# GSM/UMTS/LTE Mobile Communications Systems

## Appraisal of Quality of Service

Performance evaluation of mobile services and GSM, UMTS and LTE coverage, in the Algarve region (NUTS II)

ANACOM
AUTORIDADE NACIONAL DE COMUNICAÇÕES

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# Executive Summary

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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 RSCP** | Common Pilot Channel, Received Signal Code Power – Radio signal level received by a mobile terminal (UMTS). |
| **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** | 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* Mean Opinion Score – Quality index that quantifies the effort required to perceive a communication of the end-to-end 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. |
| **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). |
| **Scanner RF** | 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 powers established in its articles of association, carries out studies in Portugal 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, under the same conditions for the various operators, allowing objective and comparative performance analysis.

In the sampling approach followed, the set of mobile communications carried out in the mainland territory is considered as the 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.

This fourth study[1] covers the NUTS II Algarve region, with the fieldwork having taken place between 20 and 29 October 2020. This involved making 983 voice calls, 6,497 data sessions

[1] The previous studies covered the NUTS II regions of the Alentejo, North and Lisbon Metropolitan Area, and are available at https://www.anacom.pt/render.jsp?categoryId=293495

and 590,098 radio signal measurements, corresponding to approximately 328 voice calls, 361 data sessions and 65,566 radio signal measurements, by indicator and operator. The tests covered 273 kilometres.

The main results observed in the Algarve (NUTS II) are detailed by indicator, broken down by operator or type of urban areas of the INE (predominantly urban area, moderately urban area and predominantly rural area), in *Section 5*, pointing to the following aspects:

- The mobile communications systems of the operators analysed show, on average, good GSM radio coverage and reasonable UMTS and LTE radio coverage, albeit with differentiated performances among the types of urban areas, with worse performance in the predominantly rural and moderately urban areas, and among the operators, in particular the worse performance of NOS and Vodafone, in GSM and LTE and of NOS in UMTS. The radio coverage has 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 "Poor" or "Non-existent" radio coverage in predominantly rural and moderately urban areas.

- The voice service presents a good overall performance in all operators. However, in the predominantly rural and moderately urban areas, a deterioration was observed in the performance of this service, namely with respect to the capacity to establish calls.

- For data services, good overall performance was recorded in file transfers, with some differences being observed between operators and types of urban areas. The operator MEO shows the highest average file transfer speeds, in download and upload. The lowest average file transfer speeds, both in download and upload, are observed in the moderately urban and predominantly rural areas. A very high variability of this indicator is observed, with maximum speeds of 208.58 Mbps and 62.75 Mbps, for download and upload respectively, and minimums of 0.008 Mbps and 0.015 Mbps, respectively for download and upload, 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.

*Table 1* and *Table 2* summarise the differences observed between the types of urban areas and operators, and whenever possible, the respective position (from best to worst performance).

Table 1 – Summary of differences between categories of urban areas

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

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

Table 2 – Summary of differences between operators

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

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