QoE Estimation Methodology for 5G Use Cases

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Abstract. Promising development of information technology in the modern world completely affects all areas of human activity. From now on, the concept of "Quality of Experience" (QoE) is becoming increasingly popular, and great efforts have been made to improve and provide reliable and additional services with a high level of experience for users. This chapter considers the problems of functioning of quality assurance systems in the fifth generation networks. As well as the importance of service quality in wireless and mobile networks and analyzed the main features of the use of 5G technologies. Providing standard definitions and the most important developed measurement methods. Demonstrates significant improvements and approaches for service quality control to meet user expectations.

Keywords: 5G · Quality of Experience (QoE) · Quality of Service (QoS) · IoT · Network · Technology · URLLC · eMBB · V2X

1 Introduction

Despite the advances in the development of fourth-generation cellular networks, the new demands arising from new communication needs require the creation of a fifth-generation mobile network. The 5G standard promises to be a breakthrough. Unlike previous generations, it has much higher data rate and power, as well as much better reliability. It is claimed that thanks to 5G Internet of Things (IoT), unmanned vehicles and virtual reality will move rapidly from the pages of technological media to our reality.

The cellular network will operate from low to high frequencies, which can transmit large amounts of data. The developers of this standard are also trying to reduce delays and reduce electric power consumption. This is a very important solution for mobile devices and IoT devices compared to 4G. The fifth generation network will be able to transmit data on the unlicensed frequencies currently used for Wi-Fi, without creating a conflict with existing Wi-Fi networks. This is very similar to T-Mobile's LTE-U technology [1].

5G technology provides for the presence of an extensive telecommunications infrastructure (a system of powerful terrestrial data transmission channels - fiber-optic communication channels). In this regard, 5G requires a much larger number of base stations (gNb) than required by 4G or any other mobile standard. For the full functioning of the network, stations ("towers") must be located every few hundred meters.

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New applications, such as high-quality video streaming, touch Internet, traffic safety, remote real-time control and management, include new requirements for bandwidth, end-user latency (E2E) and network reliability. In addition, services include the provision of periodic or ongoing communication for machine-type communications, covering a variety of services, such as connected cars, homes, mobile works and sensors, which must be supported in efficient and scalable ways. Moreover, some new trends, such as "smart" devices, 3D immersion technology and virtual reality, affect the behavior of end users and directly affect the requirements for the network.

Also, the 5G network is expected to significantly improve Quality of Service (QoS) communication. Despite the variety of Quality of Experience (QoE) requirements, providing low latency and high bandwidth generally improves QoE. Thus, most of the previously mentioned tools can improve QoE. Traffic optimization methods can be used to meet QoE expectations. Also, installing cache and computing resources at the edge of the network allows the operator to place content and services close to the end user. This can provide very low latency and high QoE for critical interactive services such as video editing and augmented reality.

Big data, including information from sensors (such as on a device) and user statistics, can be used wisely using such models to more accurately estimate the user's expected QoE and determine the optimal resources to use to meet the expected QoE.

2 Previous Research Analysis

The benefits of 5G technology are needed to maintain quality of service. As in the previous generation, such as 3G and 4G, a quality known as QoE was identified. The 5G generation has additional qualities that the satisfaction service material focuses on QoE.

The notion, practicalities, and applications of QoE have considerably evolved since its inception in the telecommunication context [2]. Defined at the time as the "the overall acceptability of an application or service, as perceived subjectively by the end-user", QoE was understood to include "end-to-end system effects" and that it "may be influenced by user expectations and context". The evolution of QoE inference and use have included improvements on the manually aggregated scores, e.g., the mean opinion score (MOS); standardizing QoE mappings to network measurements of service delivery; association/correlation studies with user-end observations and responses; and more [3].

QoE can be defined as a process of measuring or evaluating quality for a set of program or service users with a special procedure and taking into account impact factors (possibly controlled, measured, or simply collected and reported). For example, quality assessment based on SDN/NFV [4–6] methods is an important step towards quality-based monitoring and management. Depending on the purpose and direction of the study in Rec. ITU-T describes various methods and guidelines for subjective assessment [7–9].

Regarding the measurement of QoE in 5G technology, a number of studies have conducted different approaches to measurement. The lack of measurement standards and QoS and QoE values for 5G provides opportunities and variations in measurement objects, methods and data acquisition. For example, in studies [10] and [11, 12] they used mathematical approaches, while in [13] they used a virtual approach. An approach that uses statistical analysis is also performed, as in studies [14]. The location and type of device also affect QoS and QoE measurements, as in studies [15] and [16].

It is expected that 5G technology with all the advantages meets the value of QoE, reliability and high security. Simulation to obtain QoS values from previous technologies may not be suitable for 5G technology. This is due to the value of quality present in this 5G era. Parameters such as packet loss, loss rate, network delay, PSNR and travel time are considered less effective in 5G, mainly for video media, because in assessing the quality of video media is the value of satisfaction presented in QoE. Therefore, despite the fact that the QoE parameter is still considered vital, it is not enough for the value of user satisfaction [10].

Performing a measurement process to obtain QoE values using 5G technology, a number of researchers have performed it. Various approaches, methods and objects are used to obtain results, which can illustrate the advantage of 5G technology in ensuring the quality of service to its users. Transport communication is the most widely used object, as in studies [12, 15, 17–23]. Parameters in traffic, such as data rate and reliability, are measured to obtain values from QoS and QoE. In a study [24], the value of traffic success is a measure to assess the QoE in obtaining the value of quality in terms of security.

Objects involving users are conducted to assess the QoE, such as research [25], which suggests which 5G scenario is used and where the location is located.

The article [26] proposes a dynamic approach to resource allocation by VBS and RRH, aimed at improving resource efficiency and energy, while ensuring a high level of QoE.

3 Problem Statement

5G networks has brought a lot of new possibilities to the vertical industries. And now it is necessary to provided needed level of user's satisfaction. There are a lot of new use cases appeared. And now it is necessary to measure QoE for each of them. Existing approaches are not able to provide correct measurements of this very important parameter. That's why the aim of the research is to develop the novel unified methodology for assessing the QoE in 5G networks for different use cases (UCs). To achieve the goal of the research the next tasks have to be solved:

- 5G use cases classification development;
- QoE estimation methodology development;
- Development of the approach of QoE estimation methodology implementation;
- Experimental studies of the developed methodology.

4 QoE-QoS Estimation Methodology for the 5G Use Cases

4.1 5G Use Cases Classification

Wireless networks have improved their capabilities, trying to keep up with the development of technology. Different generations of wireless cellular networks were developed before the advent of 5G. The development of the new network promises to provide extremely high data rates, much less latency and high integrity.

The fifth generation is the basic technology that is necessary for society, the state as a whole and the digital transformation of business. Not taking into account the fact that the specifications for fifth-generation broadband access are still under development. But we can say that today it is obvious that the effect of the application of this technology will go far beyond the telecommunications business.

Consider the possibility of using 5G technology in various spheres of life. For this purpose the analysis of characteristics is executed, features of a structure and characteristics of 5G technologies are considered. The main problems that can be solved using 5G technologies are highlighted below (see Fig. 1) [27].

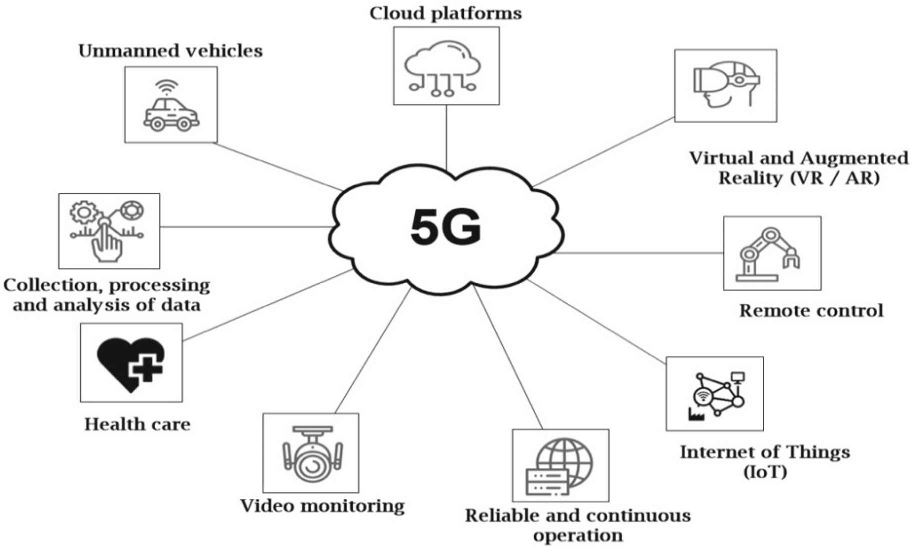


Fig. 1. Use of 5G technologies

Thanks to the basic ability of 5G to connect a large number of digital devices, such networks can implement a wide range of services called Internet of things (IoT) - finally open the door to a world where gastronomic preferences will be clear to home appliances – ordering, delivery and payment will be automated. Such 5G-based systems open up incredible opportunities for any industry and industry – from automatic humidity control and field irrigation (non-critical systems) to automatic design and production of new products in unmanned production (critical systems).

In smart city projects, 5G will allow real-time transmission of information from a much larger number of sensors at various sites. It will be possible to deploy a thousand sensors instead of hundreds, for the maintenance of which there will be enough fewer base stations than with existing networks. These can be, for example, sensors for monitoring the condition of housing and communal services, sensors of “smart lighting” or sound sensors installed for security and order in the city. In the latter case, the sensors can detect suspicious or too loud sounds, and this information will be automatically transmitted to law enforcement.

Self-governing vehicles are another area that requires a new generation of communication networks. Cars can be equipped with sensors that read all sorts of information about the road situation: the nearest vehicles, weather conditions, the condition of the asphalt, road signs. Based on this data, the trip can be managed automatically. In addition to the convenience for the driver of the car, equipping cars with sensors opens up new opportunities to improve road safety. On 5G networks, cars will be able to communicate with each other and make instant decisions about what to do in a given situation based on information received from other vehicles on the road. For example, a car could send a signal about its sudden braking, so that the car, which is in danger of a collision, could also brake sharply in automatic mode. It is impossible to implement such a service in 4G networks [27].

Augmented and virtual reality (AR/VR) services have been evolving for several years, but have not yet become widespread. The growing use of technology is constrained by the lack of a collaboration platform in an AR/VR environment. The proliferation of 5G will make AR/VR massive, allowing you to deliver 3D content, 3D video at high speed, providing low latency and interactivity.

High bandwidth of 5G channels and cloud computing power will minimize wearable AR/VR devices, eliminating the need for local video processing. Due to the high data transfer speeds and 5G synchronization, they will provide easy joint AR/VR immersion of several remote users. Third-party developers of "heavy" AR-/VR-content will have access to all the technical capabilities and services of 5G.

New services using 5G can be implemented in medicine. One of the areas of application is remote monitoring of patients. The doctor will be able to quickly receive information from special sensors and monitor the condition of patients around the clock. Due to the very low data transfer delays, 5G will also open up more opportunities for remote operations using robots. This service is especially relevant for small settlements where there are no local surgeons. Due to 5G, such a service can be deployed in wireless networks [28].

The 5G network will become a universal platform for remote control of equipment in remote and closed areas, transmission of process information to other production units, partners and regulatory authorities.

Remote control uses platform services of video streams, AR/VR, but requires cooperation with manufacturers of machinery and equipment, development of special applications. Therefore, it is logical to allocate remote manipulations in a separate platform service for scaling and distribution in different industries for a variety of types of controlled equipment.

Clinical and outpatient care is becoming radically more accessible and effective with the use of special devices for collecting and transmitting biological and medical indicators from sensors on patients, as well as with intelligent machine analysis of these data in the diagnosis and evaluation of treatment.

New technologies allow to transfer a huge amount of data without delay and are in demand in pediatrics, psychotherapy, dermatology, neurology and even in resuscitation: if the patient can not be transported to another clinic, an urgent video call from a more competent specialist can save lives. A highly qualified surgeon can remotely monitor what happens during the operation through a 5G video session and correct the actions of colleagues, or control auxiliary devices. Secure sharing ensures that data is kept confidential. Because smart devices are deployed and run in a peripheral infrastructure rather than through a centralized node, the data collected elicits immediate feedback, improving the response of the entire system.

Real-time machine analysis of data and UHD images from a remote patient builds a model from which the doctor works over the network through a connected AR-/VR-headset. Comparing the digital model of a particular patient with numerous digitized images and information from a powerful cloud MIS simplifies diagnosis, identifies future health disorders, studies their causes, suggests ways of prevention and treatment, helps to implement them remotely. Even more valuable is the use of AR tools in surgery. Often the maximum speed of completion of intervention is important, manipulations are complicated by difficulties of distinction of fabrics and bodies. Augmented reality images provide visual accentuation of diseased tissues, operational recommendations and online assessment of actions, significantly reduce the risk of medical errors and speed up the work of the surgeon. Real and VR images, 3D models are broadcast to other doctors for advice.

Thus, we can conclude that 5G will allow you to transfer practical skills over your networks, developing a new direction, not just information. Mobile networks will become an important part of the infrastructure for the development of key industries. There is a statement, according to Ericsson, that by 2026 the launch of the fifth generation mobile network standard will lead to a completely new market, reaching about $582 billion globally. Remote control of heavy industry will become a reality due to almost zero delay. This will reduce production costs and increase safety for employees.

Absolutely every user of technology will witness the development of intelligent transport systems. Unmanned automotive future awaits users in the near future. In total, 10 million smart vehicles will travel on most of the world's roads.

Ericsson Mobility Report predicts that by 2022 there will be 29 billion connected gadgets worldwide. The Internet of Things will account for 18 billion of the total. These results mean that each active consumer of technology will have several smart things at once [29].

4.2 QoE Estimation Methodology

In recent years, the technical community has shifted some attention from one related gauge, quality of service (QoS), to a more consumer-centric metric, quality of experience (QoE). Network operators and service providers from the very advent of telecommunications wanted to know, what is the level of service quality which is provided to the end users. This is because that knowledge can be extremely useful when trying to manage network topology, optimize its capacity and operating costs, introduce new services or plan investments and expansion of a network.

International Telecommunication Union (ITU) defines QoE as the overall acceptability of an application or service, as perceived subjectively by the end-user QoE can be considered as an extension of the traditional QoS in the sense that QoE provides information about the delivered service from an end-user point of view.

Whereas QoS stands between the network and an application, QoE is centred on the subscriber. In particular, QoE focuses on person-as-user who interacts with an application and person-as-customer who deals with a service provider, see Fig. 2 [29, 30].

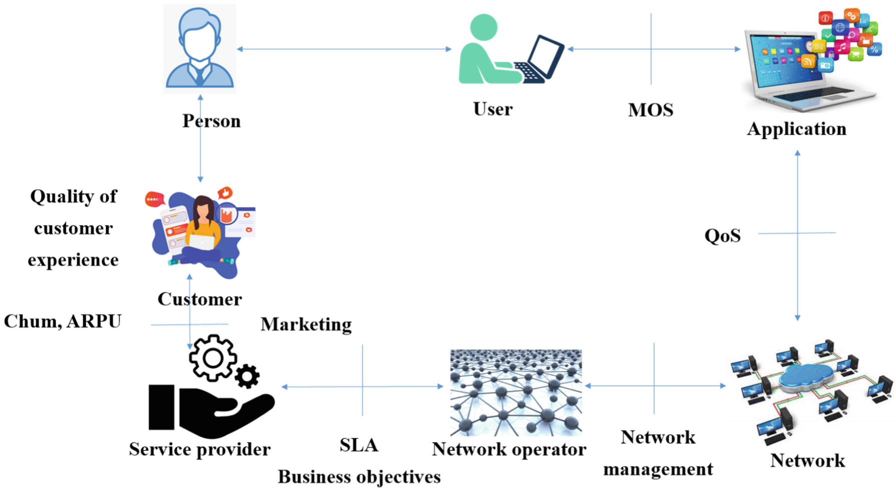


Fig. 2. QoE model

Thus, the service quality has some objective and subjective properties. Obviously that the user will hardly be satisfied if a network performance (QoS) is poor. For instance, if the re-buffering of a video is frequent during the streaming session a user will most certainly be annoyed and unsatisfied. But it was also showed that achieving the QoS targets does not necessarily ensure satisfied users. Something was still missing.

The difference between QoE and QoS is underlined below [31]:

QoS – Quality of Service:

– network characteristics/behavior;
– performance guarantees given by network provider based on measurements;

QoE – Quality of Experience:

– impact of network behavior on end user;
– some imperfections may go unnoticed;
– some imperfections may render application useless;
– not captured by network measurements.

QoE is not directly depending of radio channel conditions, but the expectation will increase with higher performance. Increasing expectation changes QoE but it happens for all technologies then. QoE considers a user's expectation, QoS is more rational based on technical measurements (Fig. 3).

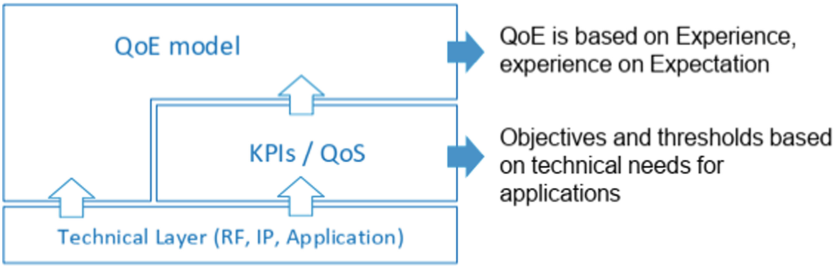


Fig. 3. Relationships between QoE, QoS and KPIs

Based on the above, the following approach is proposed for evaluating the overall QoE using QoS metrics, that can be estimated in more objective way.

To implement this approach, a set of services (UCs) was introduced that should be analyzed:

$$\left\{\bigcup_{i=1}^{n} \mathbf{S_i}\right\} = \{\mathbf{S_1}, \mathbf{S_2}, \ldots, \mathbf{S_n}\}, \tag{1}$$

where $\mathbf{S_i} \subseteq \mathbf{S}$, $(\mathrm{i} = \overline{1, \mathrm{n}})$, n is a number of services, and

$$\mathbf{S_i} = \left\{\bigcup_{\mathrm{j}=1}^{\mathrm{m_i}} \mathbf{S_{ij}}\right\} = \{\mathbf{S_{i1}}, \mathbf{S_{i2}}, \ldots, \mathbf{S_{im_i}}\}, \tag{2}$$

with S_{ij} $(\mathrm{j} = \overline{1, \mathrm{m_i}})$ is a subset of the elements of the quality assurance system.

The Subsets of QoE metrics $\mathbf{S_{ij}} \subseteq \mathbf{S_i}$ can be represented as:

$$\mathbf{S_{ij}} = \left\{\bigcup_{\mathbf{p=1}}^{\mathbf{r_{ij}}} \mathbf{S_{ijp}}\right\} = \left\{\mathbf{S_{ij1}}, \mathbf{S_{ij2}}, \ldots, \mathbf{S_{ijr_j}}\right\}, \tag{3}$$

where $\mathbf{S_{jp}}$ $(\mathrm{p} = \overline{1, \mathrm{r_{ij}}})$ are QoE indicators that characterize the QoE for $\mathbf{S_{ij}}$; $\mathrm{r_{ij}}$ is the number of such indicators.

At the second stage, QoS and QoE indicators are selected $\mathbf{S_{ijp}}$, using multi-factor correlation-regression analysis. To construct a multi-factor regression model, the following steps have to be completed:

Step 1. Select all possible QoS factors that affect the QoE indicator (or process) that is being investigated. For each factor it is necessary to determine its numerical characteristics. If some factors can not be quantitatively or qualitatively determined or statistics are not available to them, then they are removed from further consideration.
Step 2. Choose the form of a regression or multivariate model, that is, finding an analytic expression that best reflects the relationship of factor characteristics with the resultant, that is, the choice of function:

$$\hat{\mathrm{Y}} = \mathrm{f}(\mathrm{x_1}, \mathrm{x_2}, \mathrm{x_3}, \ldots, \mathrm{x_n}), \tag{4}$$

where $\hat{Y}$ is the effective sign-function; $x_1, x_2, x_3, \ldots, x_n$ are factor signs.

On the next stage subsets of QoS indicators have to be calculated using corresponding algorithms and formulas for their calculations [32]. QoE has to be calculated using i.e. MOS, DSCQR, ACR [33] or other appropriate methods/techniques. For example, in 5G-TOURS project [34], the special questionnaires were developed to estimate the QoE for each use case.

On the last stage, the obtained values are compared with the maximum permissible, possible to ensure the normal functioning of the network and achieved KPIs.

To compare the values obtained as a result of calculations with the maximum allowable was introduced the logical function of equivalence:

$$E(x, y) = \begin{cases} 1, & if\ x > y, \\ 0, & if\ x \leq y. \end{cases} \quad (5)$$

QoE is almost the most important parameter, estimating which it is possible to determine user experience and compare it with users' expectations. Respective approach based on the principles of machine learning has been developed to assess and optimize the state of the network in order to improve the QoS provision to users.

That's why was developed the QoE evaluation methodology in order to evaluate the level of satisfaction of end-users and verticals' players with the deployed use cases. This includes users' QoE as well as the feedback from the vertical players on how the technology provided can improve their business operations [31].

In addition to the validation of the QoS results which illustrates mainly the performance of the network KPIs and can be compared against the 5G PPP targets, it is of paramount importance to validate the actual satisfaction of i) end-users and ii) the

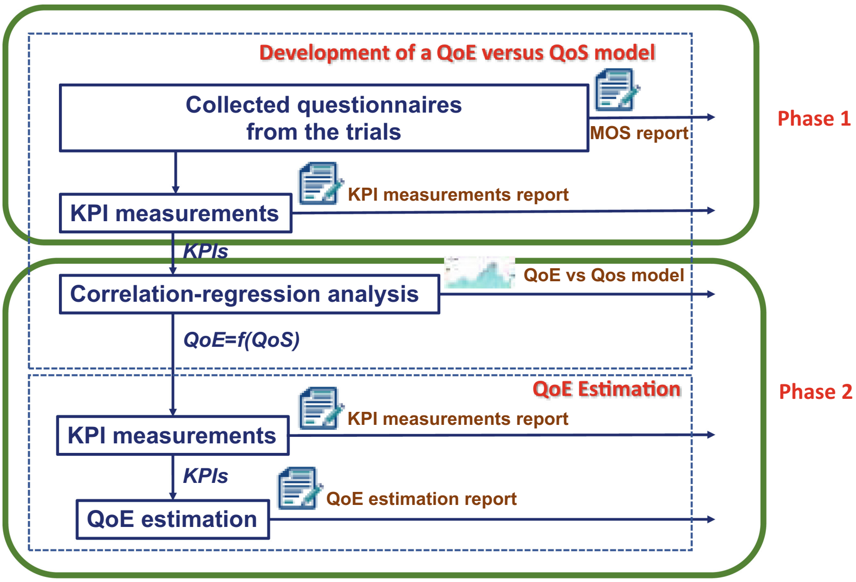


Fig. 4. . General approach for evaluation methodology

vertical players (either as service providers or users of secondary service flows). In this direction, was developed the QoE evaluation methodology, the high-level architecture of which is presented in Fig. 4.

It was discriminated between two phases. The first phase is realized during the trials execution and collects both the QoS metrics, automatically collected from the infrastructure, and the QoE metrics (and vertical satisfaction) collected using appropriate questionnaires. The second phase is realized after the trials executions and by using correlation-regression analysis which tries to create a model for QoS-QoE correlation.

Every approach taken in previous research to measure QoS and QoE has its respective potential. This potential is expected to meet the balance between QoS and QoE, an easy, fast, and accurate process, and flexibility between ideal conditions and reality. It should also remind that in 5G technology, there are three major scenarios in which there are multi-technologies in implementation so that the measurement of QoS and QoE has the potential to be very diverse.

The measurement of traffic and user response in the object approaches group has potential from the balance of QoS and QoE, ease, and flexibility as in the sub-material that becomes the measurement target. This is because the traffic has various sub-material as well as sub-material in the user response that is very flexible. User traffic and response also meet the value requirements of highly technical and systematic QoS and QoE that is very attached to users.

Quality of experience is essentially a human related experience that is difficult to measure using quantitative techniques, being the ones related to videos the most famous ones. QoE is traditionally measured through Mean Opinion Scores and questionnaires. These questionnaires include a set of multiple questions with a specific weight usually defined with a specific scale, as originally proposed by, extended with some open questions.

The rationale behind this decision is to exploit the questionnaire filling procedure to also achieve some insights behind the ones already obtained by the questions. Clearly those open questions cannot be mathematically evaluated, as discussed next, but they can provide further useful feedback.

The final version of the mentioned questionnaires tried to address four critical requirements:

a) Validate both the user satisfaction as well as the vertical satisfaction (in each UC questionnaires are generated for both users and main shareholders).
b) Cover aspects that will become useful during the QoE-QoS correlation process.
c) Share some commonalities between UCs.
d) Deal with cost and pricing aspects.

For the estimation of the overall QoE level we rely on the hypothesis function:

$$h(\theta) = \theta_0 \cdot x_0 + \theta_1 \cdot x_1 + \ldots + \theta_n \cdot x_n, \tag{6}$$

where n is the number of features in the data set; x is the QoS parameters, θ are the weight coefficients.

For estimation of the θ was proposed to use the next Normal Equation:

$$\theta = \left(X^T X\right)^{-1} \cdot \left(X^T y\right). \quad (7)$$

In the above equation,

- θ (Estimated QoE): hypothesis parameters that define it the best.
- X (Input QoS parameters): Input feature value of each instance.
- Y (Output QoE): Output value of each instance.

4.3 QoE Estimation Methodology Implementation

In this chapter will be described the process of developed methodology implementation applying to the 5G-TOURS UC5 "Remote and distributed video production". The main objective of the use case is to exploit the 5G-TOURS network features for remote television production and analyze how 5G networks could support various scenarios in which high-quality video (e.g., in 4K, HD/HDR or Video 360°) is generated and transmitted. In a typical TV production environment, video contents is delivered from cameras located in places where an event is taking place to a TV studio in the broadcasting center or to a remote studio facility on the event location itself. Such video contents could be used both for immediate live broadcasting of the event or recorded to be further edited and used in TV programs later on [35].

There was proposed to use the next implementation algorithm on practice:

Step 1 – Definition of the most relevant for the UC KPIs. For the mentioned above UC these KPIs are (Table 1):

Table 1. Most relevant for the UC5 KPIs

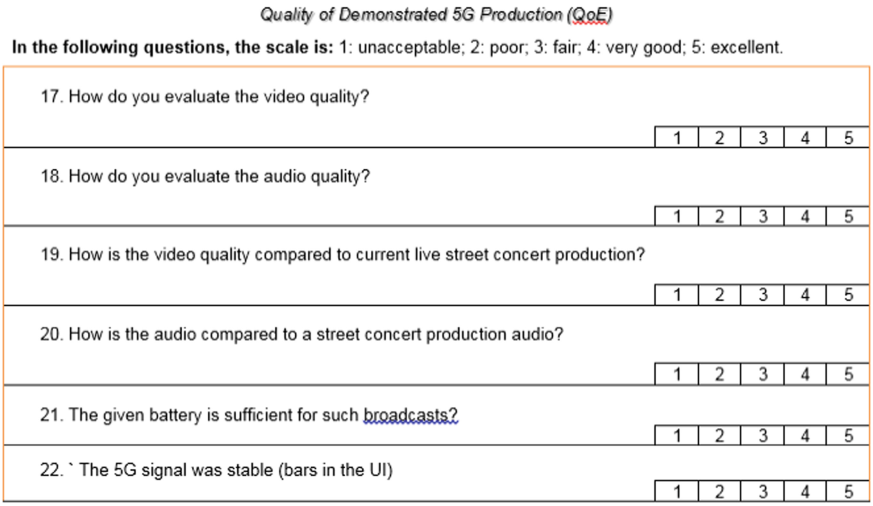
KPI_1	KPI_2	KPI_3
Latency	Throughput DL	Throughput UL

Step 2– Definition of the most relevant for the UC QoE parameters, which are the next for the UC (Table 2):

Table 2. The most relevant for the UC QoE parameters

	QoE_1	QoE_2	QoE_3	QoE_4	QoE_5
	Video quality	Audio quality	Stability of 5G signal	Breaks in the video/audio	Impact of the artifacts
Weight coefficient (K)	0,2	0,2	0,2	0,2	0,2

Step 3– Definition of the weight coefficients for each QoE parameter (see table above).
Step 4– KPI measurements according to pre-defined methodology [32].
Step 5– Collection of the QoE questionnaires. The example of QoE related part of the developed questionnaire is represented on the Fig. 5.
Step 6– Processing of the obtained experimental data (QoE and QoS). This data has to be represented in the table form (Table 3).


Quality of Demonstrated 5G Production (QoE)

In the following questions, the scale is: 1: unacceptable; 2: poor; 3: fair; 4: very good; 5: excellent.

Question					
17. How do you evaluate the video quality?	1	2	3	4	5
18. How do you evaluate the audio quality?	1	2	3	4	5
19. How is the video quality compared to current live street concert production?	1	2	3	4	5
20. How is the audio compared to a street concert production audio?	1	2	3	4	5
21. The given battery is sufficient for such broadcasts?	1	2	3	4	5
22. ` The 5G signal was stable (bars in the UI)	1	2	3	4	5

Fig. 5. QoE questionnaires

For this described above UC was proposed the next QoE-QoS mapping function:

$$QoE = A0 + A(Thr) \cdot Throughput + A(Delay) \cdot Delay, \quad (8)$$

where weight coefficients can be calculated using the normal equation (Table 4):
To estimate the MOS was proposed the next formula:

$$MOS = K1 \cdot Parameter\_1 + \ldots Kn \cdot Parameter\_n, \quad (9)$$

where $K1 + \ldots + Kn = 1$ and $K1, \ldots Kn > 0$.
During the data obtaining should be estimated the next parameters (Table 5).

Table 3. Collected during trials QoE and QoS values

QoE	QoS parameters	
MOS	Troughput, Mbps	Delay, ms
80	10	1
90	12	1
88	11	2
…	…	…

Table 4. Calculated values of weight coefficients

Coefficients		
A(Delay)	A(Thr)	A0
−4,55314	3,107015	57,3893

Table 5. Calculated parameters related to the correlation analysis

Correlation coefficient_Throughput	−0,961191417
Correlation coefficient_Throughput	0,961047169
Estimated t-criterion t	4,442136041
The table value of the t-criterion trh	2,776445105
Tabular value standard. normal Distr. zy	1,959963985
Fisher transform value z'	−1,538344072
Left interval estimate for z	−2,669929806
Right interval estimate for z	−0,406758338
Left interval estimate for rxy	−0,990452706
Right interval estimate for rxy	−0,38571676
Standard deviation for rxy	0,205270997

5 Conclusions

5G network is the first and so far the only technology that allows to flexibly combine platform services on a single technological basis, eliminates the need for the corporate consumer to build their own network infrastructure. These qualities make 5G the basis of scalable services, which significantly reduces the time of their development and implementation in various sectors of the economy. 5G technology provides more advantages than its predecessors, especially in terms of speed and power. The possibility of 5G technology in each scenario opens up different possibilities and approaches for calculating the value of quality that this technology will give.

Compared to previous generations of mobile networks, the architecture of the 5G system has been significantly improved, thanks to the introduction of network analytics functions and enhanced capabilities for interaction with third-party application functions. Combining these capabilities, new experience quality assessment (QoE) features can be developed and implemented in the next generation network. However, it is unclear how 5G networks can collect monitoring data and application metrics, how they relate to each other, and what methods can be used in 5G systems to assess quality. That is why the problems of functioning of quality assurance systems in the fifth generation networks were considered in the chapter. As well as the importance of service quality in wireless and mobile networks and analyzed the main features of the use of 5G technologies. Were provided standard definitions and the most important developed measurement methods. Were demonstrated significant improvements and approaches for service quality control to meet user expectations.

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