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SERIES E: OVERALL NETWORK OPERATION,
TELEPHONE SERVICE, SERVICE OPERATION AND
HUMAN FACTORS

Quality of telecommunication services: concepts, models,
objectives and dependability planning – Models for
telecommunication services

Quality measurement in major events

Recommendation ITU-T E.811

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Recommendation ITU-T E.811

Quality measurement in major events

Summary

Recommendation ITU-T E.811 addresses the quality assessment of mobile broadband and voice services provided during major events, such as FIFA World Cups and Olympic and Paralympic Games, by creating a useful international reference to be considered by operators and regulators when preparing to host such events.

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FOREWORD

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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.

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Introduction

To ensure a quality of service (QoS) and quality of experience (QoE) in mobile broadband and voice services in and around crowded and large venues, with thousands of people sharing pictures, videos and accessing social networks simultaneously, is a big challenge for operators and regulators worldwide. This scenario comes as a result of the fast penetration of smartphones and the increase of quality thresholds necessary to guarantee user satisfaction. Taking into account that monitoring strategies to be adopted by regulators are not well defined yet, the efforts to measure QoS and QoE parameters to assure good quality during major events are based more in empiricism than in standards and trusted technical references.

The reports from FIFA World Cup Brazil 2014 and Rio 2016 Summer Olympic Games showed the explosion of voice, data and SMS traffic during the events, not just inside the game venues at the host country but in many regions around the world, due to the massive sharing of pictures and videos in social media and streaming applications. In this scenario, the biggest challenges faced by operators is to forecast the traffic demand and then deploy an infrastructure that mix 2G, 3G, 4G, 5G and Wi-Fi offloading approaches to ensure the quality of mobile services during the events, especially inside and around the crowded stadiums. Given the lack of technical references for this specific context of service provision, the successful experiences and main issues faced by the previous host countries is sometimes the unique reference.

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Recommendation ITU-T E.811

Quality measurement in major events

1 Scope

This Recommendation addresses the quality assessment of mobile broadband and voice services provided during major events, such as FIFA World Cups and Olympic and Paralympic Games, by creating a useful international reference to be considered by operators and regulators when preparing to host major events.

This Recommendation covers the following:

- 1) traffic forecasting and network dimensioning applied to major events
- 2) establishing strategies of QoS and QoE measurements during major events
- 3) identifying the relevant key performance indicators (KPIs) to be measured
- 4) establishing network capabilities and reasonable thresholds that should be achieved to assure users satisfaction in the context of major events.

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 E.800]	Recommendation ITU-T E.800 (2008), <i>Definitions of terms related to quality of service.</i>
[ITU-T E.802]	Recommendation ITU-T E.802 (2007), <i>Framework and methodologies for the determination and application of QoS parameters.</i>
[ITU-T E.803]	Recommendation ITU-T E.803 (2011), <i>Quality of service parameters for supporting service aspects.</i>
[ITU-T E.804]	Recommendation ITU-T E.804 (2014), <i>QoS aspects for popular services in mobile networks.</i>
[ITU-T E.807]	Recommendation ITU-T E.807 (2014), <i>Definitions, associated measurement methods and guidance targets of user-centric parameters for call handling in cellular mobile voice services.</i>
[ITU-T E-800 series]	ITU-T E-800 series Supplement 9 (2013), <i>Supplement 9 to ITU-T E.800-series Recommendations (Guidelines on regulatory aspects of QoS).</i>
[ITU-T P.10]	Recommendation ITU-T P.10/G.100 (2006), <i>Vocabulary for performance and quality of service.</i>

3 Definitions

3.1 Terms defined elsewhere

This Recommendation uses the following terms defined elsewhere:

3.1.1 benchmark [ITU-T E.804]: Evaluation of performance value(s) of a parameter or set of parameters for the purpose of establishing value(s) as the norm against which future performance achievements may be compared or assessed.

3.1.2 call [b-ETSI EG 202 009-2]: Any connection (fixed or temporary) capable of transferring information between two or more users of a telecommunications system. In this context a user may be a person or a machine.

3.1.3 customer [ITU-T E.800]: A user who is responsible for payment for the services.

3.1.4 measure [ITU-T E.800]: A unit by which a parameter may be expressed.

3.1.5 multimedia services [ITU-T E.800]: A telecommunications service that supports the simultaneous use of multiple media types (e.g., voice, data, video).

3.1.6 network operator [ITU-T E.802]: An organization that provides and operates a telecommunication network for the purpose of transporting bearers of telecommunication services.

3.1.7 quality of experience [ITU-T P.10]: The overall acceptability of an application or service, as perceived subjectively by the end-user.

NOTE 1 – Quality of experience includes the complete end-to-end system effects (client, terminal, network, services infrastructure, etc.).

NOTE 2 – Overall acceptability may be influenced by user expectations and context.

3.1.8 quality of service [ITU-T E.800]: Totality of characteristics of a telecommunications service that bear on its ability to satisfy stated and implied needs of the user of the service.

3.1.9 service [ITU-T E.800]: A set of functions offered to a user by an organization.

3.1.10 session [ITU-T E.804]: Continuous usage of a given service, e.g., a speech call or a data session.

3.2 Terms defined in this Recommendation

This Recommendation defines the following terms:

3.2.1 data PoI congestion: The cumulated data session block rate of all serving cells in the point of interest (PoI), during the desired measurement interval considering all data technologies.

3.2.2 data service availability: The numerical measurement of the service uptime on a data network where network resources for the service are available and functional. Mathematically, Data Service Availability = Service Uptime (hrs) / [Service Downtime (hrs) + Service Uptime (hrs)].

3.2.3 data session block rate: The ratio of the number of rejected data session requests to the total number of data session requests.

3.2.4 data session drop rate: The ratio of the number of dropped data sessions to the total number of established data sessions.

3.2.5 delay variation (jitter): The difference between the actual end-to-end delay measured and the minimum end-to-end delay observed.

3.2.6 download/upload data rate: The volume of downloaded/uploaded data traffic per second.

3.2.7 end-to-end delay: The length of time it takes for a data packet to be sent to the destination plus the time it takes for an acknowledgement of that data packet to be received. This is also known as the round-trip time (RTT).

3.2.8 packet data traffic utilization: The ratio of the cumulative utilized packet data resource elements (REs) on the e-NodeBs and EPC to the available packet data resources.

3.2.9 RF traffic channel utilization: The ratio of the cumulative occupation of RF traffic channels on the access network to the available RF traffic channels in a specific cell.

3.2.10 voice block call rate: The ratio of the number of blocked calls to the total number of call attempts.

3.2.11 voice call drop rate: The ratio of the number of dropped calls to the total number of established calls.

3.2.12 voice PoI congestion: The cumulated voice block call rate of all serving cells in the PoI, during the desired measurement interval considering all voice technologies.

4 Abbreviations and acronyms

This Recommendation uses the following abbreviations and acronyms:

BTS	Base Transceiver Station
CE	Channel Elements
COW	Cell On Wheels
CQI	Channel Quality Indicator
CRH	Cell Reselection Hysteresis
DAS	Distributed Antenna System
EPC	Evolved Packet Core
KPI	Key Performance Indicator
LAC	Location Area Code
MNO	Mobile Network Operator
NMS	Network Management System
OTT	Over The Top
RB	Resource Blocks
PoI	Point of Interest
PM	Performance Management
QoE	Quality of Experience
QoS	Quality of Service
RAN	Radio Access Network
RF	Radio Frequency
ROA	Recognized Operating Agency
SDCCH	Stand-alone Dedicated Control Channel
SMS	Short Message Service
TCH	Traffic Channel
TFQ	Traffic Forecasting Question
TRX	Transceiver

5 Conventions

Regulator: telecommunications regulatory governmental body, for example a telecommunications agency, authority or ministry.

Operator: recognized operating agency (ROA) or operating agency licensed to provide telecommunications mobile voice and/or data services in the country that is hosting a major event.

6 Traffic forecasting and network dimensioning applied to major events

6.1 Considerations for traffic forecasting in major events

Defining the correct traffic forecasting strategy to estimate the demand for voice and data services is the first key step to ensure the provision of service quality in major events. The following actions are recommended in order to estimate the traffic of voice and data services in major events:

- a) Operators should begin performing a comprehensive mapping of the events schedule, the games specific characteristics and the locations used, in order to know when, where and how long the crowds are supposed to be at the main venues and surrounding areas, training centres, public transport lines and popular squares (points of interest (PoI)). The event sponsor may provide information about the expected audience, as well as the expected user profile.
- b) After mapping the event details the operators should better understand users' expectations for the usage of mobile networks during the games and plan their networks to provide the best possible experience. Defining an average user usage profile based on the mapping information may simplify the network design.
- c) In order to tackle the challenge of estimating usage profiles that better approximate the prepaid, post-paid and roaming users' behaviours in the scenario of major events, where the demand for telecommunication services is disproportionately excessive when compared with the regular demand faced by operators, the use of interactive forecasting methods is recommended. For example, the Delphi Methodology [SACKMAN, H. (1974)] has been used by telecommunication experts who are experienced in demand analysis, traffic management and network planning and operation, and engaged by mainly operators and vendors with know-how in service provision in stadiums and concert arenas. It is also recommended to collect information directly from users through customer surveys, in order to directly capture what their preferences would be during the games.
- d) As well as deciding which information gathering methodology should be adopted, the operators must precisely define which sort of information is important for traffic dimensioning in this scenario. In order to comprehensively understand users' behaviours and elaborate accurate usage profiles for voice and data services, it is recommended for operators to, at the least, answer the traffic forecasting questions (TFQs) below:

Table 1 – Traffic forecasting questions (TFQs)

ID	Question	Methodology
TFQ1	What is expected to be the percentage of mobile prepaid/post-paid/roaming users from a given operator inside each relevant location related to the major event, e.g., the game venue and its surrounding areas?	Delphi
TFQ2	What is expected to be the smartphone penetration among these prepaid/post-paid/roaming users?	Delphi
TFQ3	What is expected to be the distribution of the prepaid/post-paid/roaming users among the mobile network technologies available (e.g., 2G/3G/4G/5G)?	Delphi

Table 1 – Traffic forecasting questions (TFQs)

ID	Question	Methodology
TFQ4	What is expected to be the percentage of roaming users willing to use only Wi-Fi networks to access the Internet?	Delphi
TFQ5	How many traditional voice calls are the prepaid/post-paid/roaming users expected to make?	Delphi/Customer survey
TFQ6	How long (in seconds) on average are the prepaid/post-paid/roaming users expected to take on each call?	Delphi/Customer survey
TFQ7	What percentage of their voice plan are the prepaid/post-paid/roaming users willing to use in one game?	Delphi/Customer survey
TFQ8	What smartphone applications are the prepaid/post-paid/roaming users expected to use?	Customer survey
TFQ9	How many pictures are the prepaid/post-paid/roaming users expected to download/upload?	Customer survey
TFQ10	How many videos are the prepaid/post-paid/roaming users expected to download/upload?	Customer survey
TFQ11	What percentage of the data plan are the prepaid/post-paid/roaming users willing to use in one game?	Delphi/Customer survey

- e) Having collected the information to answer TFQs 5 to 11, the operators, when precisely modelling the users' voice and data traffic usage profiles per contract type and technology used, and making the correlation with these profiles and the information collected to answer TFQs 1 to 4, can then predict the peak traffic demand that should be supported by the network in each relevant location related with the major event.

6.2 Considerations for network dimensioning in major events

After conducting a forecast of the voice and data traffic demand, the operators' network dimensioning should be targeted to provide satisfactory QoS and QoE results, mainly in those KPIs identified in clause 8. In this regard, the following actions are recommended to be considered by the operators:

- complementary deployment of macro-cells, small cells and cells on wheels (COWs);
- conservative choosing of the network contention ratio (e.g., less than 1:10);
- provisioning of Wi-Fi networks for data traffic offloading;
- possibility of dynamic changing in radio access network (RAN) parameters to guarantee coverage and capacity for moving crowds.
- interference management among the RAN elements and also the professional media equipment (e.g., intermodulation issues) to avoid degradation in spectral efficiency.

7 Strategies of QoS and QoE measurement during major events

One of the main roles of the government in the preparation for hosting a major event is to ensure that the installed telecommunication network capacity in all the relevant locations related to the major event is adequate to meet the higher than typical peak demands from a large amount of users making voice calls, sending SMSs, downloading and uploading pictures and videos and accessing social media at the same time. Also, it is recommended for the government to monitor the results of the QoS and QoE main KPIs during major events in order to guarantee that the voice and data traffic demand and profile experienced during the events are aligned with the prior traffic forecasting and network planning, thus reducing response time in case of performance degradation.