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Foreword

This Technical Report (TR) has been produced by ETSI Technical Committee Speech and multimedia Transmission Quality (STQ).

Standardization offers a large portfolio of QoS and QoE metrics to describe and assess the quality of services available through mobile devices. These standards also provide measurement methodologies to produce these QoS and QoE data. With a few exceptions (e.g. Multi-RAB), these methodologies use scenarios where a service is used exclusively. This is different from typical user behavior where multiple services are interchanged in the same session, or even run concurrently. The present document addresses this topic by providing a taxonomy and a descriptive framework which integrates multiple services and the use of multi-service applications with existing QoS and QoE metrics. It thereby integrates existing single-service methodologies effortlessly, such that they become a particular case of parametrization of a multi-service test case.

Modal verbs terminology

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Introduction

Mobile communication networks and smartphones are enabling a wide range of user-centric services, from text messaging and telephony to multimedia applications. Usage of such services often takes place in a concurrent way, i.e. several services are used in parallel, or in close succession.

While standardized quality metrics exist to describe individual services, aspects of concurrent usage are only addressed in a limited way (see for instance ETSI TS 102 250-2 [i.1], clause 6.12 and ETSI TR 103 114 [i.2]).

The purpose of the present document is to provide a comprehensive framework for testing concurrent use of multiple services. This framework is designed to be modular and scalable with respect to seamless expansion to new services. It is not restricted to particular services or multi-service carrier applications, i.e. it covers the whole range of "over the top" (OTT) applications and services.

1 Scope

The present document provides a framework for concurrent tests of multiple services, using a top-level approach which is also modular and scalable with respect to new services. Also, the framework explicitly integrates measurement methodology, in particular reproducibility aspects.

2 References

2.1 Normative references

Normative references are not applicable in the present document.

2.2 Informative references

References are either specific (identified by date of publication and/or edition number or version number) or non-specific. For specific references, only the cited version applies. For non-specific references, the latest version of the referenced document (including any amendments) applies.

NOTE: While any hyperlinks included in this clause were valid at the time of publication ETSI cannot guarantee their long term validity.

The following referenced documents are not necessary for the application of the present document but they assist the user with regard to a particular subject area.

[i.1] ETSI TS 102 250-2: "Speech and multimedia Transmission Quality (STQ); QoS aspects for popular services in mobile networks; Part 2: Definition of Quality of Service parameters and their computation".

[i.2] ETSI TR 103 114: "Speech and multimedia Transmission Quality (STQ); QoS Parameters and measurement methodology for Smartphones".

3 Definitions and abbreviations

3.1 Definitions

For the purposes of the present document, the following terms and definitions apply:

IP Multimedia Subsystem (IMS): telecommunication system for standardized access to services from different networks

NOTE: IMS specifications were created and are maintained by 3GPP.

Over The Top (OTT): In the context of services which use standard services of a network but may use also proprietary protocols.

NOTE: An example would be WhatsApp™ which uses packet data transfer to implement a group of services including but not limited to telephony, text messaging and file transfer.

3.2 Abbreviations

For the purposes of the present document, the following abbreviations apply:

3GPP	3rd Generation Partnership Project
IMS	IP Multimedia Subsystem
IP	Internet Protocol
MRAB	Multi Radio Access Bearer
OTT	Over The Top
QoE	Quality of Experience
QoS	Quality of Service
RAB	Radio Access Bearer
URL	Uniform Resource Locator
ViLTE	Video over LTE
VoIP	Voice over IP
VoLTE	Voice over LTE

4 Basic considerations

Concurrent or near-concurrent use of multiple services takes place in many user situations. In most cases, this happens unnoted, such as the download of an app update, e-mail, or some pre-scheduled music or video download during direct user activities such as telephony or web browsing.

In addition, there are applications that directly support usage of multiple services, e.g. sending or receiving images, videos or other units of data during a conversation.

Therefore, the performance of a particular service may depend on the activity environment in which it is taking place.

Existing network technologies already use resource optimization strategies, which make their behavior content-dependent. This context dependency can be expected to further increase. In upcoming 5G networks, this behavior is actually part of the design. Therefore, the importance of test strategies and subsequent methods of computation of data that support the concurrent use of multiple services, will increase. Consequently, test and measurement for QoS need to cover such situations, too.

The QoS standards literature recognizes a number of services. For each service, a set of QoS parameters is defined. This set is intended to express the quality of the service from a user's point of view.

Basically, there is a close connection between a service and a use case. In many cases, like telephony, this is a 1:1 relation - the service is essentially identical with the use case. In other cases, e.g. for Packet Data, a network-provided basic service provides the technical basis for a multitude use cases which belong to different end-user scenarios.

Every use case has a number of parameters which further define how the service is being used. For the purpose of the present document, two types of parameters are distinguished. Please note that the term parameter is used here not only in the sense of a numerical value. For instance, mobile originated and mobile terminated calls are both using the basic service "telephony". Roles and activities are, in this sense, also parameters.

External parameters describe **what** exactly the use case is supposed to do, such as the called number in telephony, the video URL in video streaming, the target URL in web browsing, or the data volume to be transferred in an upload or download case. **Internal** parameters describe **how** it is done. An internal parameter would be the dial-time out or the time-out for a download.

The basic requirement of repeatability demands that all these parameters have to be reported. Actually, in order to be able to repeat a test, more information may be, and usually is, required, such as information about the used hardware and software of platforms, and of course the outer conditions of testing, such as the mode (drive/walk/stationary; type of vehicle or transport service).

In a multi-service case, this distinction is more complex, because the exact composition of a use case does not only include the parameters of each component service, but also the way these service uses are combined. In the simplest case, this is relative timing, e.g. in Multi-RAB the delay between the start of component service A and service B. It will be shown later in the present document, however, that actual relations can become much more complex.

For some time, the Multi-RAB (MRAB) use case had rather high relevance and attention in the mobile network community. There is, however, no standardized set of QoS parameters for this case. The closest case covered by QoS standardization is IMS Multimedia Telephony (ETSI TS 102 250-2 [i.1], clause 6.12) which defines QoS parameters for the sub-services Telephony, Video, Text Messaging and file transfer (called File Sharing) as well as some QoS parameters for changing media composition.

Market solutions for MRAB, which came up during the 3G period of mobile network evolution, were characterized by an explicit diagnostic viewpoint. As resource management relates closely to basic mobile network processes, cross-action could take place. For instance, setting up packet data transfer could impact existing telephony connections and vice versa. Consequently, the QoS parameters set had explicit members, which expressed this interaction, e.g. the probability that a packet data setup led to a cut-off of the telephony connection.

These considerations lead to a fundamental question regarding a general multi-service framework, namely if this framework should also consider interaction between component services. This issue will be discussed in the next clause along with some basic considerations about the function or role of QoS parameters.

5 Function and functional limitations of QoS parameters

The main purpose of QoS parameters, as stated in literature, is to provide information about the quality of a service from a user's point of view. Actually, many QoS parameters defined in standardization also have a pronounced "diagnostic" angle. Using lower protocol layers as the points of observation (e.g. the IP layer, or Layer 3 messaging events) has assumedly the purpose of abstracting from user interface details. However, these layers typically also offer a high degree of detail or granularity, which is used to define a relatively large number of sub-phases for a transaction, and, consequentially, QoS parameters. Often, these phases are not directly linked to user-observable activities or distinguishable elements of user perception.

From a diagnostic point of view, the correlation between events can play an important role. As the example of MRAB shows, the setup of one service can lead to a disruption or degradation in the performance of another service. Expressing such relations in QoS parameters would be one way of creating diagnostically useful information.

The downside, however, is the exponential increase (combinatorial explosion) in QoS parameters when services are combined in a multi-service use case scenario. It also does not make sense to assume a causal relationship between actions in general. For instance, it is reasonable to assume that the probability that an action of one service affects a property of another service is a function of the time between these events. As a consequence, a QoS parameters would eventually also need to include some kind of time-distance condition, which could complicate things even more, in particular with respect to maintaining definitions over the lifetime of the underlying services.

The computation of QoS parameters from basic measurement results can be understood as "lossy compression" anyway, because information about the correlations is lost during aggregation. To explain this point, consider the following two examples:

a) A service S1 has two QoS parameters, K11 and K12, which describe two aspects of quality. Assume two different correlations - K11 tends to be proportional or anti-proportional to K12. In the QoS parameters plane, such a relationship is not visible. If transaction results are available individually, this data set can easily be mined for underlying patterns.

b) A second service S2 is run at the same time. Again, any cross-influences between these two services, which can also point to diagnostically relevant insights, is lost when QoS parameters are computed. A solution with explicitly designed QoS parameters to cover such correlations can produce such insights - but at the price of a combinatorial explosion of the number of QoS parameters when combining services. Also, design of such QoS parameters requires assumptions about mechanisms of influence, and need time criteria, i.e. they are not very robust against changes in the subject of measurement, and are hard to maintain over a longer period of time.

6 Concept of the multi-service framework

Based upon these considerations, it is not recommendable to strive for QoS parameters that express combinations of services in the context of a multi-service QoS framework. As laid out in the following clauses, the framework is based on the assumption that the service-specific QoS parameters of each service are used. The extension towards a multi-service testing scenario is then made on the methodology level.

This means that the QoS parameters are meant to be reported along with the conditions under which they have been measured. If two or more services are being used concurrently or in an intermittent way, the mutual timing and activity pattern becomes also a part of the parameter space.

As a framework of this kind is meant to be used for a longer period of time, it needs to be open and scalable in the sense that it cannot only handle existing cases, but can describe and handle future developments (within a reasonable range) without the need of permanent re-adjustments.

In particular, such a framework should be able to deal with OTT services. At the time of publication of the present document, there is a multitude of proprietary products. Figure 6-1 shows a selection of such products along with services they provide.

Service	Facebook™	Skype™	WhatsApp™	YouTube™	Joyn™
Text Chat	x	x	x		X
Audio Clip Transfer			x		
Telephony	x	x	x		X
Video Telephony		x			X
File transfer	x			x	X
Vcard transfer					X
Video Streaming	x			x	

Figure 6-1: Schematic overview of multi-service applications (example, not meant to be complete)

To test the practical value of a multi-services QoS framework, applicability to OTT applications is therefore seen as a good test of fitness to purpose. Furthermore, it can reasonably be expected that actual tests in mobile networks will use OTT based use cases simply because this is what actual network subscribers do.

In Figure 6-1, the rows of the matrix describe particular services. The columns are associated with products. In the context of the multi-service framework, these entities are termed *applications*. This establishes a hierarchical relation: An application can offer multiple services. Such a service does not necessarily have to be a specific, application-related implementation of a generic type of service. For instance, the telephony function of a particular application can use the operating system's functions to invoke a legacy telephony call or a VoLTE call as well as implementing an application - specific flavor of a VoIP call.

7 Taxonomy of multi-service scenarios

For the purpose of a systematic treatment, it is useful to categorize multi-service tests with respect to the scenarios taking place within a single use case (which is, as in the single-service case, termed "transaction"):

- Sequential use, e.g. a voice call which is changed into a video call or vice versa (as for VoLTE/ViLTE or in Skype).
- Parallel use (including the case of successive build up).

EXAMPLES: A telephony call with a concurrent interactive screen-sharing session or a file transfer during a call.

- Perhaps a third category is useful (although it may be allocated to the second one): A person to person interaction where at a later point in time additional participants are added.

For practical purposes, it is also useful to distinguish between cases taking place in the same resource domain (e.g. a OTT application offering all its functions using packet data running directly or in some tunnel), and cases where different native or network-provided services are used (e.g. a data session running parallel to a legacy telephone call).

8 Summary

The present document establishes the basis of a generic multi-service framework consisting of the following principles:

- For the purpose of the multi-service framework, the term *application* is introduced meaning a technical entity offering one or more services.
- The term *service* means a generic type of end user related functionality for which a set of QoS parameters exists. A service can have different types of implementation. For instance, telephony can be implemented as legacy (2G or 3G based) telephony, VoLTE-type VoIP, or some other variant of VoIP. The specific implementation of a service is understood in the sense of a parameter of a specific test scenario.
- In a multi-service scenario, each service is characterized by the standard service-specific QoS parameters. Unless specific needs demand it, there are no inter-service QoS parameters.
- A full description of a multi-service scenario needs to include the parameters for each component service, and the parameters describing the activity pattern between the services, i.e. timing and sequence of usage. The extent has to be sufficient in the sense that if a test is set up by a third party using the set of information, and the same system under test is being used, the same results are produced.