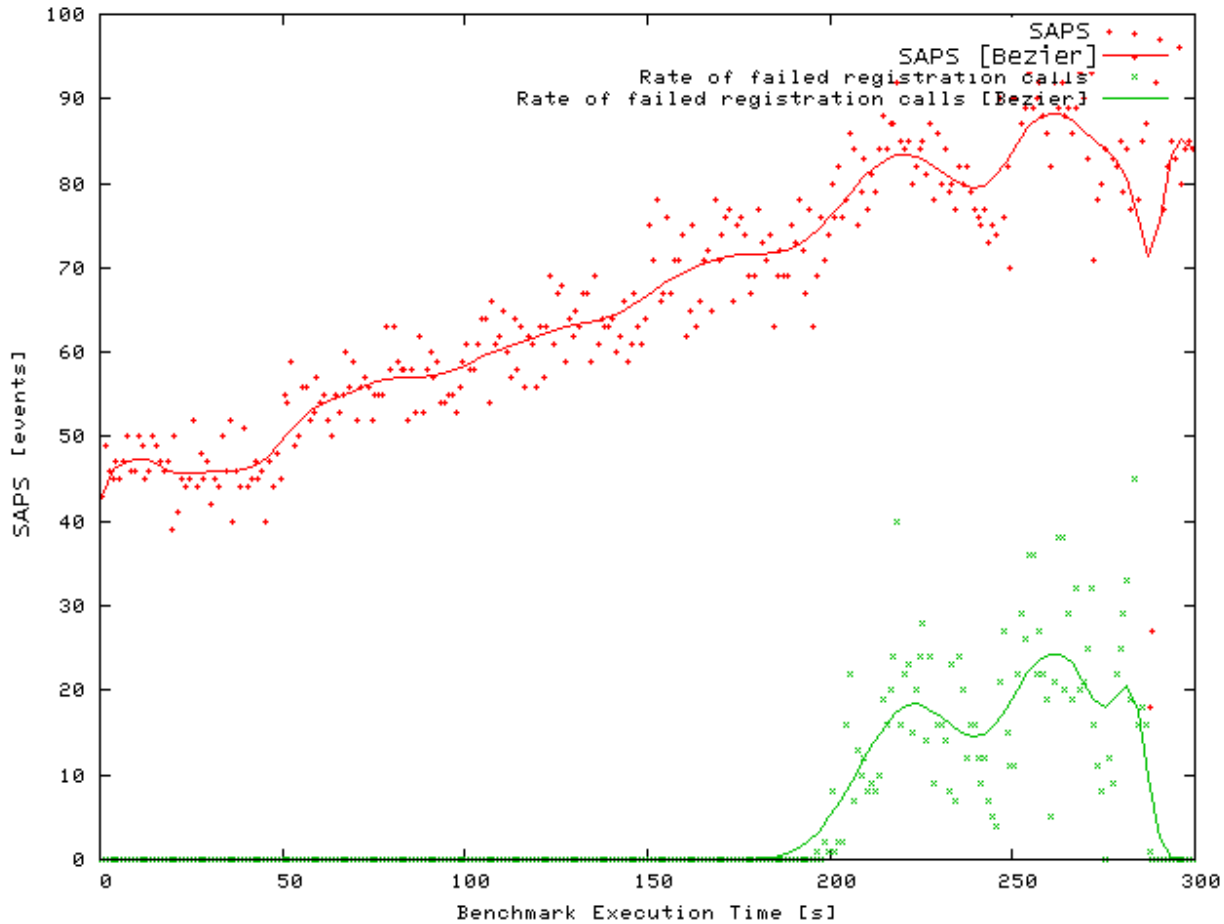


## The results of ETSI benchmarking

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

	<b>PSTN/ISDN Delay (ms)/R</b>	<b>DSL Delay (ms)/R</b>
PSTN/ISDN	68 ms / R=91 (20 ms Packet size) 48 ms / R=92 (10 ms Packet size)	102 ms - 144 ms / R=79 (20 ms Packet size) (le = 11)
DSL	108 ms - 153 ms / R=79 (20 ms Packet size) (le = 11)	160 ms - 207 ms / R=74 (20 ms Packet size) (le = 11)

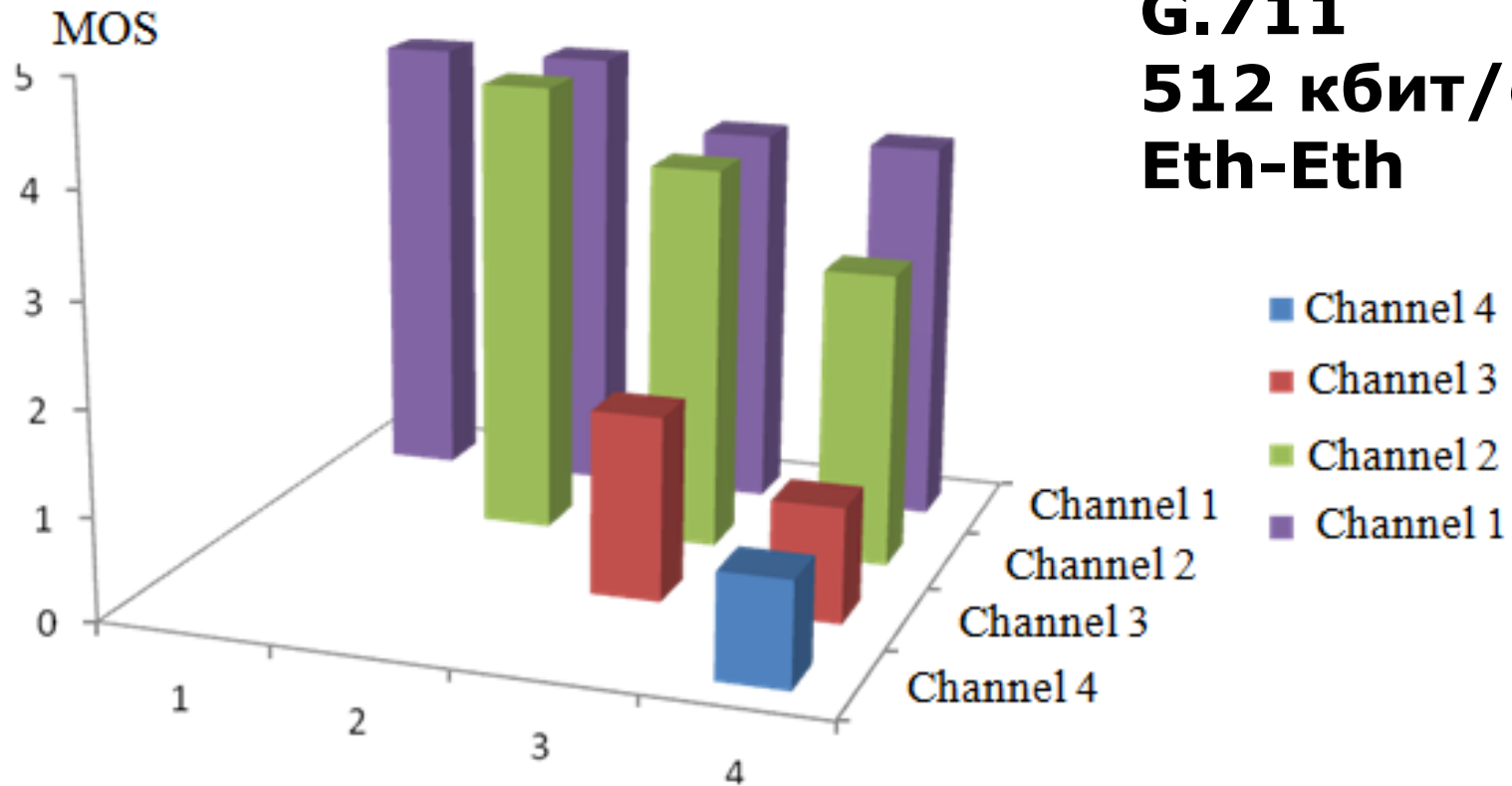
# The results of ETSI benchmarking



	Maximum	Minimum	Average	Variance	Standard Deviation	Median	Mode
Initiated Registrations Per Second [events]	98,00	18,00	66,68	225,80	15,03	66,00	63,00

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

**Service  
G.711  
512 кбит/с  
Eth-Eth**

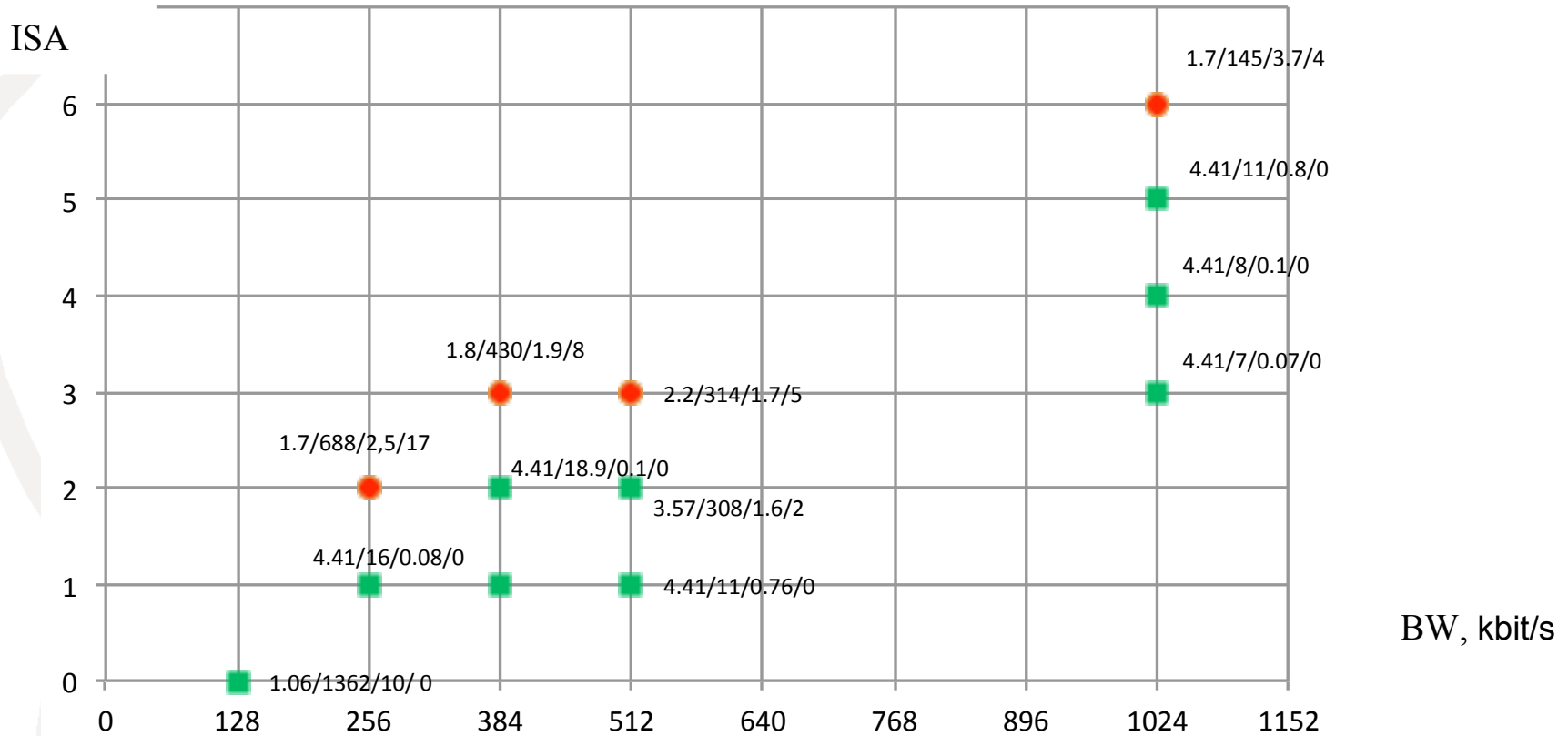


MOS distribution channels at a value of bandwidth 512 kbit/s

**LNCS. Springer 2011 "The approach of network performance and network productivity parameters on QoS estimation and its impairment. Service Benchmarking."**

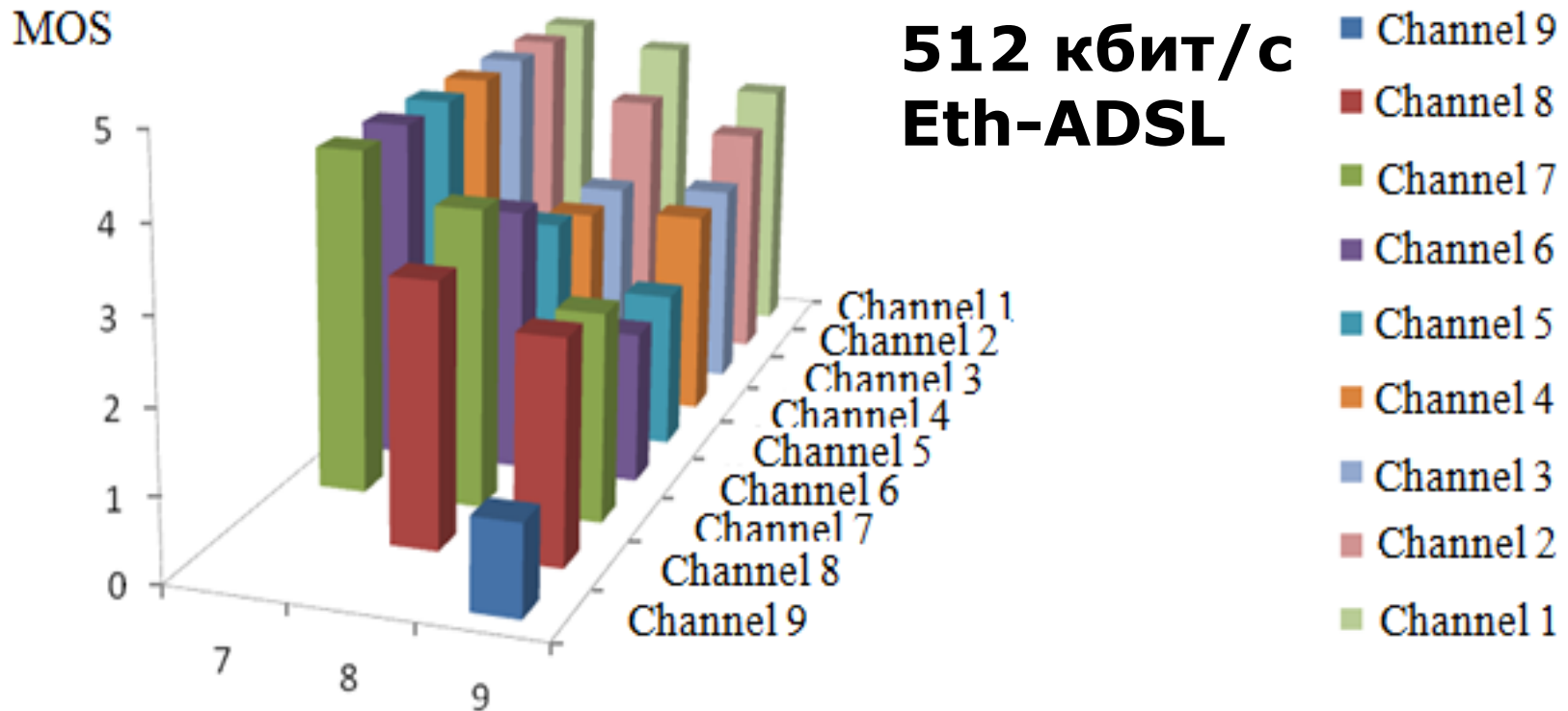
Denis.Andreev, Konstantin.Savin, Victor.Shalaginov, Viya.Zharikova, Sergey.Ilin

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

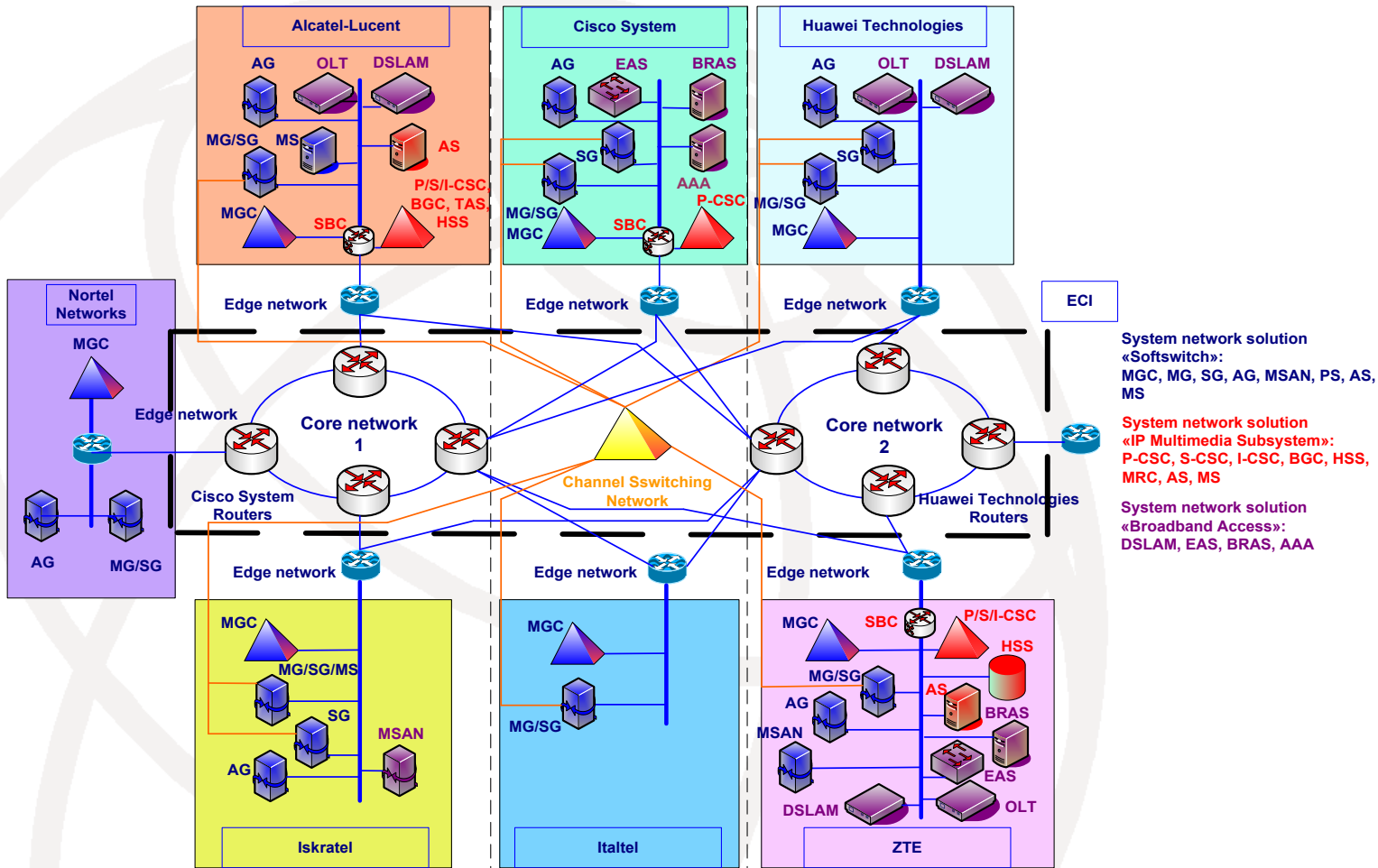


# The results of testing under innovation approach (joint project ITU-ZNIIS CIS-08)

**Service**  
**G.711**  
**512 кбит/с**  
**Eth-ADSL**



# ZNIIS Technopark Model network

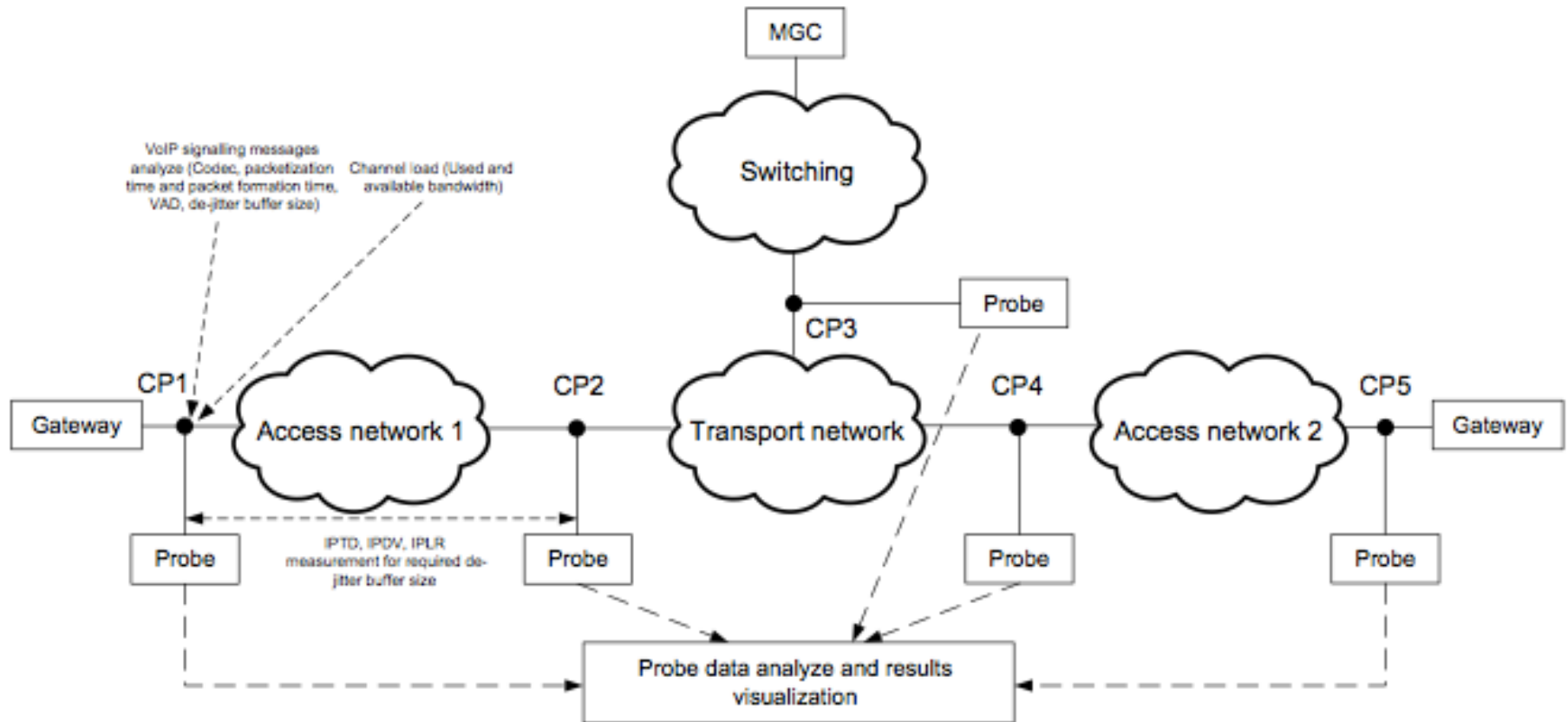


**Rec. ITU-T Q.3900 Methods of testing and model network architecture for NGN technical means testing as applied to public telecommunication networks**

# The typical approach on estimation QoS/QoE/NP by operators

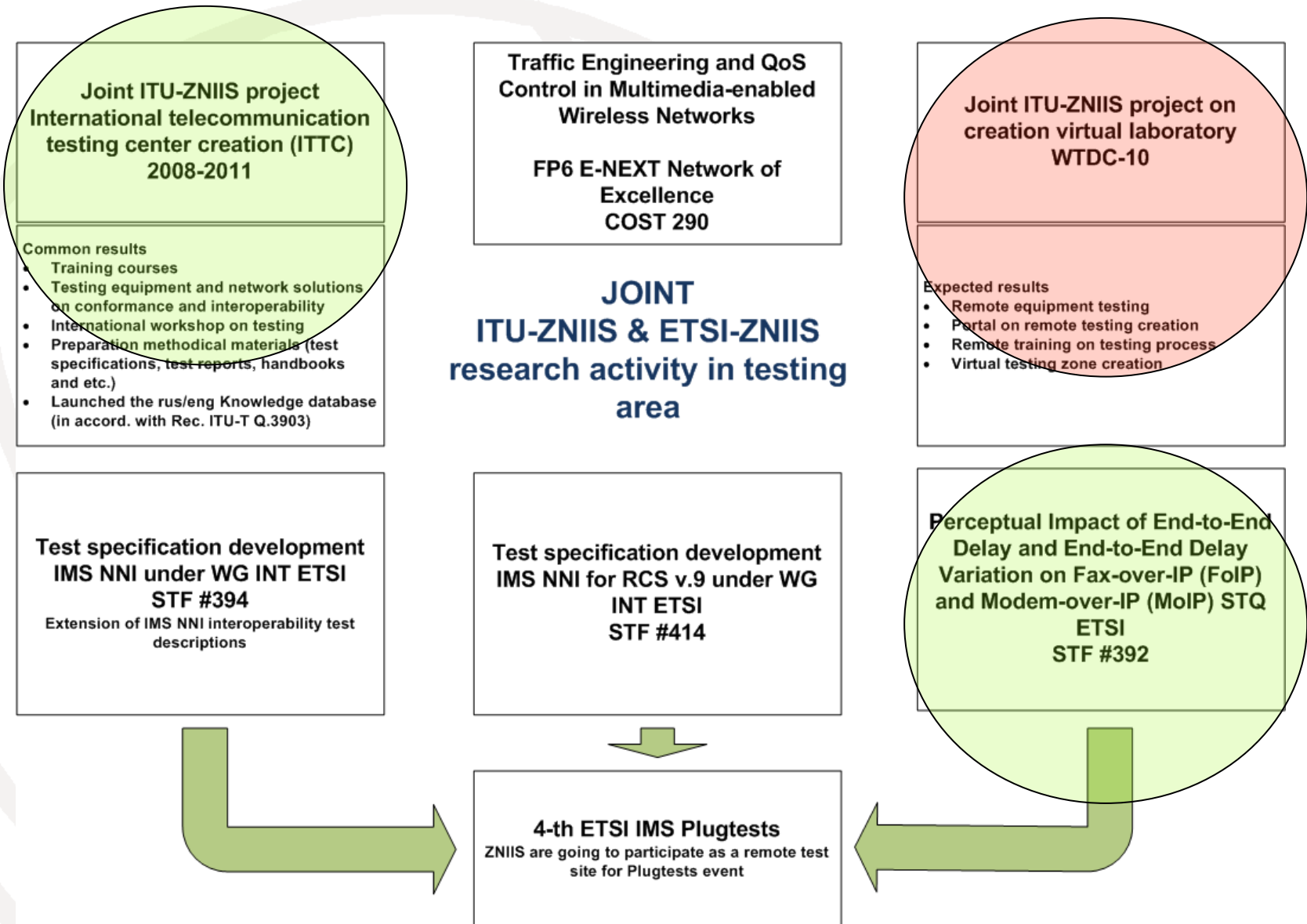
- ✓ **The QoS/NP norms on the network segment determination for different telecom technologies and services**
- ✓ **Service modeling with determination QoE model (etalon model of service)**
- ✓ **Benchmarking services and networks**
- ✓ **Interoperability testing**
- ✓ **Testing on RFP conformance**
- ✓ **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



# 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**

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