

Mobile Communications Systems

GSM/UMTS/LTE

Appraisal of Quality of Service

Evaluation of the performance of mobile services and
GSM, UMTS and LTE coverage in the region
North (NUTS II)

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ANACOM

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ABBREVIATIONS AND ACRONYMS

AMU	Moderately Urban Area.
APN	Access Point Name.
APR	Predominantly Rural Area.
APU	Predominantly Urban Area.
CEPT	European Conference of Postal and Telecommunications Administrations
CoDec	Encoder/Decoder.
CPICH	Common Pilot Channel, Received Signal Code Power – Radio signal level received by a mobile terminal (UMTS).
RSCP	
CS	Circuit Switched.
CSFB	Circuit Switched Fallback.
ECC	Electronic Communications Committee.
EPS	Evolved Packet System – Optimised system of commutation of packets of 4G networks, arising from the evolution of 3G/UMTS systems, characterised by high data debits, low latency and enabling multiple technologies in the access radio network.
ETSI	European Telecommunications Standards Institute.
FCT	Fundação para a Ciência e a Tecnologia, I.P.
FTP	File Transfer Protocol.
GigaPIX	Portuguese point of exchange of traffic between IP networks.
GSM	Global System for Mobile communications – Second generation mobile communications system (2G).
HTTP	Hyper Text Transfer Protocol
INE	Instituto Nacional de Estatística – National Statistics Institute.
ITU	International Telecommunications Union.
LTE	Long Term Evolution – Fourth generation mobile communications system (4G).
MIMO	Multiple Input Multiple Output – Technology based on the use of multiple broadcasters and multiple receptors (antennas) to improve the performance of radio communications.
MOS	Mean Opinion Score – Quality index that quantifies the effort required to perceive a communication of the extreme-to-extreme type. Its thresholds are 0 (zero) when there is no communication, and 5 (five) when the communication is perfect.
NUTS	Nomenclature of Territorial Units for Statistical Purposes.
PDP	Packet Data Protocol.
POLQA	Perceptual Objective Listening Quality Assessment – Algorithm used in the analysis of the audio quality of a voice communication (ITU-T Recommendation P.863 (01/2011)).
PS	Packet Switched – Commutation of packets.
RF	Radio Frequency.
RSRP	Reference Signal Received Power – Radio signal level received by a mobile terminal (LTE).
RxLev	Received signal level – Radio signal level received by a mobile terminal (GSM).
RF Scanner	Measurement equipment that enables collecting radio signal levels for each channel of a frequency band.
SIM	Subscriber Identity Module – SIM Card.
SMS	Short Message Service.
SMSC	Short Message Service Centre.
TCP/IP	Transmission Control Protocol / Internet Protocol.
TIPAU	Categories of Urban Areas, for statistical purposes.
UMTS	Universal Mobile Telecommunications System – Third generation mobile communications system (3G).

USIM UMTS Subscriber Identity Module – USIM Card.

WCDMA Wideband Code Division Multiple Access – Technology used in the radio component of UMTS communications systems.

I. EXECUTIVE SUMMARY

Most individual and business consumers use electronic communications services, namely telephony, messages and data, supported by GSM/UMTS/LTE mobile communications systems, to meet their daily communication needs, including emergency and security communications. In these mobile communications systems, service quality, from the user perspective, is of enormous importance, in particular due to the radio nature of the access, the mobility they offer and their manifestly high penetration/use.

ANACOM, pursuant to duties, and making use of the powers established in its articles of association, carries out studies to assess, from a user perspective, the quality of electronic communication services supported by mobile communications systems present in the market, in order to provide the consumers with impartial information on the performance of these services.

The studies present an assessment of the performance of mobile, voice and data services, and of radio coverage of GSM, UMTS and LTE interfaces, provided by MEO, NOS and Vodafone. The aim is to investigate the user's experience in terms of accessibility, retention and integrity of the services. To this end, calls are established and conversations are simulated to appraise the voice service, files are transferred, web pages are downloaded and YouTube videos are downloaded to appraise the data services, and the presence and levels of radio networks are checked to appraise coverage.

This test campaigns are carried out according to the methodology approved by ANACOM after broad consultation of the market. Measurements are performed systematically, with standardised procedures and without human intervention or decision, and under equal conditions for the various operators, allowing objective and comparative analysis of performances.

In the sampling approach followed in the study related to Mainland Portugal, started in 2019, the set of mobile communications carried out on the mainland territory is considered the total universe with the mobile voice call and the mobile data session being the statistical units considered. The sample is based on two stratification levels. The first separates the mainland territory into NUTS II, followed by a breakdown by NUTS III.

The first study addressed NUTS II of the Alentejo. The second study addressed NUTS II of the North. The fieldwork took place between 3 and 13 February 2020, which involved 952 voice calls, 6475 data sessions and 578,712 radio signal measurements, corresponding to approximately 317 voice calls, 360 data sessions and 64,300 radio signal measurements per indicator and operator. 3,255 kilometres were covered, of which 303 in tests.

The main results in the North (NUTS II) are detailed by indicator, with breakdown by operator or type of urban areas of INE (predominantly urban area, moderately urban area and predominantly rural area), in *Section **Error! Reference source not found.***, pointing to the following aspects:

- The mobile communications systems of the operators that were analysed show, on average, good GSM radio coverage and reasonable UMTS and LTE radio coverage, although with differentiated performances among the types of urban areas, with worse performance in the predominantly rural areas, and among other the operators, in particular the better performance of Vodafone in UMTS. The radio coverage presents some variability, with "very good" or "good" quality signals having been observed, but others were also recorded below the adequate parameters, notably in UMTS and LTE, with some significant levels of "non-existent" radio coverage in predominantly rural areas.
- The voice service presents a good overall performance in all operators. However, in the predominantly rural areas, a heavy deterioration was observed of the performance of this service, namely with respect to capacity to establish and retain calls.
- In data services, in file transfers, good overall performance was recorded, in download and upload, with some differences being observed between operators and, in a more accentuated manner, between types of urban areas. The capacity to establish and retain file transfer sessions, during download and upload, shows a strong deterioration in the predominantly rural areas. It was also observed that the speed of file transfer recorded in areas that are moderately urban and predominantly rural is significantly lower than that recorded in the predominantly urban areas, both during download and upload. This indicator shows very high variability, with maximum values above 249 Mbps and 64 Mbps, respectively for download and upload, and minimums below 0.05 Mbps, which make it difficult or impossible to transmit data under appropriate conditions.

- Internet browsing and YouTube video streaming services, as well as data transmission latency, perform considerably less well than file transfer, with some differences also being observed between operators and types of urban areas. In general, worse
 - performance is recorded in moderately urban and predominantly rural areas.
- and ***Error! Reference source not found.*** show the differences observed between the types of urban areas and between operators and, whenever possible, the respective position (from best to worst performance).

Annex 1

Quality indicators used to measure the performance of the services and radio coverage

1. **Radio Coverage** – availability of the GSM, UMTS and LTE radio infrastructures;
2. **Accessibility of the Voice Service** – probability of success in establishing calls;
3. **Ratio of Termination of Voice Calls** – probability of a call, after successfully established, continuing active during a period of time and terminating in a normal way, in other words, as intended by the user;
4. **Time of Establishment of Voice Calls** – period of time that the network takes to establish the communication, after the correct sending of the request (destination telephone number);
5. **Audio Quality** – perceptibility of the conversation during a voice call;
6. **Ratio of Termination of Data Sessions** – probability of a session of use of the service – file transfer, internet browsing or YouTube video streaming – being established and taking place successfully, i.e. remaining active during the entire predefined period for file transfer, enabling the transfer of the entire web page or the full reproduction of multimedia contents;
7. **Data Transfer Speed** – quantifies the average speed of data transfer during a file transfer session;
8. **Duration of Web Page Transfer** – quantifies the average time required to transfer a web page;
9. **Time before Start of Viewing Contents** – period of time between the request for a multimedia content and the start of viewing the first image of this content, on the user's terminal equipment, in a YouTube video streaming session;
10. **Duration of the Interruptions** – aggregates the duration of all the interruptions or stoppages in the reproduction (freezing) occurred during a YouTube video streaming session;
11. **Video Quality** – quantifies the visual quality of the communication, during a YouTube video streaming session;
12. **Video Resolution** – quantifies the average number of pixels of the image during the

13. video reproduction, of a YouTube video streaming session;

14. **Data Transmission Latency** – quantifies the time required for the bundle of information to travel from the user's equipment to the Content Server or vice-versa.

Annex 2

Summary of differences between categories of urban areas

			APU vs. APR	AMU vs. APU	APR vs. AMU	1st position best performance	2nd position	3rd position worst performance	
Voice Service	mobile ↔ mobile	Affordability of the Service	≠	=	≠	APU / AMU	APR	---	
		Call Termination Ratio	≠	≠	≠	APU	AMU	APR	
		Time of Establishment of Calls	=	=	=	APU / AMU / APR	---	---	
		Audio Quality	=	≠	≠	APU / APR	AMU	---	
Data Services	Transfer of Files	download	Data Session Termination Ratio	≠	=	≠	APU / AMU	APR	---
			Data Transfer Speed	≠	≠	=	APU	AMU / APR	---
		upload	Data Session Termination Ratio	≠	=	≠	APU / AMU	APR	---
			Data Transfer Speed	≠	≠	=	APU	AMU / APR	---
	Internet Browsing	reference	Data Session Termination Ratio	≠	≠	≠	APU	AMU	APR
			Web Page Transfer Duration	≠	≠	=	APU	AMU / APR	---
		public	Data Session Termination Ratio	≠	≠	≠	APU	AMU	APR
			Web Page Transfer Duration	≠	≠	=	APU	AMU / APR	---
	YouTube Video Streaming	Data Session Termination Ratio	≠	≠	≠	APU	AMU	APR	
		Time before Viewing	=	≠	=	---	---	---	
		Duration of Interruptions	=	≠	≠	APU / APR	AMU	---	
		Video Resolution	≠	≠	=	APU	AMU / APR	---	
		Video Quality	≠	≠	=	APU	AMU / APR	---	
	Latency	Data Session Termination Ratio	≠	≠	≠	APU	AMU	APR	
		Latency	=	=	=	APU / AMU / APR	---	---	
	Radio Coverage	GSM, UMTS & LTE	GSM Signal Level	≠	≠	≠	APU	AMU	APR
UMTS Signal Level			≠	≠	≠	APU	AMU	APR	
LTE Signal Level			≠	≠	≠	APU	AMU	APR	

APU – Predominantly Urban Area | AMU – Moderately Urban Area | APR – Predominantly Rural Area

Annex 3

Summary of differences between operators

			MEO vs. Vodafone	NOS vs. MEO	Vodafone vs. NOS	1st position best performance	2nd position	3rd position worst performance	
Voice Service	mobile ↔ mobile	Affordability of the Service	=	=	=	MEO / NOS / Vodafone	---	---	
		Call Termination Ratio	=	=	=	MEO / NOS / Vodafone	---	---	
		Time of Establishment of Calls	≠	≠	≠	Vodafone	NOS	MEO	
		Audio Quality	≠	≠	≠	Vodafone	NOS	MEO	
Data Services	Transfer of Files	download	Data Session Termination Ratio	=	≠	=	---	---	---
		Data Transfer Speed	≠	≠	≠	Vodafone	MEO	NOS	
	upload	Data Session Termination Ratio	=	≠	=	---	---	---	
		Data Transfer Speed	=	=	=	MEO / NOS / Vodafone	---	---	
	Internet Browsing	reference	Data Session Termination Ratio	=	=	=	MEO / NOS / Vodafone	---	---
			Web Page Transfer Duration	≠	≠	≠	NOS	Vodafone	MEO
		public	Data Session Termination Ratio	≠	≠	=	NOS / Vodafone	MEO	---
			Web Page Transfer Duration	=	=	=	MEO / NOS / Vodafone	---	---
	YouTube Video Streaming	Data Session Termination Ratio	=	=	=	MEO / NOS / Vodafone	---	---	
		Time before Viewing	=	=	=	MEO / NOS / Vodafone	---	---	
		Duration of Interruptions	=	=	=	MEO / NOS / Vodafone	---	---	
		Video Resolution	≠	=	≠	Vodafone	MEO / NOS	---	
		Video Quality	≠	≠	=	NOS / Vodafone	MEO	---	
	Latency	Data Session Termination Ratio	≠	≠	=	NOS / Vodafone	MEO	---	
Latency		≠	≠	=	NOS / Vodafone	MEO	---		
Radio Coverage	GSM, UMTS & LTE	GSM Signal Level	≠	=	≠	Vodafone	MEO / NOS	---	
		UMTS Signal Level	≠	=	≠	Vodafone	MEO / NOS	---	
		LTE Signal Level	≠	≠	≠	Vodafone	NOS	MEO	