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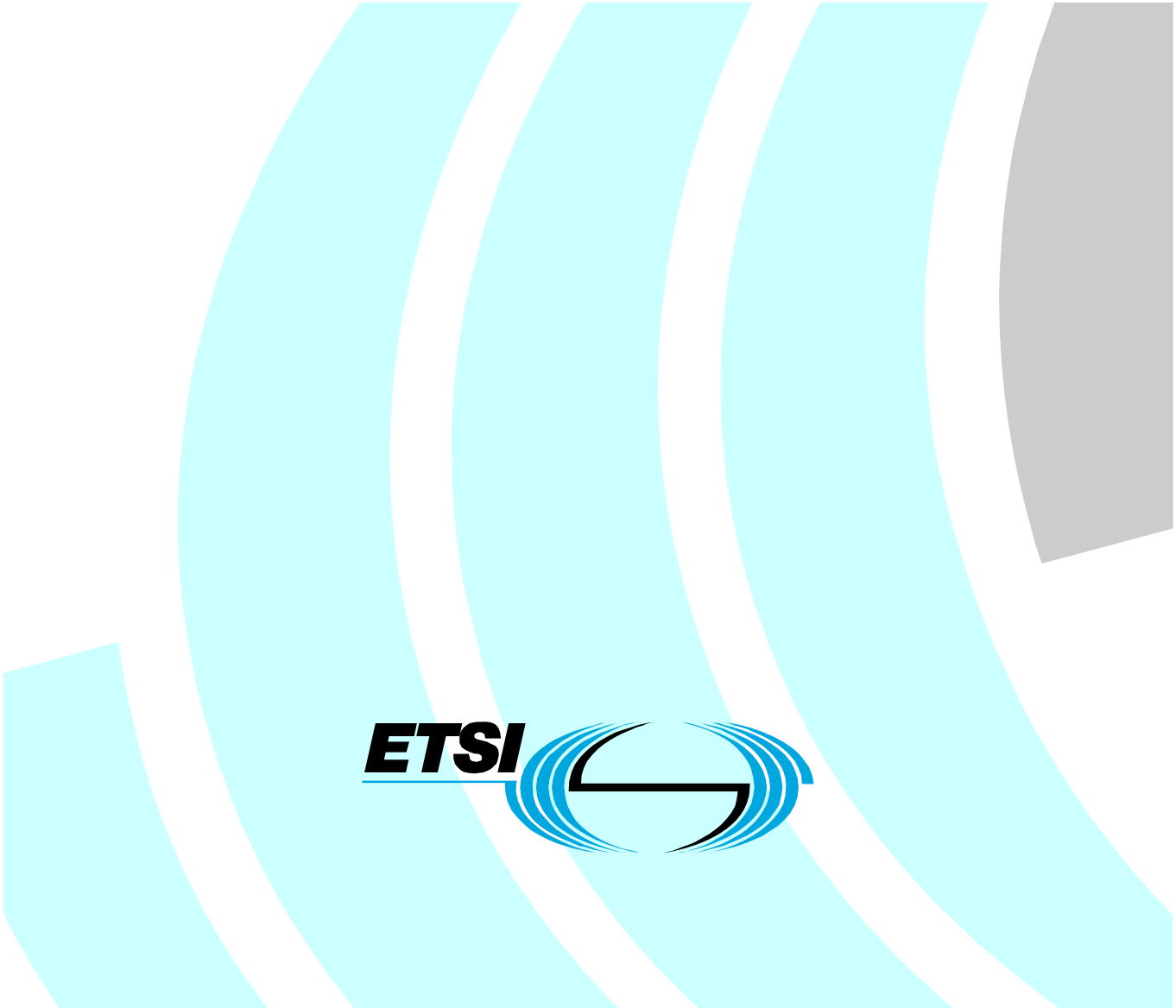
Technical Report

Human Factors (HF); Quality of Experience (QoE) requirements for real-time communication services



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Contents

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Foreword

This Technical Report (TR) has been produced by ETSI Technical Committee Human Factors (HF).

1 Scope

The present document is based on Guidelines produced in Specialist ETSI Task Force 354 and a Web-Based Guideline access and Tutorial System (WBGTS) (http://portal.etsi.org/stfs/STF_HomePages/STF354/STF354.asp). The main content of the WBGTS are Quality of Experience (QoE) guidelines for real-time communication services expressed in Quality of Service (QoS) terms.

The Guidelines and the present document are primarily intended for professionals in network operator, equipment manufacturer and service provider organisations who are concerned with the user experience of communication services. Over the last 10 years that include pre-cursor projects to STF 354 about 2000 intended guideline users have been involved in the development work of the WBGTS. The present document describes an assessment of the current guidelines and the tutorial system and identifies needs for future work.

2 References

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2.1 Normative references

The following referenced documents are indispensable for the application of the present document. For dated references, only the edition cited applies. For non-specific references, the latest edition of the referenced document (including any amendments) applies.

Not applicable.

2.2 Informative references

The following referenced documents are not essential to the use of the present document but they assist the user with regard to a particular subject area. For non-specific references, the latest version of the referenced document (including any amendments) applies.

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[i.13] ETSI ES 202 739: "Speech and multimediaTransmission Quality (STQ); Transmission requirements for wideband VoIP terminals (handset and headset) from a QoS perspective as perceived by the user".

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3 Definitions and abbreviations

3.1 Definitions

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

asynchrony: when audio and video information that leaves one communicating party at the same time is received by the other communicating party at different times

NOTE 1: E.g. typically the audio information arrives before the video information in an asynchronous situation.

NOTE 2: It is calculated as audio delay subtracted from video delay (e.g. if audio delay is 50 ms and video delay is 200 ms, then asynchrony is 150 ms; if audio delay is 100 ms and video delay is 50 ms, then asynchrony is -50 ms).

audio communication: use of a service that transmits voice in real-time over a telecommunication network, such as ordinary telephony with a handset and loud-speaking audio conferencing

audio conferencing: telephone service that does not rely on amplification of the voice signal in very close proximity to the recipient's ear

EXAMPLE: Loud-speaking audio communication.

audio delay: time required for an audio signal generated at the talker's mouth to reach the listener's ear

audio protocol: set of rules defining the way audio information is represented in a network

audio telephony: "ordinary" telephone service using a handset as distinct from loud-speaking audio conferencing

avatar telephony: service for transmitting voice signals in real-time over a telecommunication network in combination with a graphical (human) representation of the speaker

bandwidth: range of frequencies which can safely be conveyed in a communication channel

burst packet loss: loss of two or more packets in sequence

communication media: types of information with which humans communicate

NOTE: Examples are text, audio and moving image (graphics and video). This is consistent with the "Nature of information" component of the ETSI definition of a *representation medium*, which has various possible coded forms (ETR 160 [i.16]).

communication service: service that is provided via a telecommunication network

NOTE: Examples are audio-telephony, email, videoconferencing, avatar-telephony, audio conferencing.

communication situation: combination of task, motive, content and user (group) characteristics

communication task: what the end-users (want to) do with a communication service

NOTE: E.g. social chatting, buying or selling shares, conducting a job interview, etc.

communicative behaviour: end-user behaviour while using a communication service, including turn taking, interruptions, verbal and non-verbal back-channels and gaze

conversational text: See real-time text.

data communication: use of a service that transmits personal computer-based information (e.g. presentation slides)

data conferencing: See data communication.

duration: length of time of the communication task

dyadic communication: (distance) communication between two people

effectiveness: accuracy and completeness with which specified users can achieve specified goals in particular environments

NOTE: See ISO 9241 [i.27] definition.

efficiency: resources expended in relation to the accuracy and completeness of goals achieved

NOTE: See ISO 9241 [i.27] definition.

end-users: people who use a communication service

fitness-for-purpose: correct balance between technological performance and human performance, such that the interaction is both sufficient and beneficial for communication and consistent with human expectations

frame-rate: frequency by which a full video frame is updated, sometimes called video temporal resolution or image frequency

group: (distance) communication between three or more people

NOTE: Either in a point-to-point or a multi-point configuration.

interpersonal perception: extent to which the perception of the other person's attributes (how likeable, intelligent, friendly, etc.) is positive or negative

media effects: effect a particular communication medium has on an end-users task outcome, communicative behaviour, attitudes and beliefs

media/medium: See Communication Media/Medium.

monitor size: number in inches of the diagonal of the image screen on a screen

multimedia communication: use of a service that transmits voice, video and data signals in real-time over a telecommunication network

multimedia conferencing: service for transmitting voice, video and data signals over a telecommunication network

multi-point: distance communication between three or more locations

network quality of service: degree of conformance of the service delivered to a user by a provider with an agreement between them

NOTE: From ITU-T Recommendation E.860 [i.32].

packet loss: loss of one packet that can be described using a certain statistical model

packet size: magnitude of a data being transmitted over a packet switching network in number of Bytes

personal involvement: extent to which the communication parties are committed to the outcome of the task or perform the task more on behalf of another party than themselves

point-to-point: communication between two locations

quality of experience (1): measure of user performance based on both objective and subjective psychological measures of using an ICT service or product

NOTE 1: It takes into account technical parameters (e.g. QoS) and usage context variables (e.g. communication task) and measures both the process and outcomes of communication (e.g. user effectiveness, efficiency, satisfaction and enjoyment).

NOTE 2: The appropriate psychological measures will be dependent on the communication context. Objective psychological measures do not rely on the opinion of the user (e.g. task completion time measured in seconds, task accuracy measured in number of errors). Subjective psychological measures are based on the opinion of the user (e.g. perceived quality of medium, satisfaction with a service).

EXAMPLE: A service provider may conclude that a service with a certain level of QoS used for a particular communication situation offers users excellent QoE, whist with a different level of QoS provides poor QoE.

quality of experience (QoE) (2): 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.

NOTE 3: ITU-T Recommendation P.10 [i.37]/G.100 Amendment 2 definition.

quality of service: totality of characteristics of a telecommunications service that bear on its ability to satisfy stated and implied needs of the user of the service

NOTE: ITU-T Recommendation E.800 [i.31] definition.

Quality of service delivered/achieved by service provider (QoSD): statement of the level of QoS achieved or delivered to the customer

NOTE 1: Achieved or delivered QoS is expressed by metrics for the pertinent parameters for a service.

NOTE 2: ITU-T Recommendation E.800 [i.31] definition.

Quality of service experienced/perceived by customer/user (QoSE): statement expressing the level of quality that customers/users believe they have experienced

NOTE 1: The level of QoS experienced and/or perceived by the customer/user may be expressed by an opinion rating.

NOTE 2: QoSE has two main man components: quantitative and qualitative. The quantitative component can be influenced by the complete end-to-end system effects (network infrastructure).

NOTE 3: The qualitative component can be influenced by user expectations, ambient conditions, psychological factors, application context, etc.

NOTE 4: QoSE may also be considered as QoSD (QoS delivered/achieved by service provider) received and interpreted by a user with the pertinent qualitative factors influencing his/her perception of the service.

NOTE 5: ITU-T Recommendation E.800 [i.31] definition.

Real-time (1): describes information and communication technologies that are able to generate and deliver information in a time-frame similar to the real-life process that it is assisting

EXAMPLE 1: Real-time charging and billing information is to be generated, processed, and transported to a desired conclusion in less than 1 second

EXAMPLE 2: Refers to the generation of network management information in a time frame comparative to the real life process that it is controlling or monitoring

real time (2): Occurring immediately. The term is used to describe a number of different computer features. For example, real-time operating systems are systems that respond to input immediately. They are used for such tasks as navigation, in which the computer reacts to a steady flow of new information without interruption. Most general-purpose operating systems are not real-time because they can take a few seconds, or even minutes, to react. Real time can also refer to events simulated by a computer at the same speed that they would occur in real life. In graphics animation, for example, a real-time program would display objects moving across the screen at the same speed that they would actually move.

NOTE: Webopedia definition.

real-time communication service: service with which users expect to share information instantly and continuously with one or more other user

NOTE 1: A real-time communication service generates and delivers either text, audio, graphics, video and data or some combination of these communication media.

NOTE 2: The information sharing process occurs either by: (1) a person interacting via technology directly to another person (person-to-person) or; (2) a person interacting with a machine (person-to-machine).

EXAMPLE: An example real-time person-to-person communication service is videoconferencing and an example real-time person-to-machine communication service is Live TV.

real-time computing: study of hardware and software systems that are subject to a "real-time constraint", i.e. operational deadlines from event to system response

NOTE 1: By contrast, a non-real-time system is one for which there is no deadline, even if fast response or high performance is desired or preferred. The needs of real-time software are often addressed in the context of real-time operating systems, and synchronous programming languages, which provide frameworks on which to build real-time application software.

NOTE 2: Wikipedia definition.

real-time text: service for transmitting alpha-numeric characters in real-time over a telecommunication network

Real-time Transport Protocol: standardized packet format for delivering audio and video over the Internet

NOTE 1: RTP is frequently used in streaming media systems (together with the RTSP) as well as in videoconferencing and push to talk systems. For these it carries media streams controlled by H.323 or Session Initiation Protocol (SIP) signalling protocols, making it the technical foundation of the Voice over IP industry.

NOTE 2: RTP is usually used in conjunction with the Real-time Transport Control Protocol (RTCP). While RTP carries the media streams (e.g. audio and video) or out-of-band signalling (DTMF), RTCP is used to monitor transmission statistics and quality of service QoS information. When used in conjunction, RTP is usually originated and received on even port numbers, whereas RTCP uses the next higher odd port number.

NOTE 3: Wikipedia definition [i.44].

remote inspection: videoconferencing with video as data (e.g. for a remote person to see an object or environment rather than the person(s) with whom they are talking) (sometimes also called Tele-inspection and Tele-data)

resolution: term denoting the degree of detail which can be created by a particular visual display system expressed in pixels in x- and y-directions

satisfaction: comfort and acceptability of the work system to its users and other people affected by its use

NOTE: ISO 9241 [i.27] definition.

situation formality: relative amount of ceremonious or conventional communication versus casual or unconstrained communication

task outcome: extent to which task performance dependent on the medium

task: what users of *communicative technology* actually do in order to accomplish some *task goal*

NOTE: In experiments tasks may be described to the participants or they are embedded in scenarios as a part of a *situation*.

telephony: service for transmitting voice signals in real-time over a telecommunication network

text communication: use of a service that transmits alpha-numeric characters in real-time over a telecommunication network

NOTE: Also known as real-time text and conversational text.

urgency: extent to which a task is particularly urgent or under particular time pressure

usability: *effectiveness*, *efficiency*, and *satisfaction* with which specified users achieve specified goals in particular environments

NOTE: See ISO 9241 [i.27] definition.

user satisfaction: comfort and acceptability of the task performance to the service user

NOTE: Operationalized as the extent to which the service is assessed to be a pleasant communication medium for the task.

video communication: use of a service that transmits voice and video signals in real-time over a telecommunication network, i.e. use of videotelephony or videoconferencing

NOTE: For the current report the communication involves a loud-speaking audio system and not a handset.

videoconferencing: service for transmitting voice and video signals in real-time over a telecommunication network for group communication

NOTE: In the current report the audio system is considered loud-speaking and not with a handset or headset.

video delay: time between the input of the first pixel of a particular picture at the sending end encoder and the output of the pixel from the decoder at the receiving end

video protocol: set of rules defining the way video information is represented when transferred in a network

videotelephony: service for transmitting voice and video signals in real-time over a telecommunication network for dyadic communication

3.2 Abbreviations

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

CIF	Common Intermediate Format
GSM	Global System for Mobile (telephony)
ICT	Information and Communications Technology
IP TV	Internet Protocol Television
IPR	Industrial Property Rights
IST	Information Society Technologies
ITU	International Telecommunication Union
LTE	Long Term Evolution
MOS	Mean Opinion Score
QoE	Quality of Experience
QoP	Quality of Perception
QoS	Quality of Service
QoSD	Quality of Service Delivered
QoSE	Quality of Service Experienced
SLA	Service Level Agreement
STF	Specialist Task Force
UMTS	Universal Mobile Telecommunications System
WBGTS	Web-Based Guidelines and Tutorial System

4 What is Quality of Experience (QoE)?

Definitions of QoE and related concepts and work are introduced and distinguished below. In order to measure QoE emphasis is given to the importance of performing user tests that are within a particular usage context, for which the technical parameters of the service are known. It is argued that user experience should be measured by objective psychological variables in addition to subjective variables.

4.1 A definition of QoE for the current document

There are different definitions of Quality of Experience across current ITU, ETSI and other literature (considered further in clause 4.3.2.2).

In the absence of a suitable harmonised definition, the current document defines Quality of Experience (QoE) as:

> *"A measure of user performance based on both objective and subjective psychological measures of using an ICT service or product."*

NOTE 1: It takes into account technical parameters (e.g. QoS) and usage context variables (e.g. communication task) and measures both the process and outcomes of communication (e.g. user effectiveness, efficiency, satisfaction and enjoyment).

NOTE 2: The appropriate psychological measures will be dependent on the communication context. Objective psychological measures do not rely on the opinion of the user (e.g. task completion time measured in seconds, task accuracy measured in number of errors). Subjective psychological measures are based on the opinion of the user (e.g. perceived quality of medium, satisfaction with a service).

EXAMPLE: A service provider may conclude that a service with a certain level of QoS used for a particular communication situation offers users excellent QoE, whist with a different level of QoS provides poor QoE.

Other main definitions of QoE and related concepts are considered below.

4.2 QoE and QoS

The usability of devices and services has been studied for a long time, but attention to user experience and QoE is more recent. A description of the differences between "usability", "user experience", "user perception" and "quality of experience" is provided in this clause.

The present document describes an approach that aims to be:

- Understandable by people who are stakeholders in user experience.
- Usable by these stakeholders.
- A reference for these stakeholders when defining "user experience" for a service, routine or product.

A similar term to QoE is QoS (Quality of Service). Among service providers, network operators and equipment manufacturers the term QoS has been in use for a long time and has reached a high level of common understanding. QoS work is based on technical performance (i.e. it is mainly technology-centred) whereas QoE is based on end-user behaviour (it is user-centred) (see figure 1). Subsequent clauses of the present document will explain further the distinction between QoE and QoS.

It is argued that work on QoS is critical, but not sufficient, for measuring user experience: **QoE and QoS are distinct and both are important and should be related**.

The present document presents an approach to measuring and communicating QoE to stakeholders that intentionally incorporates QoS in order to combine information on users and technology.

In particular, the present document develops results from ETSI STF 284 and ETSI STF 354 to define how QoS metrics can be described in terms of QoE.

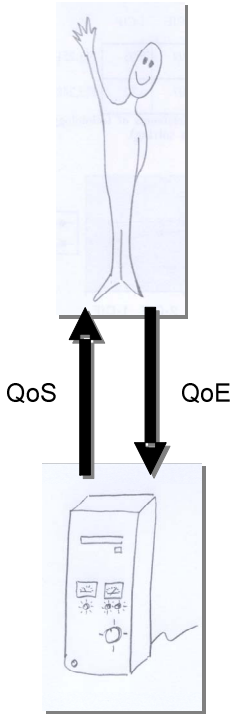

Figure 0: QoS is based on technical performance whereas QoE should be based on end-user behaviour

4.3 Usability and user experience

During the 1980s and 1990s most user-centred work focused on the usability of information and communication technology (ICT). Since 1998 usability has been defined in ISO 9241, [i.27], p. 2 as the extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use.

In recent years the use of ICT has extended from the workplace to the home and for applications that support leisure and social activities in addition to work. Consequently, the concerns of human-computer interaction have evolved from a focus on effectiveness and efficiency to user experience factors such as enjoyment, engagement and the appeal of using and owning ICT, e.g. [i.3].

Whereas, most of the work on user experience is conducted in relation to computer applications, there is also the need to address the user-centred development of telecommunication services. Telecommunication services are similar to computer applications in that they require users to interact with devices and applications with hardware and software interfaces. In addition, however, with telecommunication services users have the specific intention to communicate with other people at distance. This communication is either direct to other people through technology (e.g. a telephone, a videophone) or involves interaction with a machine rather than with a person (e.g. to access web content, to watch video from a web camera).

During either person-to-person (two-way) communication or person-to-machine (one-way) communication the users will interact with a service that will have properties that may vary and that may have an effect on users's behaviour. For example, a delay between the arrival of audio and video information may lead to lack of lip-synchrony of the speaker as perceived by a listener. Properties such as audio-video asynchrony, transmission delay, video frame-rate and resolution have the potential to help or hinder communication. These technical properties relate to Quality of Service (QoS).

For communication services it is possible to distinguish three approaches to quality:

- Quality of Service (QoS).
- User-perceived QoS (or Quality of Perception (QoP)).
- Quality of Experience (QoE).

As will be described next, whereas QoS is a mainly technology-centred approach to quality, user-perceived QoS (or QoP) and QoE are complementary user-centred approaches.

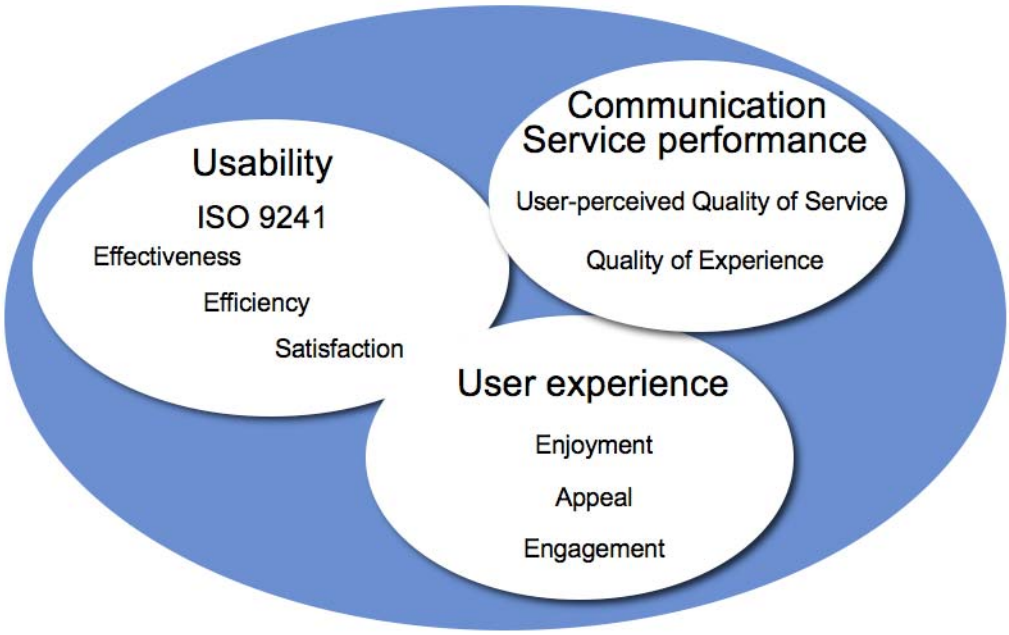

Figure 1: The main concepts for user-centred applications and services

4.3.1 Technology-centred approach: Quality of Service (QoS)

The technology-centred approach mainly emphasises the concept of QoS and has its strongest reference from the ITU (International Telecommunications Union). The ITU Recommendation E.800 [i.31] is the key reference and states that QoS is the:

> *"Totality of characteristics of a telecommunications service that bear on its ability to satisfy stated and implied needs of the user of the service." (ITU-T Recommendation E.800 [*i.31*], p. 3).*

Although the ITU definition refers to user satisfaction, QoS is mainly used by technicians to define technical parameters of telecommunication applications such as network delay and packet loss.

In addition, a focus on user satisfaction is rather limited because it is only one of many measures of user behaviour with a communication service. For example, other measures include the time taken to perform a communication task (a measure of efficiency) and the accuracy with which a task is completed (a measure of effectiveness).

4.3.2 User-centred approaches: QoE and User-perceived QoS

There are two main user-centred approaches:

- Quality of Perception (QoP) or User-perceived QoS.
- Quality of Experience (QoE).

As outlined below, these two approaches are mainly distinguishable by the type of data collected from users.

4.3.2.1 Quality of Perception (QoP)

The QoP approach is primarily concerned with the detectability of a change in quality or the acceptability of a quality level. Typically the user perception of quality is measured with a subjective rating scale analysed as a "Mean Opinion Score" (MOS).

For example, results of MOS ratings for network performance parameters such as transmission bit rate and packet loss for audiovisual QoS for communication over IP networks are summarised in ES 202 667 [i.10] and a set of ETSI standards provide terminal equipment requirements which enable manufacturers and service providers to enable good quality end-to-end speech performance as perceived by the user [i.11], [i.12], [i.13] and [i.14].

The MOS method is standardised within the ITU (e.g. ITU-R Recommendation BS 1534-1) [i.28].

The ITU also offers a related definition of QoS experienced/perceived by customer/user (QoSE) (ITU-T Recommendation E.800) [i.31]:

A statement expressing the level of quality that customers/users believe they have experienced.

NOTE 1: QoSE has two main components: quantitative and qualitative. The quantitative component can be influenced by the complete end-to-end system effects (network infrastructure).

NOTE 2: QoSE has two main man components: quantitative and qualitative. The quantitative component can be influenced by the complete end-to-end system effects (network infrastructure).

NOTE 3: The qualitative component can be influenced by user expectations, ambient conditions, psychological factors, application context, etc.

NOTE 4: QoSE may also be considered as QoSD (QoS delivered/achieved by service provider) received and interpreted by a user with the pertinent qualitative factors influencing his/her perception of the service.

4.3.2.2 Quality of Experience (QoE)

The concept of Quality of Experience (QoE) is attracting growing attention and is linked to user-experience. As the concept of QoE is relatively new and evolving, there are several published definitions.

ITU-T [i.37] defines QoE as:

- 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.

There are also definitions offered in ETSI documents that date before the ITU definition [i.15], [i.20], [i.18], [i.21] and [i.19].

Consistent with the ITU-T definitions of QoE and QoSE, the majority of work to date on QoE has concerned subjective measurement of experience and QoE is typically defined in terms of user perception and/or user satisfaction e.g. [i.42]. Typically users rate some perceived quality aspect on a scale (e.g. to give a Mean Opinion Score or MOS) and/or users report their ability to operate a service and their level of satisfaction through survey techniques such as interviews, focus groups and questionnaires [i.40].

However, data about QoE would be more comprehensive and potentially more valid and reliable if objective as well as subjective psychological measures are included. For example, user effectiveness and efficiency can be measured objectively in addition to subjective user satisfaction. This is consistent with accepted good practice in psychological research which does not rely on opinion and self-reported behaviour when objective measures of human behaviour can be collected. Objective QoE data include measures of the communication process and the task outcome (see [i.6] and [i.18]). Example measures of the process of communication are the number of communication interruptions and the amount of turn-taking. Example measures for the outcome of communication are the length and accuracy of the task performed.

It is because it is argued that QoE should extend beyond subjective measures of user-perception and user satisfaction to include objective measures of communication process and outcome that the current document has provided an alternative definition above, in addition to the ITU-T definition.

4.3.3 The co-existence of QoS and QoE

If a service should be improved for customers or end-users, the stakeholders need to know that the QoE level is inadequate and should be able to decide which one or more technical QoS parameter could be upgraded in order to achieve higher QoE. A QoE measure therefore needs to be stated together with the technical conditions of a communication service if it is to be useful for stakeholders.

Consequently, QoE should be expressed in QoS terms. [i.25] and [i.20].

Figure 2 summarises the relation between the different approaches and illustrates our focus on QoE that combines user-based measures (e.g. user experience) with technical measures (e.g. QoS).

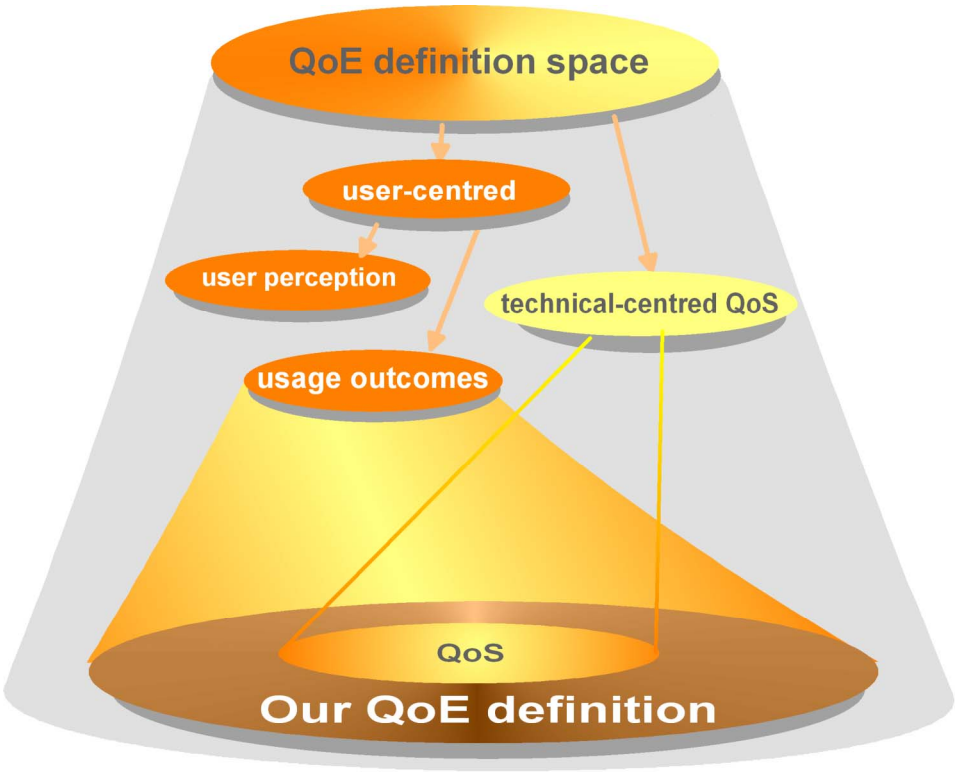

Figure 2: The relation between different QoS and QoE approaches. QoE is user-centred, expressed in technical QoS measures and based on both subjective and objective psychological measures

4.4 The QoE context of the present document

Figure 3 shows a context diagram for a broader range of QoE user situations than is the focus of the present document. "Touch points" are areas where end-users or customers come into contact with service provider, network operator and product manufacturer organisations. QoE should ideally be measured for every touch point. For example, this could be in the early stage when a potential user is browsing in a shop with no definite purchase choice or at the point where a future user orders a product. Other potential touch points are when installing the product and setting it up to work. Another situation is when the user has problems, has a question about how to use a service, requires an explanation of a bill or needs support from a service provider.

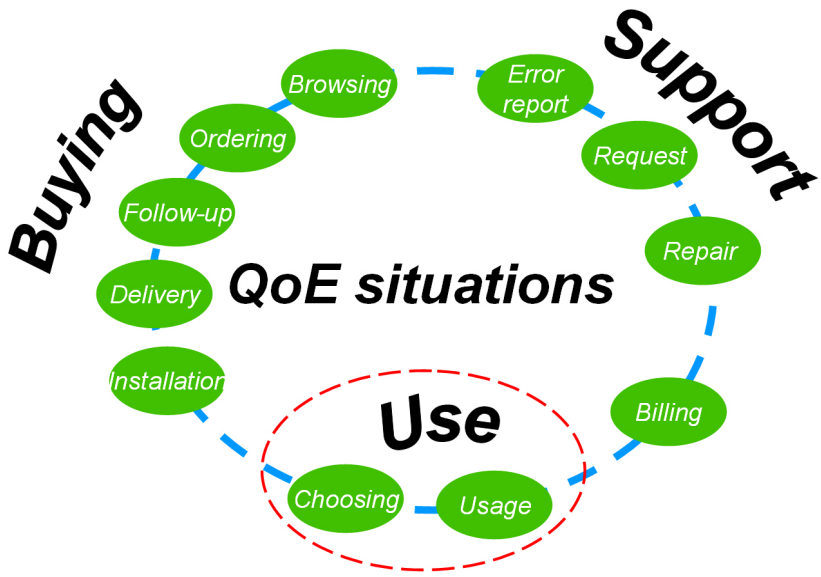

Figure 3: User touch points: examples of where end-users and supply organisations may come into contact

The focus of the current report is the Use context indicated in Figure 1, which can be divided into two situations [i.26]:

- The Choosing situation.
- The Usage situation.

Each of these is described further below.

4.4.1 The Choosing situation

An example of a choosing situation is when buying a terminal for watching TV. In the shop people are faced with many televisions so that they can compare and choose based on sharpness, brightness, reflections, etc. (see Figure 4). The choosing situation is where the users' perception of a medium's quality (i.e. the QoP approach summarised in clause 4.2.2.1) is very appropriate.

Figure 4: Example from a choosing situation

4.4.2 The Usage situation

Once a product has been bought (such as television) or a service has been selected for trial (such as videoconference system) various factors of user experience may emerge as more or less important. For example, when a television has been bought and the users are sitting in their living room watching a film, the situation becomes very different than in the shop (see Figure 5). Now poor sound quality will be easier to detect because of a different environment and artefacts with the video may not be detected because of an engagement in the content of the film.

NOTE: Some materials contained herein is the copyright of, or has been supplied by Peter Brooks.

Figure 5: Example of an usage situation

To really understand the usage situations, user tests should be performed within a relevant context. Because the current report focuses on real-time communication services, the usage context concerns communication task situations, where at least task efficiency, task effectiveness and user satisfaction, are measured.

Human communication is complex as it is dependent on an interplay of various psychological factors. For instance, visual and non-verbal auditory cues are used to initiate conversation, co-ordinate turn-taking, identify objects or events being talked about and monitor attention, emotion and understanding (e.g. [i.23]). Visual cues include body orientation, eye-gaze and gesture and non-verbal auditory cues include coughs and non-speech cues such as "mhm", "erhh" and "uhuh". Humans combine visual information from lip and teeth movements ("facial speech") with spoken information in order to derive an understanding of what is said. Facial expressions provide information about states of knowledge, belief, understanding and agreement, with particularly important aspects being information from the eyebrows and mouth [i.9] and their timing [i.8].

These factors represent unconscious behaviours that are open to disruption by non-normal situations. For example, modification of the normal frequency and duration of head nods can disrupt speakers' abilities to communicate [i.2]. Without lip-shape information listeners cannot tolerate as much noise interference [i.43]. If visual facial speech information artificially conflicts with verbal information, humans automatically blend the seen and heard speech as a combination of the two types of information [i.39].

The interplay of human communication factors may be disrupted when communicating with - or through - technology. Changes in timing and the information available may be perceived by users at the conscious or unconscious level. Even if people detect discrepancies in the delivery of media, the technical difficulties still affect users as unusual psychological experiences that are likely to be evaluated negatively. Furthermore, timing and other changes may be small enough to be unconsciously perceived. For example, there is evidence that even when people do not identify 170 ms audio-video asynchrony in a video, their ratings of the speaker are negatively affected [i.41].

Therefore, people can be expected to behave differently with different communication services and different levels of QoS. In addition, it can be expected that discrepancies from normal human communication will be evaluated negatively. Stakeholders can not be expected to predict the quality of end-user behaviour without recommendations or guidelines based on QoE tests. QoE tests require appropriately designed laboratory experiments and field studies.

5 For whom are QoE data important?

In the current report persons who have a professional interest to use data about the QoE of telecommunication services are referred to as "stakeholders", because they have a job function that can influence the development of better services if they understand the end-users of these services.

Stakeholders come from three main groups:

- Network operators.
- Product manufacturers (equipment and software).
- Service providers.

It is not the organisations themselves that are addressed, but persons with particular roles in these organisations. Some key roles within these organisations that are believed to have a requirement for QoE data are listed in table 1. For example, sales people, marketing managers and technical developers often refer to "user experience" but may do so without a clear understanding of what it is. A reason for this is a lack of organised support for information and training about QoE data. Currently different people describe "user experience" in different, and usually imprecise, ways. Typical descriptions include customers being "satisfied with a service", "feeling good" towards a service or having a "good perception" of a service.

Table 1: Main work functions of users of QoE data: technical, customer and management orientation

Technically oriented	Customer oriented	Management
Product strategist	Marketing	CEO (Chief Enterprise Officer)
Strategic service developer	Service portfolio	CTO (Chief Technical Officer)
System integrator	specialist	CMO (Chief Marketing Officer)
Project leader	Sales person	Chief of Strategy
SLA (Service Level Agreement)	Sales support	COO (Chief Operation Officer)
negotiators	Customer support	CRO (Chief Research Officer)
Technical researcher	Project leader	CDO (Chief Development
Interaction designer	Human factors	Officer)
Development engineer	researcher	Sales director
Audio/video codec engineer	Service host	

Over the last 10 years that include pre-cursor projects to STF 354 the STF members have held meetings, workshops, interviews and presentation discussions with over 2000 stakeholders. This activity has found support for an important need for more information about users and the usage situation and for the availability of guidelines on QoE.

Typically stakeholders appear to believe that user experience is a subjective measure and are not aware that experience with a service can also be measured and analysed more objectively. Nevertheless, stakeholders often argue that user experience should have a more precise meaning and should be comparable. For example, it should be possible to compare the users' experiences with two service implementations to determine which one is best; and it should be possible to rank order several services to reveal those that work best on a specific technical implementation.

6 How can QoE data help?

The main ways in which QoE data can help network operators, service providers and equipment manufacturers are summarised below.

6.1 To prevent churn

Although developing a product or service that has instant appeal may increase the probability of a purchase and use, the profitability and image of the supplier can be predicted to be affected if subsequently the product or service does not meet up to expectation. Soldani, Li and Cuny [i.42] argue that profitability and image is affected by defections to the competition, especially when they occur during the early stage of the introduction of a product or service. Soldani et al. [i.42] report that:

- 82 % of customers churning do it due to frustration over the product or service;

- 90 % of customers do not complain before churning;
- 1 frustrated customer tells 13 other about the bad experience;
- for each that calls with a problem, 29 never call.

Therefore, there may be a negative chain-reaction and a supplier cannot rely on customer feedback in order to correct mistakes - it will probably be too late. Thus, user test data before going to market and good user experience after purchase is critical for customer retention and having a good image for gaining new customers.

6.2 To prevent product or service rejections

There is a history of products and services that have been rejected from the market despite that marketing departments have predicted success and without conclusively being able to explain the rejection. . One important reason for rejection is that the QoE has been too low in the usage situation (see clause 4.4.1), although possibly a positive perception may be apparent in the choosing situation (see clause 4.4.2). Some of these rejections would have be foreseen, understood and avoided if QoE data were applied or user tests been performed before product launches.

6.3 To optimise a product or service

Within technical teams working with products, there may be little knowledge of how a certain set of technical parameters will be experienced by the end users. A particularly important situation is when trade-off decisions are required, such as with packet loss versus delay for speech services, frame-rate versus resolution for audio-visual services and bitrate versus latency for multimedia broadband (MBB) services. STF work with technical stakeholders has indicated that currently these trade-off decisions are not based on any evidence of their potential effects and that these stakeholders have a strong desire to know more about how user experience may be influenced by their decisions.

6.4 By expressing QoE expressed in terms of QoS

In clause 4 it is argued that the focus of QoE should be extended to include how end-users experience use of a specific service, terminal or network. I is also argued that QoE data should succeed where possible to combine knowledge of both user experience and technical parameter values; for example, to provide a statement about QoE with a particular communication service with known levels of QoS. In recognition of this, clause 7.3.1 introduces a systematic approach for extracting and combining user experience and technical parameters from user test results. It proposes a way to measure QoE and derive a body of QoE data as guidelines. If the relevant QoE data exists it is then possible to compare one service delivered with different Quality of Service parameters to see which QoS-level is good enough.

7 Providing QoE data for real-time communication services

In the absence of a previous accepted definition, a definition of real-time communication services is provided below and the main services addressed by the current report are summarised. Key related user-centred work on real-time communication services is introduced and requirements for guideline development and dissemination are presented.

7.1 Real-time communication services

A real-time telecommunication system generates and delivers information in a time-frame similar to the real-life process that it is assisting. Depending on the real-life process being assisted, the time-frame may include seconds or be perceived by end-users as immediate. These systems therefore have real-time technical requirements and constraints for their implementation associated with real-time computing and the real-time transport protocol (or RTP).

One group of real-time telecommunication systems concerns real-time communication services that enable communication between people. In the absence of a previous accepted definition, the present document defines a real-time communication service as:

A service with which users expect to share information instantly and continuously with one or more other user. These real-time communication services generate and deliver either:

- Text.
- Audio.
- Graphics, such as a computer animation to create a moving image (e.g. an avatar).
- Video.
- Data, mainly concerning the transmission of shared visual information such as a "White board" or presentation document (e.g. Microsoft PowerPoint).
- Or some combination of these communication media.

Some real-time communication services enable primarily two-way communication, whilst others enable primarily one-way communication (Figure 1). Some services support both one-way and two-way communication. Two-way communication services enable people in different places to share information by speaking, writing, moving their bodies or using other signals in a way intended to be similar to communication when in the same place at the same time. An example of a two-way communication service is videoconferencing. With one-way communication a person interacts with a machine as an end-point rather than directly to another person. Therefore, a person generating the information does not necessarily interact directly with the end-user of the service and the end-user of the service may not necessarily interact with the information being delivered in a way that influences or directs the actions of the person generating the information. An example of a one-way communication service is Live TV. A real-time communication service that promotes both one-way and two-way communication is Real-time Gaming, as end-users may interact with both machine-generated content and other people through text, voice or person-generated avatars.

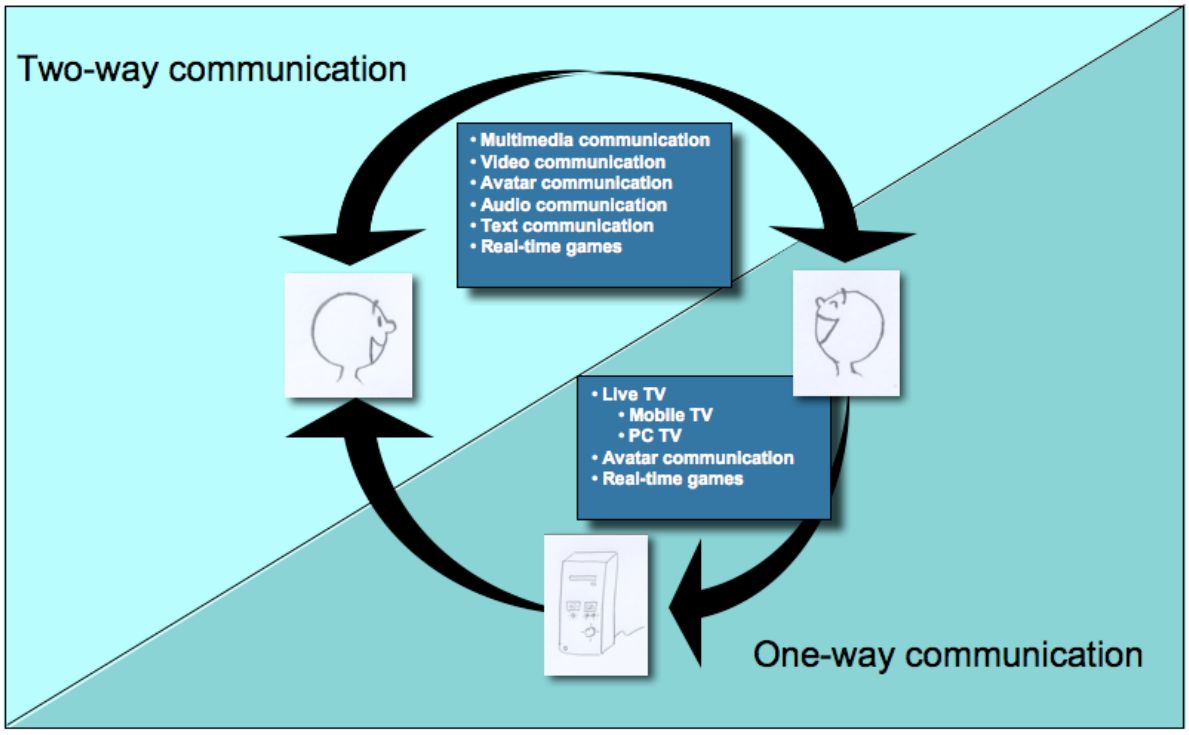

Figure 6: Real-time communication services enable two-way and one-way communication

Whether the real-time communication service is videoconferencing, Live TV, Real-time Gaming or some other service, the generation and delivery of the information is in a time-frame of "immediate". People expect to talk during a videoconferencing as if communicating face-to-face and people view a live TV broadcast as if they are watching "as it happens". Non-real-time communication services (such as e-mail, voice-mail, video-mail, web content and media on demand) usually do not place the same requirements on the users or technology for the generation and delivery of the communication media. For example, the content of a web site or an e-mail may be created significantly in advance of the end-users' perception and interaction with the material.

User expectations for real-time communication services can be illustrated with examples from related work:

- TS 123 107 [i.25] defines four QoS classes for 3G ("conversational", "streaming", "interactive" and "background") for which the main distinguishing factor concerns the delay sensitivity of the traffic. Conversational and Streaming classes are mainly intended to be used to carry real-time traffic flows.
- ITU-T Recommendation G.1010 [i.36] defines four user-centric QoS categories on the basis of tolerance to packet loss and one-way delay: "interactive" (delay <<1 s), "responsive" (delay ~2 s), "timely" (delay ~10 s) and "non-critical" (delay >>10 s).
- ITU-T Recommendation Y.1541 [i.38] defines two classes of network Quality of Service (QoS) for real-time, jitter sensitive, high interaction applications (VoIP and "video teleconferencing"): "Class 0" applies for constrained routing and distance while "class 1" applies for less constrained routings and distances.
- ES 202 667 [i.10] classifies audiovisual applications for IP networks into the two groups of "delay sensitive" and "delay insensitive" applications.

In addition to one-way delay of a medium, the delay of arrival between two or media, such as audio and video, is another parameter related to user expectations for instant and continuous information. For example, the potential different arrival time of audio and video in videoconferencing and live TV concerns the lip-asynchrony of the speaker.

Some example end-to-end delay and audio-video synchrony recommendations for real-time communication services are provided in table 2.

Table 2: Examples of end-to-end delay and audio-video synchrony recommendations for real-time services

Medium	Service or application	End-to-End one-way delay (seconds)		Audio-Video asynchrony or Lip-asynchrony (seconds)	Audio or Video arriving first	Source (see note)
		Preferred	Limit			
Text	Real-time text	< 1 s	2 s	Not applicable	Not applicable	ITU-T F.700 [i.33] (see note)
Audio	Audio communication	< 0,15 s	0,4 s	Not applicable	Not applicable	TS 122 105 [i.22] ITU-T. G.108 [i.34] ITU-T. G.114 [i.35]
		0,1 s	0,4 s	Not applicable	Not applicable	ITU-T Y.1541 [i.38]
	High Quality streaming	< 10 s		Not applicable	Not applicable	ITU-T. G.1010 [i.36]
	Speech, mixed speech and music, medium and high quality music	< 10 s		Not applicable	Not applicable	TS 122 105 [i.22]
Video	Video communication	Not specified	Not specified	0,04 s	Not specified	ETR 297 [i.17]
		Not specified	Not specified	< 0,08 s	Video	ANSI TI.552 [i.1]
		0,1 s	0,4 s	0,1 s	Not specified	ITU-T Series H, Suppl. 1 [i.30] (see note)
		0,1 s	0,4 s	Not specified	Not specified	ITU-T Y.1541 [i.38]
		< 0,15 s	0,4 s	< 0,1 s	Not specified	TS 122 105 [i.22]
		< 0,15 s	0,4 s	< 0,08	Not specified	ITU-T. G.1010 [i.36] (see note)
		Not specified	Not specified	< 0,2 s	Audio	EG 202 534 [i.15]
	Television	Not specified	Not specified	< 0,185 s	Video	ITU-R. BT.1359-1 [i.29]
		Not specified	Not specified	< 0,09 s	Audio	ITU-R. BT.1359-1 [i.29]
		< 0,1 s	0,4 s	Not specified	Not specified	ITU-T Y.1541 [i.38]
	« One-way »	< 10 s	Not specified	Not specified	Not specified	ITU-T. G.1010 [i.36] (see note)
	Movie clips, surveillance, real-time video	< 10 s		Not specified	Not specified	TS 122 105 [i.22]
Data	Real-time games	< 75 ms	Not specified	Not applicable	Not applicable	TS 122 105 [i.22]
	Interactive games	< 200 ms		Not applicable	Not applicable	ITU-T. G.1010 [i.36] (see note)
	Telnet	< 200 ms	Not specified	Not applicable	Not applicable	ITU-T. G.1010 [i.36] (see note)
		< 250 ms	Not specified	Not applicable	Not applicable	TS 122 105 [i.22]
	Telemetry - two-way control	< 250 ms	Not specified	Not applicable	Not applicable	TS 122 105 [i.22]
	Bulk data transfer/retrieval, still image	< 15 s	< 60 s	Not applicable	Not applicable	ITU-T. G.1010 [i.36] (see note)

Medium	Service or application	End-to-End one-way delay (seconds)		Audio-Video asynchrony or Lip-asynchrony (seconds)	Audio or Video arriving first	Source (see note)
		Preferred	Limit			
	Bulk data transfer/retrieval, playout and synchronization information, still image	< 10 s		Not applicable	Not applicable	TS 122 105 [i.22]
NOTE: The source is contained in an appendix or a supplement (informative) rather than the body or annex(es) of the Recommendation document.						

The real-time communication services addressed in the current document concern services that are initiated by users in order to deliberately share information. The present document excludes systems that act in automatic or artificially intelligent ways on behalf of people but without deliberate initiation by people. For example, it does not include agent, sensor and ubiquitous systems that undertake and execute actions without reference to people in either the choice of decision or the course of action.

Therefore the key elements of real-time communication services are considered to be:

- User expectations to share information instantly and continuously with one or more other user
- Real-time technical requirements and constraints
- User deliberately initiates their use.

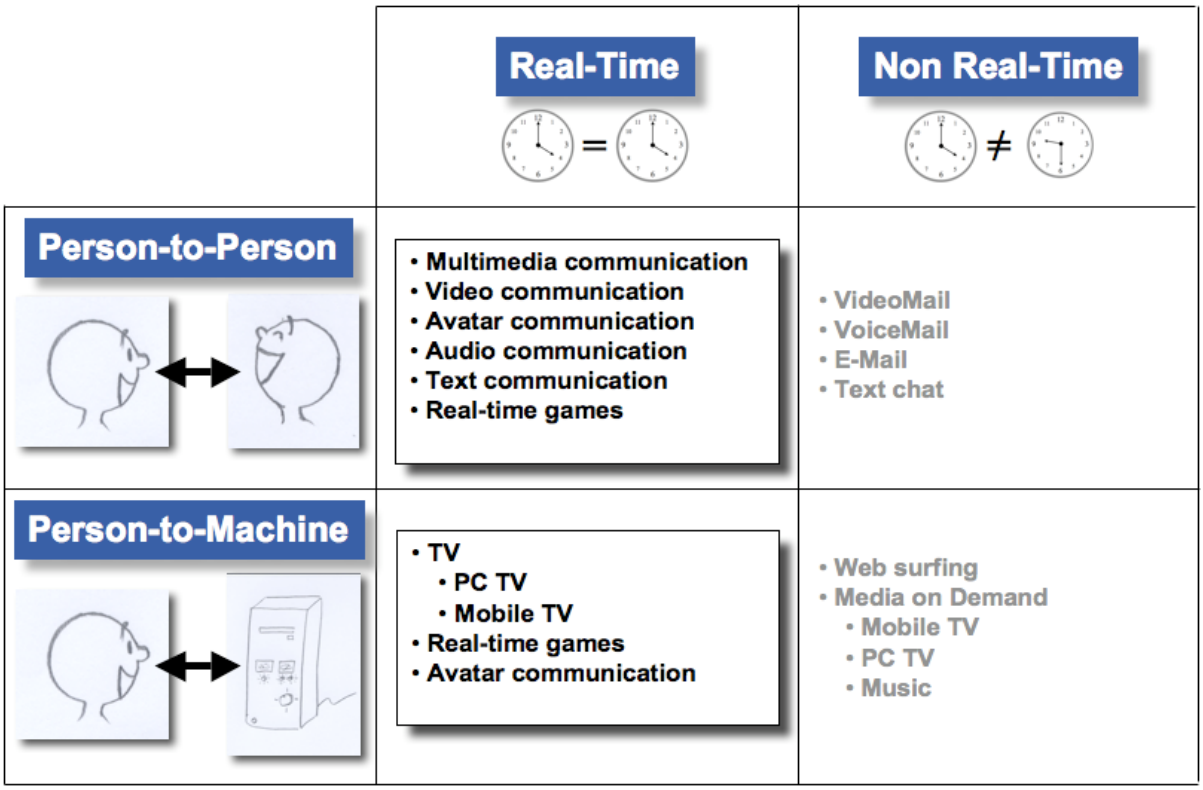

Figure 7: Communication services can be either real-time or non-real-time

The real-time communication services addressed by the WBGTS (Web-Based Guideline and Tutorial System) (http://portal.etsi.org/STFs/STF_HomePages/STF354/STF354.asp) are:

- Text communication
  - A text communication service enables people to use alpha-numeric characters for writing a message. To be considered a real-time service the alpha-numeric characters should be delivered to the receiver at one or more remote site as they are created by the user (e.g. within 1 second of being typed according to ITU-T Recommendation F.700 [i.33]). Services such as "text chat" are not considered real-time services even if they may deliver text almost immediately. With "text chat" the text information may not be transmitted instantly and continuously, because it is the sender who decides when to transmit the text (e.g. by pressing the "enter" key or clicking on a "send" button to send a sentence or paragraph).
- Audio communication
  - An audio communication service enables people to use their voice to communicate through a handset or headset (e.g. telephony between two people) or a loud-speaking function (e.g. audio conferencing between groups of people at two or more locations). This service is also known as conversational voice.
- Video communication
  - A video communication service combines voice and video information. There are two main categories of video communication that are distinguished primarily on the basis of the video information that is transmitted. These two types of video communication are "face-to-face video communication" and "remote inspection / observation / viewing video communication".
  - Face-to-face video communication. A face-to-face video communication service is typically referred to as videotelephony when the communication is between two locations or videoconferencing when the communication is between groups of people at three or more locations. This service is also sometimes known as video teleconferencing (VTC).
  - Remote inspection or "see what I see" (SWIS) video communication. A remote inspection video communication service enables observation of an object or environment while also engaging in person-to-person communication using audio communication. It enables a person to see what is talked about rather than who is talking. The minimal configuration for remote inspection is one-way video with two-way audio. The service is sometimes also called Tele-inspection and Tele-data.
- Multimedia communication
  - A multimedia communication service combines two or more media. A typical situation is the use of voice, video and computer presentation graphics (e.g. Microsoft PowerPoint). Another example is the combination of text and video without audio as in a "total conversation call" for hearing-impaired people.
  - A video communication service is actually a special case of multimedia communication because it combines video and audio. However, it is treated as a separate, fundamental category.
- Real-time games
  - Real-time games use multiple media for interactive, imaginative experience. The media are predominantly graphics, text and audio. Real-time games are a special category of multimedia communication.
- Live TV including PC TV and Mobile TV
  - A Live TV service televises an event at the same time that it happens. It is a special category of multimedia communication using predominantly video and audio and that is primarily one-way communication.

7.2 Guidelines development and dissemination

7.2.1 Guideline development

As well as requiring QoE data for the optimum design of a particular communication service, data may also required to aid the selection between candidate communication services (e.g. reasons for choosing between audio conferencing and video conferencing). Guidelines that address real-time communication services can be derived from existing empirical results available in the literature. Where user-based results are not known, there is a requirement to obtain new data. For example, initial user tests with videotelephony [i.4] have been extended to a range of real-time person-to-person communication services [i.5] in order to systematically collect QoE data through laboratory experiments and field studies and to derive industry-oriented guidelines [i.24] [i.18] in EG 202 534 [i.15].

All system and service developers deal with continually evolving technology and applications. This requires all persons to apply a certain amount of multidisciplinary knowledge, incorporating for example knowledge of technologies and knowledge of users. Therefore, information on related concepts should be available in order to help guideline users understand and apply the information on key topics. This implies the development of tutorial information that explains the key concepts to which the guidelines refer (considered further below).

The application of QoE data will be different between different guideline users. For example, it will depend on their particular role in the development of a system or service. It is possible that particular QoE data can be useful for different developers dealing with apparently different, though related, issues. It is also possible that particular QoE data can be used by the same person differently at different times, depending on a particular project at hand. The implication is that the development of guidelines from base knowledge of user behaviour should be topic related and allow for different abstractions to different guidelines. Base knowledge should be made accessible in a format that promotes abstraction to concise and applicable conclusions.

Although developers typically appreciate the need for user-based knowledge, their main reference points and decisions usually concern the technical QoS characteristics of a service. Therefore, whilst QoE embodies psychological measures of user behaviour it is should also be expressed in relation to technical QoS. Any guidelines should succeed where possible to combine both QoE and QoS measures to provide an expression of the usage outcome when performing a particular communication task with a particular communication service with known levels of QoS [i.7].

TR 102 274 [i.18] proposes an approach for extracting and combining QoE and QoS parameters from user test results where these data are known. The approach derives a database of detailed intermediate guidelines from which more concise guidelines can be abstracted. The intermediate guidelines are constructed based on the clause shown in figure 9.

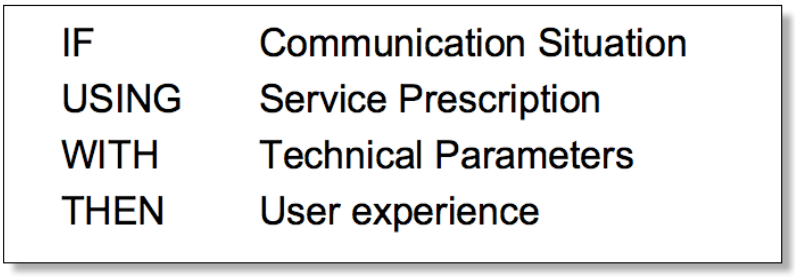

Figure 8: Intermediate guideline format

In Figure 8, the attributes "communication situation", "service prescription", "technical parameters" and "user experience" have sub-attributes and sometimes sub-sub-attributes in order to cover the problem space and to correspond to existing knowledge of media effects on communication behaviour. For example, the attribute 'Communication Situation' has the sub-attributes 'Task', 'Setting' and 'User'; and 'Task' is defined by sub-sub-attributes including 'Duration', 'Situation formality' and 'Urgency'. The 'Service prescription' contains the service used (e.g. audio conferencing, video conferencing) and the 'technical parameters' concern QoS measures such as network delay and packet loss.

With essential information collected and structured, guidelines can be abstracted and grouped to state the principal messages of relevance to the intended guideline users.

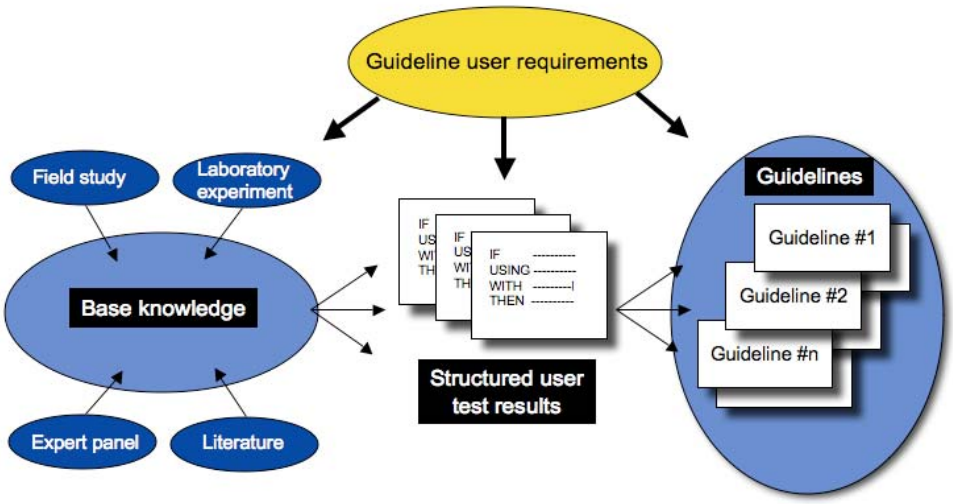

Figure 9: Guidelines are derived from structured user test results and based on guideline user requirements

The 'user experience' attribute could include many measures of user behaviour. For example, in the area of real-time communication the traditional usability variables of (communication) effectiveness, efficiency and satisfaction can be supplemented with measures of interpersonal perception and social presence. Depending on the original user tests, all of these measures have the potential to consist of multiple variables. However, most users of QoE data are not human factors practitioners and instead come from technical and business backgrounds (table 1). Therefore, meaningful summary statements of user behaviour are required that may differ from the original used in a user test.

In summary:

- providers of equipment and supporting services should understand the requirements placed on equipment and services by end-users;
- guidelines are needed that bring user-centred research results into a common format for key persons in network operator, product manufacturer and service provider organizations;
- the guidelines should:
  - Provide information on key topics of concern that will aid development choices and should be supported by tutorial information on key and related concepts;
  - Provide QoE data that can be used by persons with different professional perspectives and who are not human-factors specialists;
  - Link QoS and QoE variables.

7.2.2 Guideline dissemination

It is not obvious that when a standardization work is completed it reaches all the persons for whom it was intended. To increase dissemination and therefore uptake of best practice the work should be:

- **Visible as relevant:** especially for the purposes of a person's work at that time, but also when information from an unexpected source can have high utility and provide new knowledge because it offers a new perspective.
- **Capable of giving an overview:** often it can seem that there is too much relevant material in the public domain and it is too time consuming to determine if a certain work is really important.
- **Capable of giving detail:** for some stakeholders a guideline may appear to conflict with another guideline or may prompt questions about detail of the user test situation that may be resolved if further detail is easily accessible.
- **Understandable:** the terms and the language should be easy to understand as possible for the intended audience. It can be difficult to apply meaningful conclusions from a work that is formalized according to a particular discipline (e.g. engineering, human factors, standardization) rather in a more introductory way.

In an attempt to meet these requirements a Web-Based Guideline and Tutorial System (WBGTS) has been developed by STF 354. In particular the web-based system can have the following key properties:

- The system can have hyperlinks, so information can be identified and traversed in additional ways possible with a report;
- Guidelines can be filtered according to topics and services to enable personalised searching from general to specific requests;
- Tutorial support can be effectively provided and is necessary because:
  - The guidelines cover complex and continually evolving area (e.g. guideline users are dealing with an increasingly wide technological area).
  - The area is multidisciplinary (the guidelines deliberately combine multidisciplinary knowledge, such as from more technical QoS to more psychological QoE perspectives).
- With internet access a web-based system can be available anytime and everywhere.

8 Web-Based Guideline and Tutorial System for improved dissemination and application of QoE data

An overview of a Web-Based Guideline and Tutorial System (WBGTS) for real-time communication services is provided below. The main facilities offered by the web-based system are summarised along with a discussion of the main types of guidelines and their current maturity and restrictions. Maintenance of the web-based system is also addressed.

8.1 The main facilities of the web-based system

The WBGTS (Web-Based Guideline and Tutorial System) offers three main facilities:

- Navigation.
- Education.
- Dissemination.

8.1.1 Navigation facility

The aim of the navigational facility is to assist guideline users to discover whether or not guidelines exist that cover the issue in which they are interested.

The navigation facility offers three paths to reach a specific guideline, via:

- Communication services.
- Guideline topics.
- User keyword *search*.

EXAMPLE: A network provider is considering to launch a new ADSL product for video calls. A Strategic network planner in this organization would like to determine the number of subscriptions that are possible on the same sub-network. By using the "Find a guideline" link it is possible to find guidelines about "Services" and then "Video communication" as a Service sub-set. Also, navigating through the Topic of "Technical parameters" will similarly lead to information on Packet loss.

If the need concerns one specific service, such as Audio communication, all other information is excluded. This is also the case when selecting a particular topic, such as "Purpose of communication". If the topic of "Purpose of communication" is chosen and then Negotiation task, then all guidelines from user tests based on a negotiation context will be presented for all the services for which there are test results.

If neither of these paths provide relevant information for a particular guideline user it is possible that the general search engine could identify additional information. There could be a problem with terminology. For example, between use of the words Delay and Latency. Whilst navigating via Services and Topics enables a relatively simple but effective traverse through a relatively broad information space, the Search function is available as a final option to the user when necessary.

The navigation engine also enables guideline users to enter deeper into available data than in a traditional ETSI Standard, ETSI Guide or an ETSI Technical Report. Due to the constraints of a mainly "linear" paper or electronic document, these documents usually present single-sentence summary justifications for guidelines whereas detailed information for each empirical source is made available with the web-based system. These detailed justifications provide more comprehensive information about the test result from which it is derived (e.g. types of users, experimental design, complete technical set-up, statistical results) and provides the reference to the literature from which it was derived.

Table 3 shows the services and topics in which the Guidelines are grouped.

Table 3: Guideline topics per service

Service	Topic	Service	Topic
Text communication	Delay	Face-to-face video (continued)	Person perception
	Duration		Deaf or hearing impairment
	Negotiation		Speech impairment
	Person perception	Remote inspection video	Audio-video asynchrony
	Deaf or hearing impairment		Resolution
Audio Communication	Delay		Frame-rate
	Jitter		Packet loss
	Stereo		Cost-benefit
	Spatial speaker recognition		Self view
	Packet loss		Instruction task
	Media Quality		Problem solving task
	Business communication		Showing surroundings
	User performance		Object recognition task
	Listening task		Blind or visual impairment
	Negotiation task	Multipoint video	Window configuration
	Problem solving task	Multimedia communication	Audio-video asynchrony
	Instruction task		Appearance
	Person perception		Eye contact
	Elderly		Media Quality
	Deaf or hearing impairment		Urgency
Face-to-face video	Packet loss		Deaf or hearing impairment
	Audio-video asynchrony		Cognitive impairment
	Delay		Medical interview task
	Packet loss	Real-Time Games	Delay
	Resolution		
	Media Quality		Background noise
	Screen size		Person perception
	Reliability		Social wellbeing
	Cost-benefit	TV	Frame-rate
	Urgency		Packet loss
	Negotiation task		Colour depth
	Problem solving task	Mobile TV	Frame-rate
	Instruction task		Resolution
	Decision making task		Packet loss
	Medical interview task		Bit-rate
	Group video communication		Screen size
	Human support		Content type
	Appearance		Pattern of use
	Eye contact		Viewing distance

8.1.2 Education facility

The aim of the education facility is to assist guideline users to understand terms, expressions and concepts used. The guidelines deliberately incorporate multidisciplinary data (e.g. linking QoE and QoS aspects). Guidelines users working in technical areas may understand Packet loss, whereas persons working in more marketing and financial areas may benefit from an explanation of this term. On the other hand, the more technically-oriented guideline users may benefit from explanations of the more user-centred concepts, such as a communication task based on Negotiation.

EXAMPLE: A Human Factors specialist working at a service provider organization becomes responsible for considering user implications of packet loss. However, he does not understand the implications of packet loss sufficiently to immediately apply his knowledge of psychology. He chooses the lessons about packet loss and becomes informed about the causes of errors on a digital line and the measurement of Bit Error Rate. He also learns that when packets are transported over a digital line and a Bit Error damages the packet this results in either the packet repairing itself (if it has enough information) or the packet being lost. The packet may contain audio or video information and therefore damage or loss may lead to the user perceiving some type of distortion.

The education facility offers lessons within specific areas. Examples are:

- Packet loss.
- Delay jitter.
- Lip-synchrony / asynchrony.
- Frame-rate / resolution.
- User-perceived reliability.
- Social presence.
- Heterogeneous transcoding.
- User task types.
- Influence of participant status.
- Quality of Experience (QoE).

Each lesson has the same structure:

- What is it? (e.g. "What is packet loss?");
- Why is it important?
- Special topic-specific sub-lesson(s) (e.g. for packet loss: "How does Internet cope with Packet loss?", "What does 5 % Packet loss mean?", "Causes of Packet loss", "QoS implications on QoE");
- Conclusion
- Frequently asked questions.
- References to literature (if relevant).

8.1.3 Dissemination facility

Dissemination is not a mechanism in the web-based system. Rather, the web-based system is used to enhance the dissemination process.

EXAMPLE: An equipment manufacturer developing 3G mobile terminals recognizes that it is necessary to know if the video quality of a new device is good enough. A Development engineer in this organization wonders if there could a Standard or published Guide to which she could refer and be able to state that the new product is quality assured for users. She uses a general search function and discovers a guideline that states that CIF with 15 frames per second is good for remote inspection.

The web-based system provides a tool by which persons responsible for improving user experience may become further informed about empirical knowledge and key concepts. It should be:

- **Findable** by searching of intentional users. The URL should be associated with ETSI, the key authors and with the supporting Standardization document. The web-based system is located within the ETSI web-site.
- **Accessible** when the guideline users require. An automatic feature of a website is that it is available anytime and anywhere with a terminal and internet connection.

8.2 Types of Guidelines

Figure 10 shows the distribution of guidelines across the real-time communication services. As is to be expected from the availability of user test results, there are more guidelines within some services than others. The three services with the most guidelines are face-to-face video communication, audio communication and mobile TV.

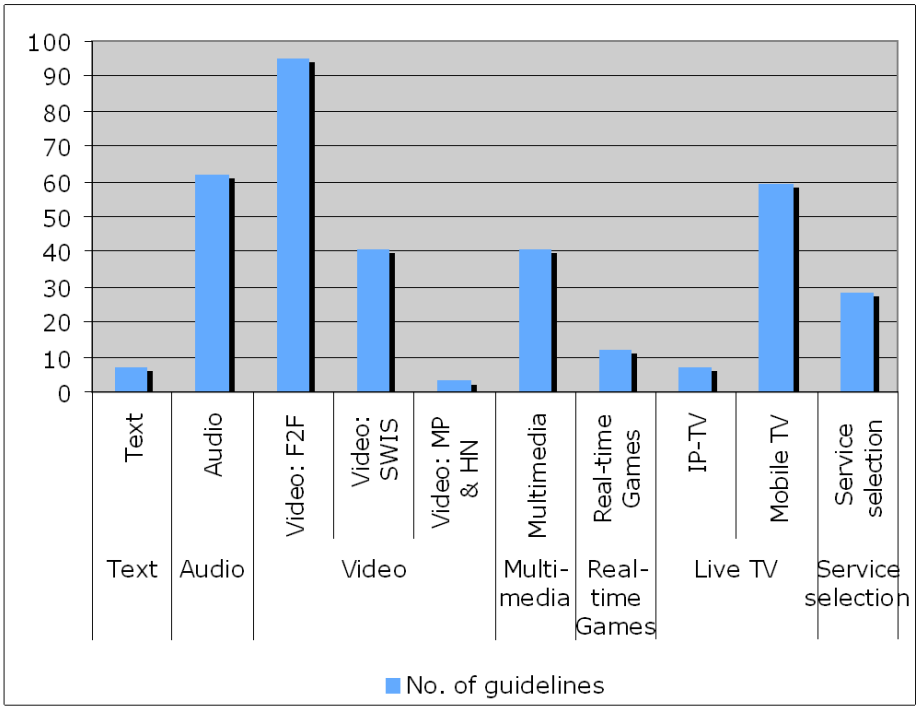

Figure 11: Distribution of guidelines across the real-time communication services

Figure 12 shows the distribution of guideline test results by the type of original source document. The two main sources are conference proceedings and research reports. This is consistent with the state-of-the-art nature of user testing of communication services, where research is disseminated by contract and company research reports and scientific conferences where the time-scales involved are less than, for example, journal articles and books. However, journal articles make up the third main source. Only 10 % of the guideline sources come from existing ETSI or ITU documents that have been found to be based on user tests.

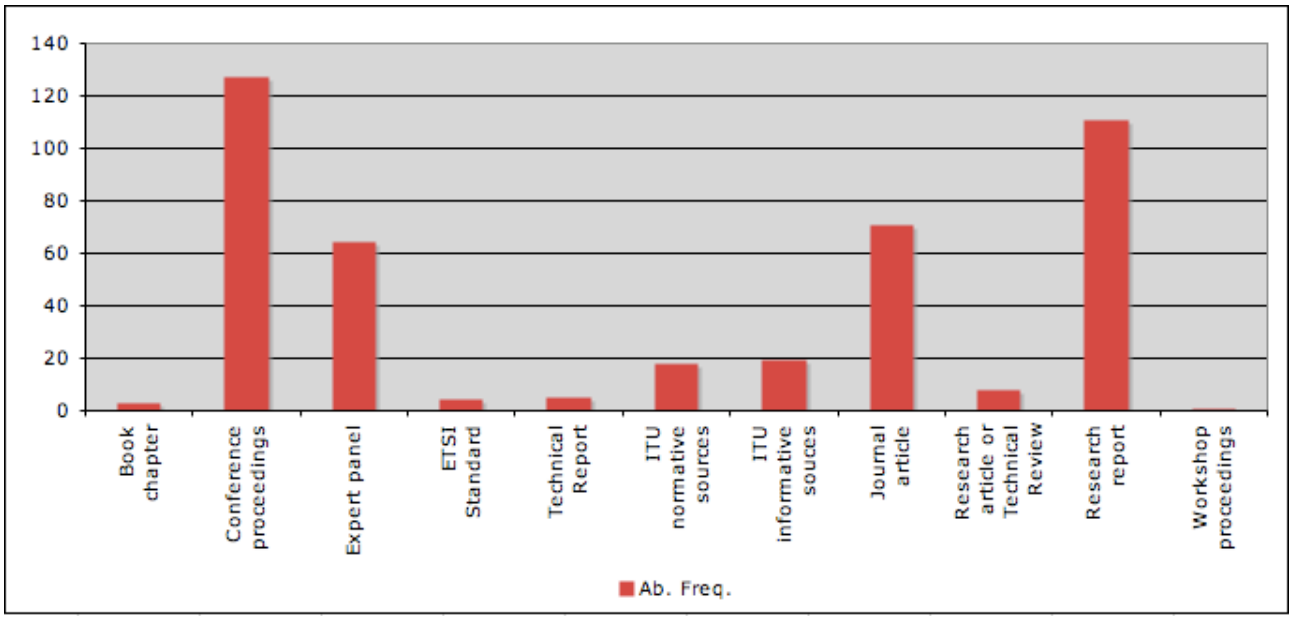

Figure 12: Types of empirical source

8.3 Maturity and restrictions of the guidelines

The guidelines are considered initial because there is a very large range of potential communication situations, service prescriptions and technical parameters for which user experience data could be collected. To date a relatively small number of empirical studies has been performed and new usage situations and (potential) services for testing continually emerge. Further study is required to increase the range of the guidelines. Also, the validity of some guidelines remains open for further study, principally because:

- Some of the user tests on which the guidelines are based should be replicated and extended to different user groups and task types. There may be cross-cultural issues concerned with real-time communication services, and the available user test data is mainly restricted to samples within particular countries (e.g. the UK and Norway).
- Some of the user tests should be repeated with different technical parameters to be more relevant to current service developments. For example, whereas there is data that with CD stereo audio quality users may rate social presence higher than 3,1 kHz mono or stereo, there is no known similar experiment done with wideband speech/audio.
- Most of the empirical tests involve condition comparisons that reveal where significant differences between conditions or groups exist but they were not designed to identify precise thresholds for QoE.
- Most of the laboratory results for two-way communication concern dyadic communication (i.e. between two people) that is point-to-point (i.e. between two locations). Some field data exists for group communication (i.e. between three or more people) that is point-to-point. There is currently little data available for multi-point communication (i.e. between three or more locations).;
- Different user tests may have their different strengths and weaknesses, due to particular research designs and choice of more objective or more subjective user measures.
- Some guidelines are based on conclusions by expert panels rather than user tests, although this is relatively few (about 7 %).

8.4 Maintenance of the Web-based system

As with most websites, there is an issue of maintenance of the web-based system. Furthermore, this particular site can expect to require updating due to a number of reasons:

- Existing guidelines should be modified or removed - for example, due to new research findings and changes in technologies, media and services.
- New guidelines should be added - as new research findings become available.
- Tutorial elements should be modified - for example, due to changes in technologies, media and services.
- New tutorials should be added - as new terminology, expressions and concepts appear.
- The user interface should be modified - as experience from use reveals difficulties and as user expectations change for an up-to-date design.
- Errors should be corrected - as usage reveals poor and no functioning elements.

Updating the web-based system could be primarily driven by the responsible Technical Body. In addition, it can be expected that users of the web-based system will provide requests for changes and additions. Indeed, this is actively encouraged by the "Send us feedback" link on the homepage.

9 Towards generic QoE guidelines by including non real-time services

The guidelines available today concern real-time communication services where at least one person wishes to communicate. The framework and methodology used have been developed for this purpose. For example, there are important elements of methodology drawn from the psychology of human communication.

However, it has been identified that the framework and methodology may also be applicable and useful for non real-time services. For example, recent tests in Norway and Denmark with Mobile Broadband (for web browsing, email and video on-demand) provide evidence of the potential value of this work for all non real-time services that involve people.

Possible extension of the guidelines beyond the real-time focus toward generic communication services is a recommendation for further work in clause 11.

10 Conclusions

The collection of guidelines for real-time person-to-person communication has been a continuous task since the EC 4th Framework Programme project Vis-à-Vis (1998 to 1999), with the collection of the requirements of intended guideline users in progress since the EC 5th Framework Programme project Eye-to-Eye (2000 to 2003). With the inclusion of the work of an earlier ETSI STF (284) and the current ETSI STF (354), approximately 540 individual user tests results have been collected from which over 350 guidelines have been developed.

Experience from direct stakeholder engagement has shown a very high level of support for the aims, approach and results of the work. However, due to the multidisciplinary nature of this area there can be additional challenges with communicating concepts and understanding terminology. Indeed, this emphasises the role of the Web-based Guideline and Tutorial System over and above a traditional standards document. Also, not all the guidelines that have been requested by stakeholders have been developed, due primarily to an absence of supporting data on which to base a conclusion. To address this needs further collection of user test data.

Within technical teams working with end-user products, there is recognition that often there is too little knowledge of how a certain set of technical parameters will be experienced by the end users. The work has confirmed a strong need among stakeholders to know more about this topic. A particular need for information concerns when the technician should understand the trade-offs between different technical parameters, such as effects of packet loss versus delay for speech services, frame-rate versus resolution for audio-visual services and bitrate versus latency for multimedia broadband services.

11 Recommendations for further work

Three candidates for further work have been identified, with the aims to:

- Expand towards generic QoE guidelines;
- Document the user test framework and guideline derivation methodology in a separate ETSI document;
- Update the Web-Based Guideline and Tutorial System.

11.1 Extend towards generic QoE guidelines

A need has been identified for collecting generic guidelines for all user-centred services. This implies that the current framework and methodology should be analysed to assess if it will also work for non real-time human communication.

There have been requests for guidelines within M2M (Machine-to-Machine) and avatar-to-avatar communication, but it is believed that these require other methodologies. Extension towards generic QoE guidelines would be based on a prerequisite that there is at least one person as a user for which QoE should be measured.

11.2 Document the user test framework and guideline derivation methodology in a separate ETSI document

It is the STF experience that the user test framework and guideline derivation methodology is stable for those service areas to which it has been applied. There is a strong argument to make the methodology available for other people because there is a continual need for more empirical data that can be converted into guidelines. There are advantages of enabling stakeholders reference an ETSI Document that comes from a body that has already used the methodology.

This document should provide an in-depth description of the framework and methodology; including what it is, what it can be used for, what it cannot be used for and how new guidelines can be produced with good quality.

11.3 Update the Web-Based Guideline and Tutorial System

Every web-based system needs an update and maintenance programme. This work should address the user interface and the content of the site.

In the specific case of the WBGTS user interface enhancement and error correction can be based on feedback received through active promotion of the site and requests for evaluation (a "Send feedback" function is implemented). Regarding content, it is expected that there will be guidelines and tutorials that require modification or removal as well as the useful addition of new guidelines and tutorials.

History

Document history		
V1.0.0	November 2009	Publication
V1.0.1	December 2009	Publication
V1.0.2	January 2010	Publication