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USA
Soldiers Field Boston, MA 02163 +1.800.427.5577

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Comparative assessment of the quality of mobile communications

M.M. Makhmudov Ph.D.,
SUE UNICON.UZ

Abstract: This article highlights the possibilities of improving the system for assessing the quality of telecommunications services, the use of a wide range of control and measurement systems, testing and quality control of mobile communication networks, and provides examples of network evaluation calculations.

Keywords: ICT, Mobile, Radio, Qos, Drive-test, ETSI, DL-UL, GSM, LTE, 2G, 3G, 4G, 5G.

The introduction of effective management mechanisms and automation of processes for detecting and obtaining data on violations of the requirements of legislation and other regulatory documents, state standards and the quality of telecommunications services provided is one of the topical issues of the ICT industry in Uzbekistan.

Reliable mobile communication is becoming an important condition not only for comfort and safety, but also for solving work tasks remotely, regardless of the location of the subscriber. Over the past two years, there has been a widespread proliferation of remote format of work and study around the world, which greatly increases its relevance.

Currently, the quality of mobile communication is quite a hot topic, as one of the key areas of development of the telecommunications market is to improve the quality of communication services. Activities of mobile operators are carried out in a competitive market environment, and competitive advantages of operators are achieved not only through the introduction of the most advanced technical means of transmission and switching, but also by improving customer service. It is very important to study the needs of users and service quality indicators describing these requirements.

According to the decision of the Government of 07.03.2018. "On measures to further improve the quality of communication, informatization and telecommunication services". [1] it is necessary to control the quality of services in the following areas of telecommunications: 1. Transmission lines, channels, tracts of trunk and intrazone communication network; 2. Local telephone communication; 3. Cable, terrestrial-cable television broadcasting; 4. Television; 5. Satellite communication; 6. Radio broadcasting; 7. Radio communication and mobile communication networks; 8. Data transmission networks; 9. Unauthorized transmission of international voice traffic bypassing international switching centers; 10. Technical operation of telecommunications networks.

It should be noted that not all indicators can be monitored through an automated control system, for example, for the first direction control is based on the data obtained both in the automated mode and in statistical reports. And in the sector "Radio communications and mobile networks" such an indicator is the network

capacity, from the user's point of view, taking into account geographical distances: - *the share of calls that do not meet the standards for the connection establishment time by region; - coefficient of the connection establishment time in packet-switched data transmission, by region; - coefficient of data transfer service interruption, by region; - the share of calls that do not meet the standards for voice quality, by region.*

To measure the listed parameters, mechanisms with a direct field trip are required, i.e. using "Drive Tests" systems. [2]. For this purpose, compact systems are currently available as a solution for foot and field measurement work.

According to ETSI TR 103 559 V1.1.1 (2019-08) "Speech and multimedia Transmission Quality (STQ); Best practices for robust network QoS benchmark testing and scoring" an example representing best practices is provided [3]. The information is intended to illustrate how to apply in practice the benchmarking and network assessment given in the main body of ETSI TR 103 559. In this regard, examples of coefficients, limits and thresholds that can be applied to areas and mobile services are given, as well as examples of network assessment calculations.

Table -1 Mobile services test indicators

1. Telephony				
Indicators	**Lower limit**		**Upper limit**	**Percentage**
	Cities	Outside the cities		
Composite Call Success Criterion combining: − Call Setup Success Ratio − Call Setup Time < 15 s − Inverse of Call Drop Ratio − Ratio of calls with no 2 consecutive speech samples < 1,3 MOS	87%	80%	100%	70%
Average of MOS across all Samples	2,5 MOS		4,4 MOS	15%
Average of Call Setup Time [s]	2,5 s		8 s	3%
90th percentile of Call Setup Time [s]	3 s		10 s	12%
2. Data Services				
Indicators	**Lower limit**		**Upper limit**	**Percentage**
	Cities	Outside the cities		
Streaming video	87%	80%	100%	22%
Static Page (Kepler)	87%	85,5%	100%	22%
Dynamic pages	87%	85,5%	100%	22%
3. YouTube video				
Indicators	**Lower limit**		**Upper limit**	**Percentage**
	Cities	Outside the	Cities	Cities	Outside the

		cities			cities Outside the cities
Successful composite session Criteria of unification: Successful access to the video and its streaming, no fading beyond the permissible level	87,0%	80,0%	100%		55%
Average video resolution [p]	480		1080		25,0%
Ratio of videos with no freezing [%]	95,0%	90,0%	100,0%		15,0%
Video access time [s]	1,5 s		4,5 s	5,0 s	5%
4. File Download (based on 3 MB File Size)					
Indicators	**Lower limit**		**Upper limit**		**Percentage**
	Cities	Outside the cities	Cities	Outside the cities	Outside the cities
Composite Session Success Criterion combining: • Success to access and download the file • Achievement of min. throughput of 384 kbit/s	87%	80%	100%		60%
Average Download Session Duration [s]	1 c	1,5 c	10 c		12%
10th percentile of Download throughput [kbit/s]	384 kbps		27500 kbps	11000 kbps	20%
90th percentile of Download throughput [kbit/s]	27500 kbps	16500 kbps	88000 kbps	66000 kbps	8%

The example above assumes that different types of mapping functions are used for different QoS (Quality of service) factors/parameters. Direct access functions are used for all QoS parameters with the following exceptions where square root conversion functions are used: Speech Quality, Data Throughput, Cp Video Resolution and Average DL (Downlink-Downlink) and UL (Uplink-Uplink) file session duration.

Test scores are evaluated as aggregate values. The metrics also have a bad saturation area limit, above which the customer experience does not degrade significantly, and a good saturation area limit, above which the customer experience does not improve. The average values fall between the good and bad limits. If the score increases with the value, it is a score with an increasing value. Starting with a minimum below the acceptable limit, the value score is 0%. Between the bad and

good limits the score increases to 100%. In the saturation area between the good limit and the maximum, the value score stays at 100%.

The value estimate increases as the value decreases, then it is a value estimate with decrease. In the saturation region between the good limit and the minimum value, the value estimate is stable at 100%. Between the good and bad limits, the score decreases to 0% and stays there above the bad limit.

$$\boldsymbol{S = \frac{V - L}{G - L} * 100}$$

Where:

S- Score, V- Value, L- Lower limit, G- Upper limit

Based on the above-mentioned indicators to determine the quality of communication services of mobile operators in Uzbekistan, there were conducted measurements and tests, as well as a comparative assessment of the basic technical characteristics and quality of mobile services in the networks of 4 operators (conditionally called A, B, C and D) in Tashkent and outside of Tashkent city.

These measurements and tests were based on the ETSI ETSI standard TR 103 559 V1.1.1 (2019-08) [3]. Table 5 shows the results of the calculation of the main indicators of voice service quality for Triple mode tests (free choice of GSM, WCDMA or LTE technology).

The tests concern telephony, data services, file downloading. This goal is achieved by conducting comparative analysis in designated test areas that represent or actually cover the majority of users of mobile services. The results collected in the different areas are individually and collectively weighted and summed up into an overall percentage. The volume of mobile traffic is growing rapidly and has doubled globally in recent years, especially in indoor areas such as shopping malls, stadiums, event halls, airports and trains.

For network operators, such indoor or isolated venues are a challenge, as they require a denser network of terminals and more base stations. The Freerider 4 system is the perfect solution to easily and conveniently test these difficult locations, such as supporting all coverage measurement applications, field optimization, benchmarking and cellular network analysis. It supports the latest 5G networks as well as legacy technologies such as GSM, UMTS and LTE. Devices such as scanners and test mobiles can be added or upgraded in the field.

These measurements and tests were based on the ETSI ETSI standard TR 103 559 V1.1.1 (2019-08) [2]. Table 5 shows the results of the calculation of the main indicators of voice service quality for Triple mode tests (free choice of GSM, WCDMA or LTE technology).

Table -2 Test indicators of mobile services in Tashkent

Services	General parameters			Example of a walking test result in Tashkent	Big and Medium
	Unit	Lower	Upper	Operators	RAW=MIN(MAX((V-L)/(G-L)*100;

		limit (L)	limit (G)	Operator A (V)	Operator B (V)	Operator C (V)	Operator D (V)	Operator A (V)	Operator B (V)	Operator C (V)	Operator D (V)
1) Telephoney											
Composite Success Criterion	*%*	*87*	*100*	97	94	95	98	87%	82%	90%	92%
AVG Call Setup Time	s	8	2.5	3	5	4	2	91%	89%	90%	95%
AVG Speech Quality	MOS	2.5	4.4	3.89	3.66	3,93	3,97	90%	88%	91%	92%
2) Data Services											
Streaming Video		*87*	*100*	93	95	92	98	86%	88%	86%	91%
Kapler Static Page											
Composite Success Criterion	*%*	*87*	*100*	91	93	89	96	85%	90%	80%	94%
Live Web Page											
Composite Success Criterion	*%*	*87*	*100*	90	93	91	98	85%	90%	85%	95%
3) YouTube video											
Composite Success Criterion	*%*	*87*	*100*	91	93	96	97	86%	88%	90%	93%
Video Starting Time	s	4.5	1	2	2.5	2,3	2	95%	92%	93%	95%
Play Outs Without Interruptions	*%*	*95*	*100*	90	90	93	95	86%	86%	89%	93%

AVG Resulution	p	480	1080	1080	1080	1080	1080	100%	100%	100%	100%
4) File Upload											
3 Mb Fixed Size											
Composite Success Criterion	%	*87*	*100*	97	94	95	98	92%	88%	90%	93%
Averadge Sessiont Time	kbit/s	10	1	7	5.5	6.5	9	80%	85%	80%	80%
P10 Data Rate	kbit/s	384	27500	26500	26000	27000	27500	90%	91%	94%	100%
P10 Data Rate	kbit/s	27500	88000	85000	86000	87000	88000	90%	93%	95%	100%

Table -3 Test indicators of mobile services outside cities

Services	General parameters			An example of an out-of-town walking test result				Big and Medium			
	Unit	Lower limit (L)	Upper limit (G)	Operators				RAW=MIN(MAX((V-L)/(G-L)*100;			
				Operator A (V)	Operator B (V)	Operator C (V)	Operator D (V)	Operator A (V)	Operator B (V)	Operator C (V)	Operator D (V)
1) Telephoney											
Composite Success Criterion	*%*	*85.8*	*100*	91	85	85	80	75%	80%	80%	75%
AVG Call Setup Time	s	8	2.5	6	6.2	6.8	7.1	50%	60%	65%	50%
AVG Speech Quality	MOS	2.5	4.4	3.4	3.2	3,1	2,9	75%	75%	75%	70%
2) Data Services											
Streaming		*85.8*	*100*	93	90	89	94	75%	75%	73%	80%

Video											
Kapler Static Page											
Composite Success Criterion	*%*	*85.8*	*100*	91	89	90	93	71%	69%	70%	72%
Live Web Page											
Composite Success Criterion	*%*	*85.8*	*100*	89	92	95	97	70%	74%	76%	78%
3) YouTube video											
Composite Success Criterion	*%*	*85.8*	*100*	91	93	96	97	72%	72%	75%	78%
Video Starting Time	s	5	1.5	3	1.5	3	1.5	69%	100%	69%	100%
Play Outs Without Interruptions	*%*	*90*	*100*	91	95	92	96	70%	75%	70%	75%
AVG Resulution	p	480	1080	720	1080	720	1080	50%	75%	50%	75%
4) File Upload											
3 Mb Fixed Size											
Composite Success Criterion	%	*85.8*	*100*	80	86	80	85	75%	80%	75%	80%
Averadge Sessiont Time	kbit/s	10	1.5	7	6.5	7	6	70%	65%	70%	65%
P10 Data Rate	kbit/s	384	11000	850	950	850	900	75%	85%	75%	85%
P10 Data Rate	kbit/s	16500	66000	35000	45000	35000	40000	75%	85%	75%	85%

Vol.2. Issue 2 Pages 86-94.
10.5281/zenodo.7261344

The Freerider 4 (R&S®FR4) test devices manufactured by Rohde & Schwarz GmbH [4] were used for measurements and tests. The system includes a promising modular design for control system optimization, comparative testing and analysis of cellular networks, support for up to 12 test cell phones, and support for 5G including millimeter band (5G and LTE 4x4 MIMO). Monitoring of the quality characteristics of mobile communication services was carried out with the help of Samsung Galaxy S10 smartphones. The test devices provide correct results, taking into account all the modern technologies and features implemented in the network of each operator during the period of work. The system fully supports GSM, WCDMA, CDMA2000®, 1xEV-DO, WiMAX™, LTE, NB-IoT, LTE-M signals, RF power scanning, unmodulated signals and 5G channel power scanning. Walking-test performed about 1000 repeated mobile-to-mobile voice connections of 120 seconds duration, as well as about 2500 sessions of data download and video clip playback from YouTube resource simultaneously in each operator's network. During the study, the test phones were in a mode of free choice of 2G, 3G or 4G technology.

The main way of remote communication in mobile networks is talking on the phone in real time. Therefore, it is important for the subscriber to quickly and successfully dial up and make a phone call without cutting off and distortion of the voice of the interlocutor. Table 2 and 3 show the main final evaluations of the quality of communication services.

1. 1) Telephoney

In Tashkent, “Operator D” demonstrates the best results in terms of the quality of voice communication services and is noticeably ahead of its competitors. “Operator D” is slightly behind “Operator D”, but ahead of “Operator A”.

Outside of the city, all operators have a significant deterioration in the quality of voice communication services. It is possible to exchange voice information, but with limitations, in particular, with distorted sounds and reduced intelligibility of speech, which may lead to the need to repeat individual words.

2. Mobile Internet access services

Operator D is in the lead in Tashkent and is noticeably ahead of the competition. “Operator B” is slightly behind the leader, but noticeably ahead of “Operator A” and “Operator C”. Out-of-town mobile access services showed delays and distortions while accessing the Internet resource.

3. YouTube video.

In the city, “Operator D” shows the maximum score for the quality of video playback from YouTube resource, but outside the city the quality of services deteriorates noticeably. The lowest final score in “Operator D” network is caused by the noticeable lag from the competitors in terms of the quality of video playback from the YouTube resource.

4. Data loading

The best value of the index, describing the speed of downloading data from the Internet, is marked in the network of “Operator D”. In particular, the value of 10% registered in the network of “Operator D” significantly exceeds similar values noted in competitors' networks: 100% values of speeds greater than 24 Mbps. “Operator A”

Vol.2. Issue 2 Pages 86-94.
10.5281/zenodo.7261344
and “Operator B” show close results and lag behind "Operator C". Outside the city the data load deteriorates sharply, “Operator A” and “Operator B” show close results and lag behind “Operator D”.

Conclusion

1. It should be noted that improving the quality of cellular services is a pattern of industry development, a condition for the competitiveness of the services provided and the viability of enterprises in market conditions. In order to ensure the regularity, it is necessary to carry out purposeful activity on quality management.

2. It is necessary to improve the list of quality indicators and the establishment of quality standards for them. Conducting measurements on radio and mobile networks is a key part of quality management activities in different environments, taking into account a variety of factors.

3. Adopt the above quality standards for mobile networks according to ETSI TR103559V1.1.1 (2019-08) [4] and best practices for benchmarking mobile networks.

4. summarizing the above, as a conclusion, we can note the fact that the purpose of measuring the quality of service does not change, although user habits and user service quality requirements may change over time.

List of references

1. Decree of the Cabinet of Ministers of 07.03.2018. No. 185 “On measures to further improve the quality of communication, informatization and telecommunication services”.

2. R&S®ROMES4 Drive test software Measuring coverage and QoS in mobile networks. Source: https://www.rohde-schwarz.com/products/test-and-measurement/network-data-collection/rs-romes4-drive-test-software_63493-8650.html

. ETSI TR 103 559 V1.1.1 (2019-08) “Speech and multimedia Transmission Quality (STQ); Best practices for robust network QoS benchmark testing and scoring”.

4. Test and measurement system. Source: https://www.rohde-schwarz.com/search/download-center_63448.html?term=Freerider4