

I EXECUTIVE SUMMARY

I.I GENERAL FRAMEWORK

In June and July 2007, Autoridade Nacional de Comunicações (ANACOM) carried out an assessment of the quality of mobile services – voice (GSM), video-telephony (UMTS) and network coverage (GSM and WCDMA) – provided by operators OPTIMUS, TMN and VODAFONE in the main urban agglomerations – Ponta Delgada, Angra do Heroísmo and Funchal – and major roads of the islands of the Autonomous Regions of the Azores and Madeira, by analysing technical parameters that translate the quality perception from the consumer's standpoint.

The methodology that was used in this study relies on field tests performed from the user's standpoint, by using an automatic measurement system that reflects the several features affecting the quality of the services (end-to-end measurements). On the other hand, measurements were carried out on equal terms regarding the three operators, namely at the same time, at the same locations and with the same parameters, thus making it possible to perform comparative analysis of the observed performances.

The main quality indicators were analysed, considering the user's perspective and the services under study:

1. **Network Coverage** – Availability of the GSM and WCDMA (UMTS) radio networks;
2. **Service Accessibility** (voice or video-telephony) – probability of success when setting up calls;
3. **Call set up time** (voice or video-telephony) – period of time that the network takes to establish the communication, after the correct sending of the request (targeted telephone number);
4. **Call Termination Rate** (voice or video-telephony) – Probability that a call has, after being successfully set up, to be maintained during a period of time, ending normally, i.e., according to the user's will;
5. **Call Audio Quality** (voice or video-telephony) – perceptibility of the conversation during a call;
6. **Call Video Quality** (video-telephony) – perceptibility of the communication's video feature.

Data collection took place on working days and during normal working hours, between 11 June and 30 July 2007. 9,076 test calls and 1,259,005 radio signal level measurements were made, standing for more than 83 hours of measurements along 3,269 kilometres.

The used sample provided global results, by operator, with a maximum error below 4.1% in the Azores

archipelago, and below 5.1% in Madeira, for a 95% confidence level.

In view of these services' penetration rate, of the diversity of the terminal equipment that is used, and given each user's subjective view itself, it is impossible to rigorously reproduce each consumer's conditions of interaction with the networks. In this context, the results of this study must thus be understood as an indicator of the networks' global behaviour. The transposition/extrapolation of these results to specific situations requires some prudence, at the risk that biased conclusions might be taken.

The technical and methodological options of this study directly influenced its results and must be taken into account when analyzing the results, namely the following ones:

- Tests were exclusively based on a technical solution (equipment + software) and performed in a totally automatic way, thereby setting homogenous conditions for the monitoring of the three operators and eliminating the subjectivity inherent to the human user;
- It used NOKIA 6680 terminal equipment;
- Tests were carried out in moving vehicles and with outdoor antennas (without gain);
- Call duration, both for voice and video-telephony, was 120 seconds;
- Voice tests were made with manual selection of the 2G (GSM) infrastructure, while video-telephony tests were made with automatic selection of the 2G or 3G (GSM/UMTS) infrastructure;
- Coverage indicators, particularly WCDMA coverage, do not take into account networks' loads (number of simultaneous users and type of services used);
- The new measurement systems call on the most recent testing techniques and implement new reckoning algorithms; therefore, the results produced are not directly comparable with those of the studies carried out on these regions in previous years;
- The results of the study only reflect the behaviour of the networks on the locations and moments of the measurements;
- On the other hand, operators are permanently improving their networks. The technical interventions necessary for these improvements can cause momentary degradations of the service in the geographic area of intervention.

I.II MAIN RESULTS AND CONCLUSIONS

The performance of the mobile communications systems analysed in this study present important differences among the analysed operators, technologies and types of locations.

One of the features that contributed to the observed differences is the fact that operator OPTIMUS does not have a WCDMA coverage in the Azores archipelago, and that its GSM coverage is only available in 5 of the 9 islands. Operators TMN and VODAFONE also do not have WCDMA coverage in the islands of Flores and Corvo.

In general, GSM coverage is wider than WCDMA coverage. However, for both technologies, there are large areas with poor or even non-existent radio coverage, especially in major roads.

The voice service presents good performances in urban areas. In major roads there is a degradation of this service, particularly regarding the *Service Accessibility* and the *Call Termination Rate* indicators. In the Azores' major roads, OPTIMUS' *Service Accessibility* is below 50%.

The performance of the video-telephony service stands below the one recorded for the voice service, namely the *Service Accessibility* indicator, due to the existence of large areas without WCDMA radio coverage. The lowest levels are recorded in major roads; in the Azores, they are even below 50%, for operators TMN and Vodafone, and null for operator OPTIMUS.

GSM and WCDMA Networks Coverage

Mobile networks' coverage present important differences among the analysed operators, technologies and type of locations.

In urban agglomerations (Figure 1 and Figure 2), the mobile networks of TMN and VODAFONE present good coverage levels. Results obtained for WCDMA are still good, although below the GSM ones.

On its hand, operator OPTIMUS presents different results in the urban agglomerations of both analysed autonomous regions. In the Autonomous Region of Madeira (Figure 2), it presents levels that are close to those observed for operators TMN and VODAFONE, both for GSM and WCDMA. In the Autonomous Region of the Azores (Figure 1), for GSM, results stand below those recorded by the two other

operators, although still good. For WCDMA, there is no coverage both in Ponta Delgada and in Angra do Heroísmo.

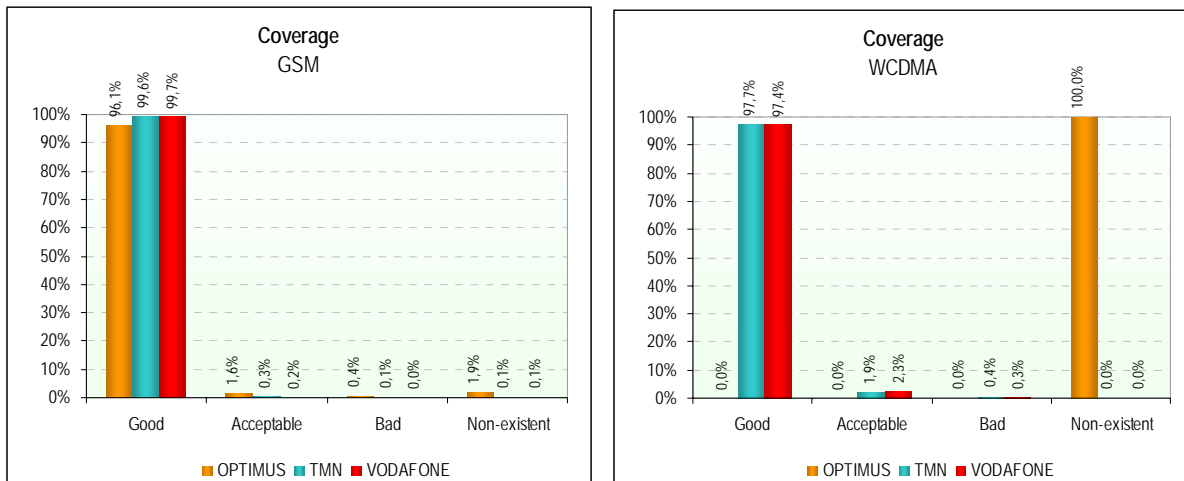


Figure 1 – Coverage indicator, on the Urban Agglomerations of the A. R. of the Azores.

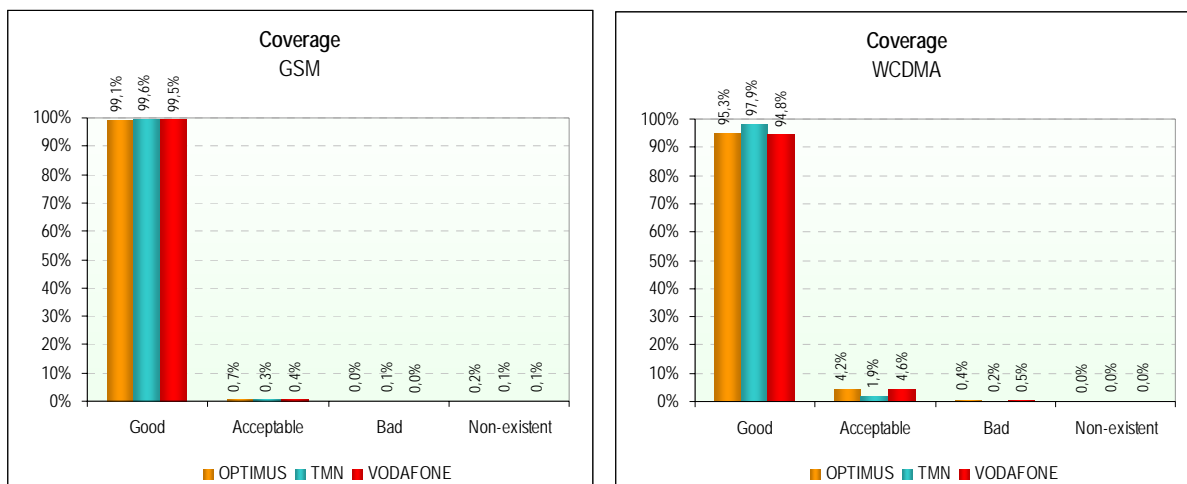


Figure 2 – Coverage indicator, on the Urban Agglomerations of the A. R. of Madeira.

Major roads (Figure 3 and Figure 4) present large areas with poor or no coverage at all, especially in the Azores and for the WCDMA technology.

For GSM, operator OPTIMUS presents the lowest performances, with good coverage levels around 41%, in the Azores archipelago, and 83.2% in the Madeira archipelago. For WCDMA, the worst coverage levels are recorded in the Azores archipelago. Operator OPTIMUS is not present on any of the islands and TMN and VODAFONE are not present on the Flores and Corvo islands. TMN's and

VODAFONE's good coverage levels stand at 60% and 41.7%, respectively. In the Madeira archipelago, the good coverage levels for operators OPTIMUS and TMN are close to 80%, while for VODAFONE they stand at 56%.

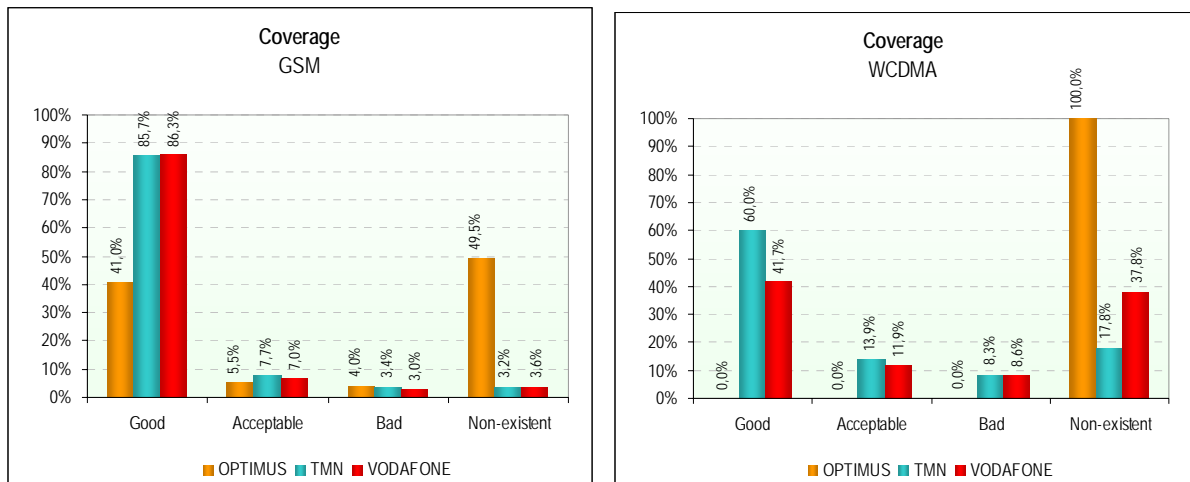


Figure 3 – Coverage indicator, on the Major Roads of the A. R. of the Azores.

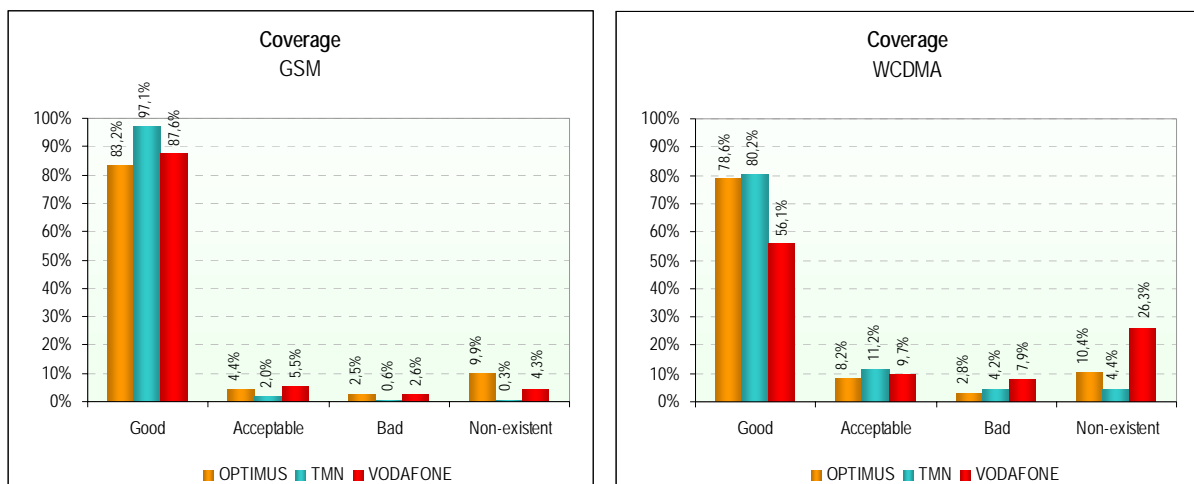


Figure 4 – Coverage indicator, on the Major Roads of the A. R. of Madeira.

Voice Service (GSM)

The voice service, regarding the *Service Accessibility* and *Call Termination Rate* indicators, presents different performances between the analysed urban agglomerations and major roads.

On urban agglomerations, both in the Azores and in the Madeira archipelago, these indicators present good levels (Figure 5 and Figure 6). The lowest value was recorded by TMN in Funchal, with a 95% *Call Termination Rate*.

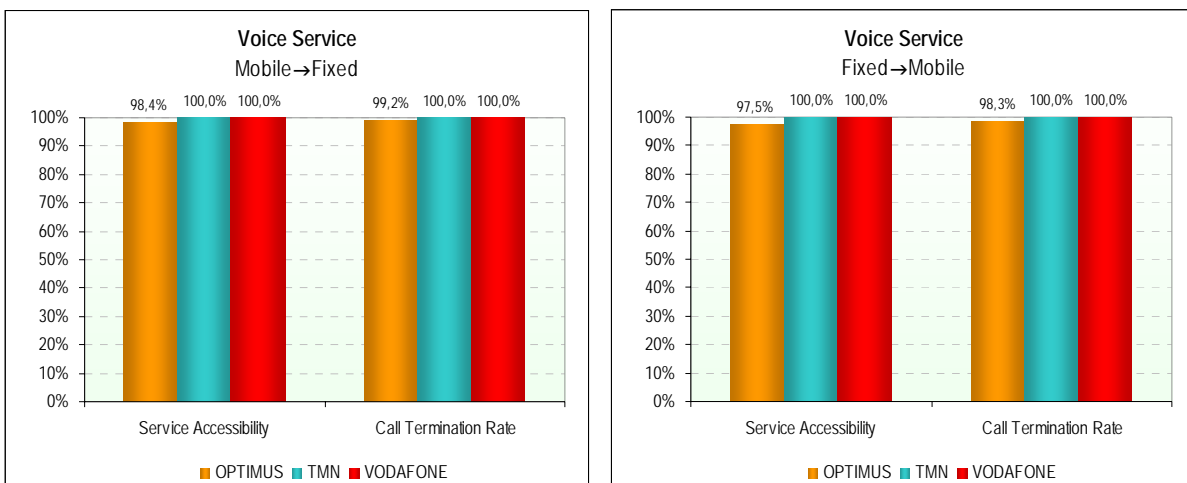


Figure 5 – *Service Accessibility* and *Call Termination Rate* indicators, on the Urban Agglomerations of the A. R. of the Azores.

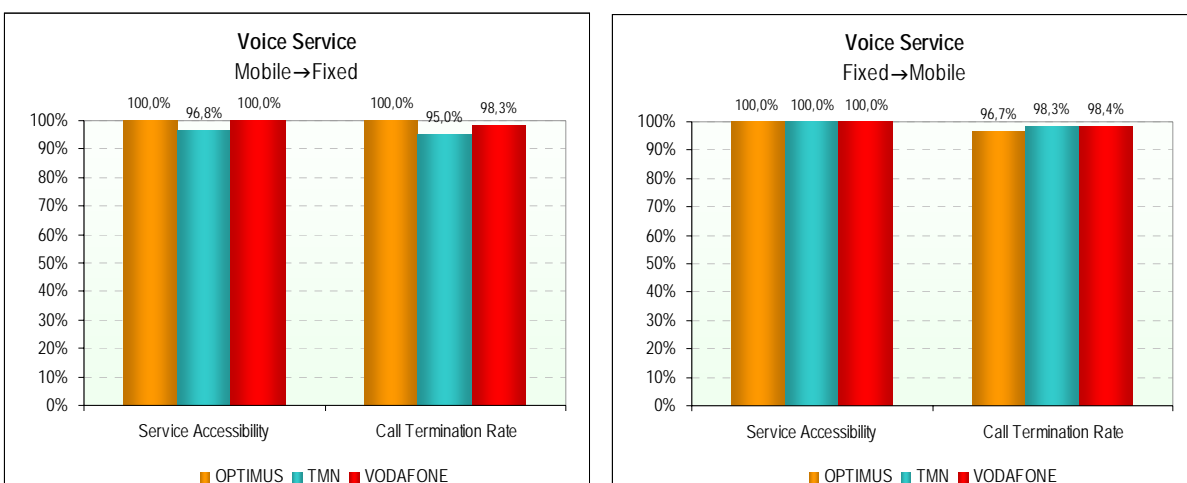


Figure 6 – *Service Accessibility* and *Call Termination Rate* indicators, on the Urban Agglomerations of the A. R. of Madeira.

In major roads there is a general degradation of these indicators, mainly caused by the numerous areas where mobile networks have poor or no radio coverage (Figure 7 and Figure 8). The highest

degradation is recorded by operator OPTIMUS in the Autonomous Region of the Azores, with a *Service Accessibility* below 42%.

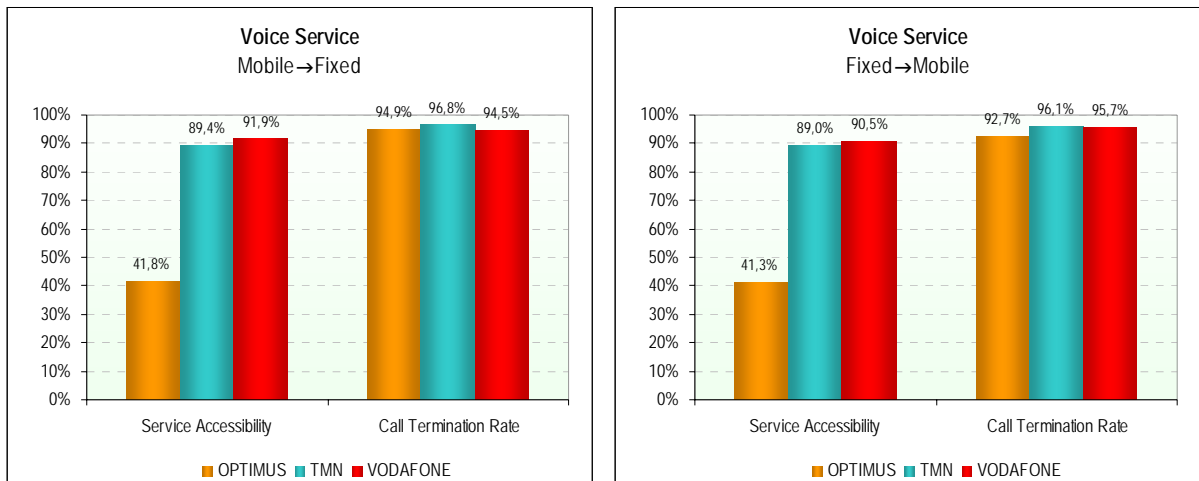


Figure 7 – *Service Accessibility* and *Call Termination Rate* indicators, on the Major Roads of the A. R. of the Azores.

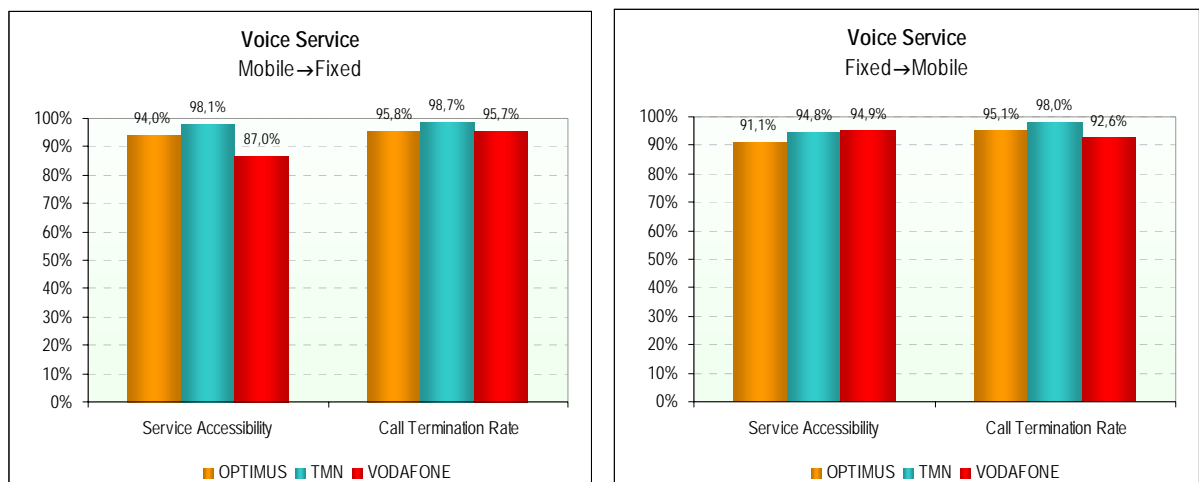


Figure 8 – *Service Accessibility* and *Call Termination Rate* indicators, on the Major Roads of the A. R. of Madeira.

The networks of operators OPTIMUS, TMN and VODAFONE show good average voice call set up times, regardless of the analysed locations (Figure 9, Figure 10, Figure 11 and Figure 12).

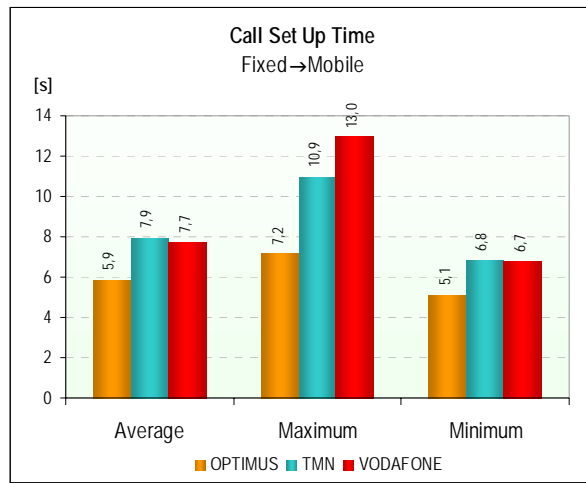
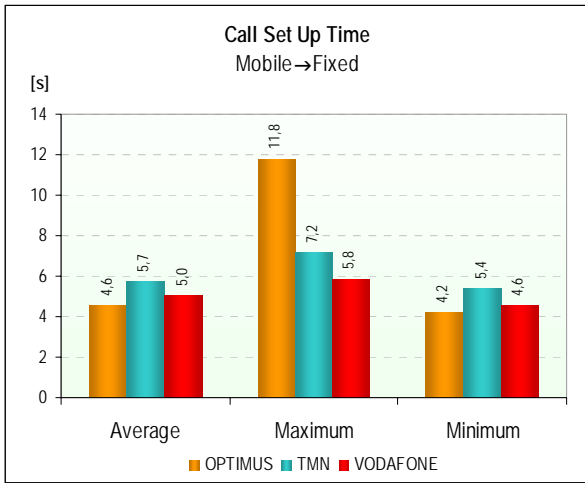


Figure 9 – *Call Set Up Time* indicator, on the Urban Agglomerations of the A. R. of the Azores.

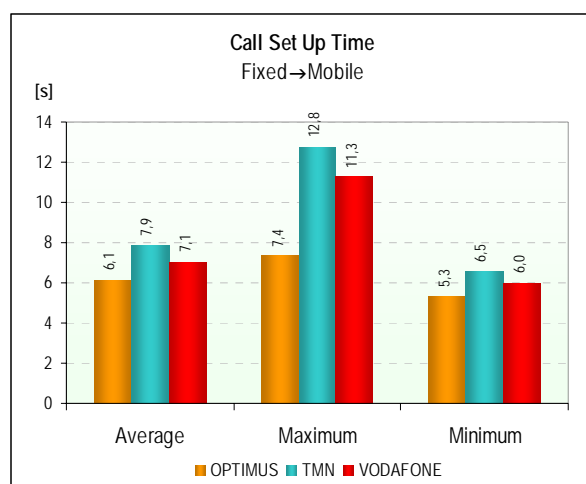
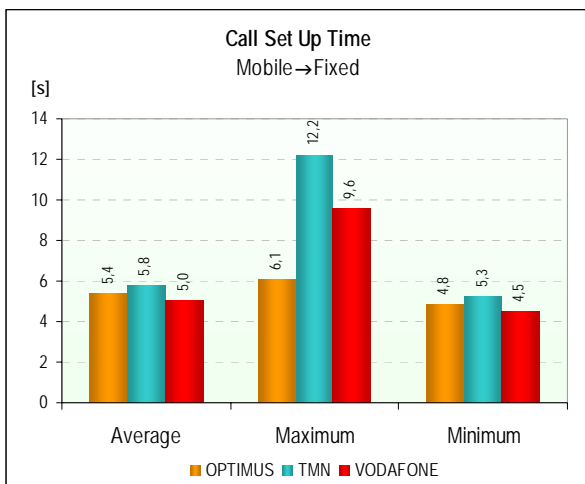


Figure 10 – *Call Set Up Time* indicator, on the Urban Agglomerations of the A. R. of Madeira.

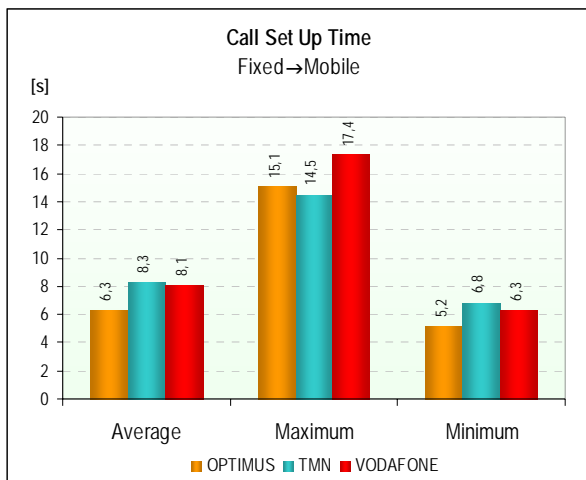
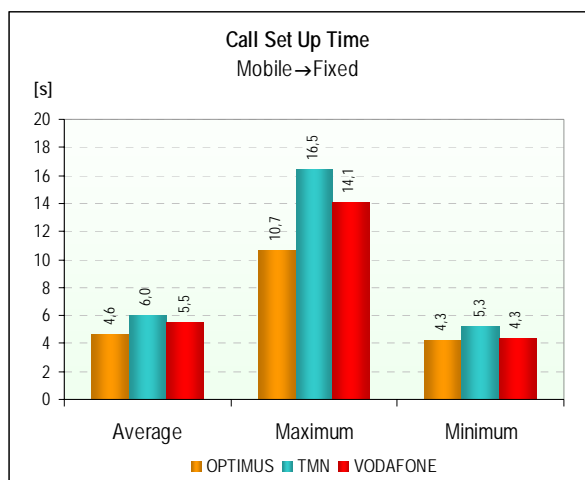


Figure 11 – *Call Set Up Time* indicator, on the Major Roads of the A. R. of the Azores.

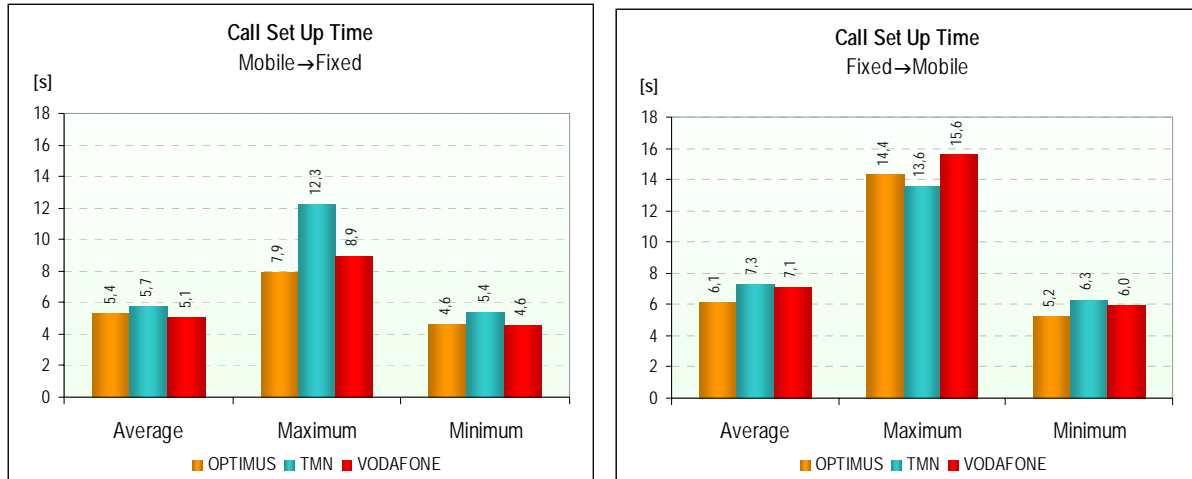


Figure 12 – *Call Set Up Time* indicator, on the Major Roads of the A. R. of Madeira.

Normally ended voice calls (120 seconds duration) present good average *Audio Quality*, both on urban areas and on the major roads of the Azores and Madeira archipelagos. TMN shows the best performance, although differences between operators are not significant (Figure 13, Figure 14, Figure 15 and Figure 16).

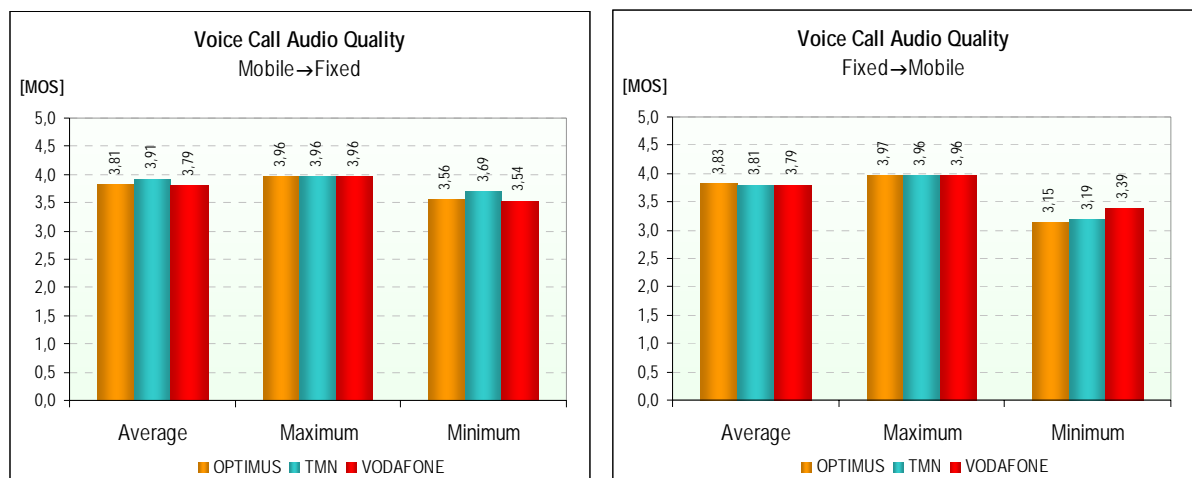


Figure 13 – *Call Audio Quality* indicator, on the Urban Agglomerations of the A. R. of the Azores

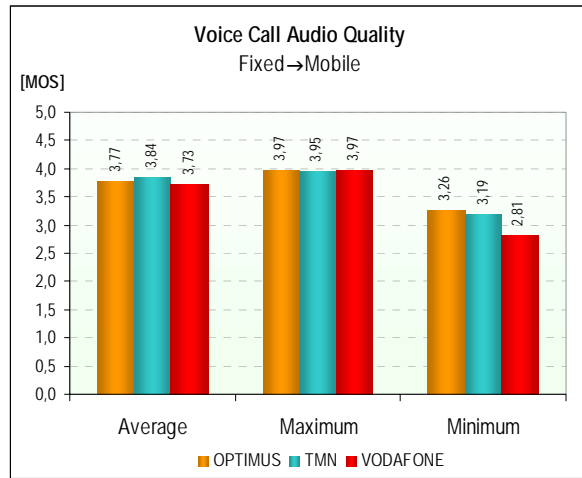
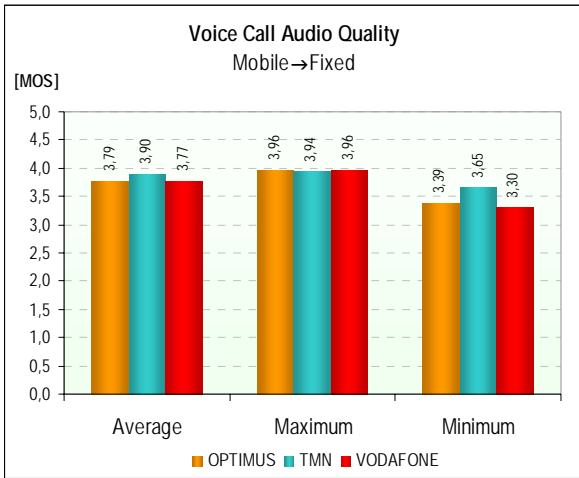


Figure 14 – *Call Audio Quality* indicator, on the Urban Agglomerations of the A. R. of Madeira.

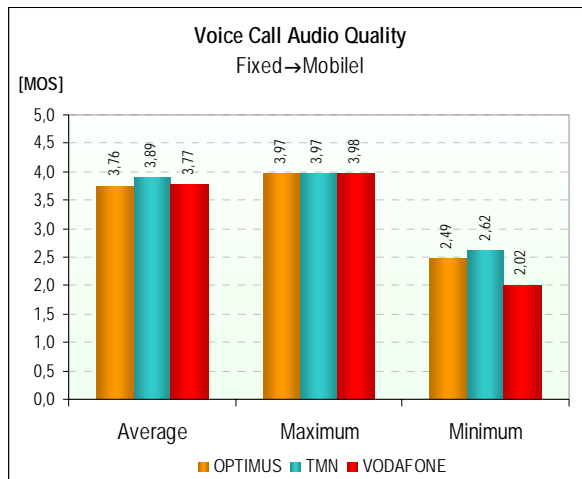
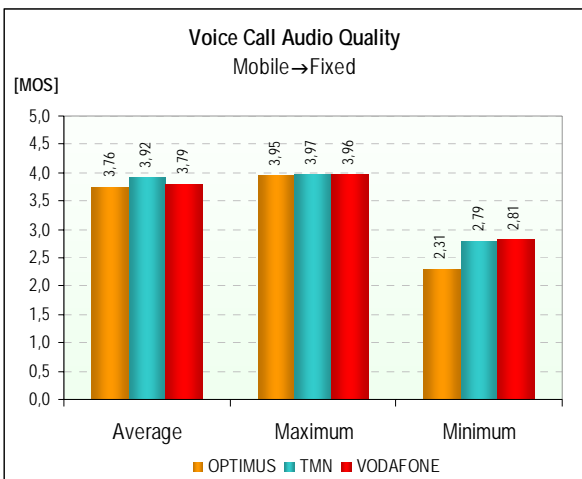


Figure 15 – *Call Audio Quality* indicator, on the Major Roads of the A. R. of the Azores.

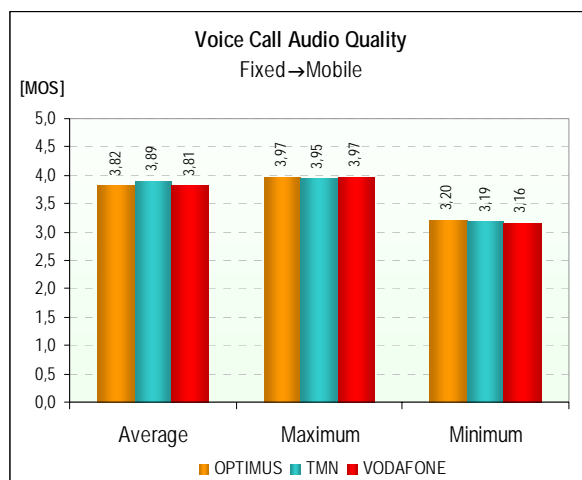
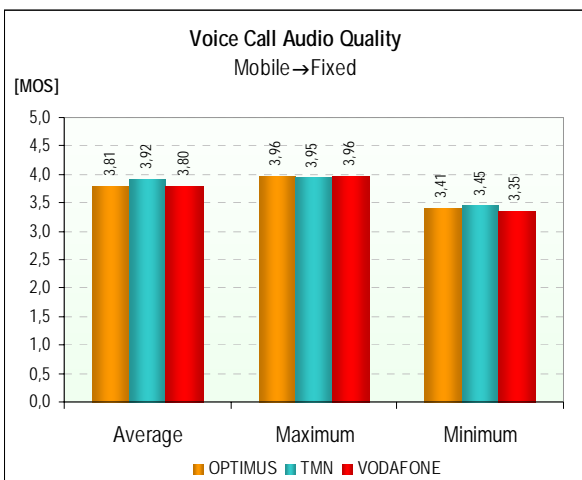


Figure 16 – *Call Audio Quality* indicator, on the Major Roads of the A. R. of Madeira.

Video-telephony Service (UMTS)

The video-telephony service's performance is below the one recorded for the voice service, namely regarding the *Service Accessibility* indicator on the major roads analysed.

As previously mentioned, operator OPTIMUS does not have a radio network supporting third generation services (WCDMA) in the Azores archipelago, thus preventing the access to the video-telephony service. The indicators concerning this operator present null values.

As with the voice service, the video-telephony service presents better performances on urban agglomerations than in major roads.

On urban agglomerations, the performance of operators TMN and VODAFONE can still be considered acceptable. In the Azores (Figure 17), operator VODAFONE presents the best performance with a 92.5% *Service Accessibility* and a 95% *Call Termination Rate*. In Madeira (Figure 18), the best performances were recorded by operators TMN and VODAFONE, with a *Service Accessibility* around 87% and a *Call Termination Rate* around 99%. The *Call Set Up Time* indicator shows good results, with operator VODAFONE recording the best performances (Figure 17 and Figure 18).

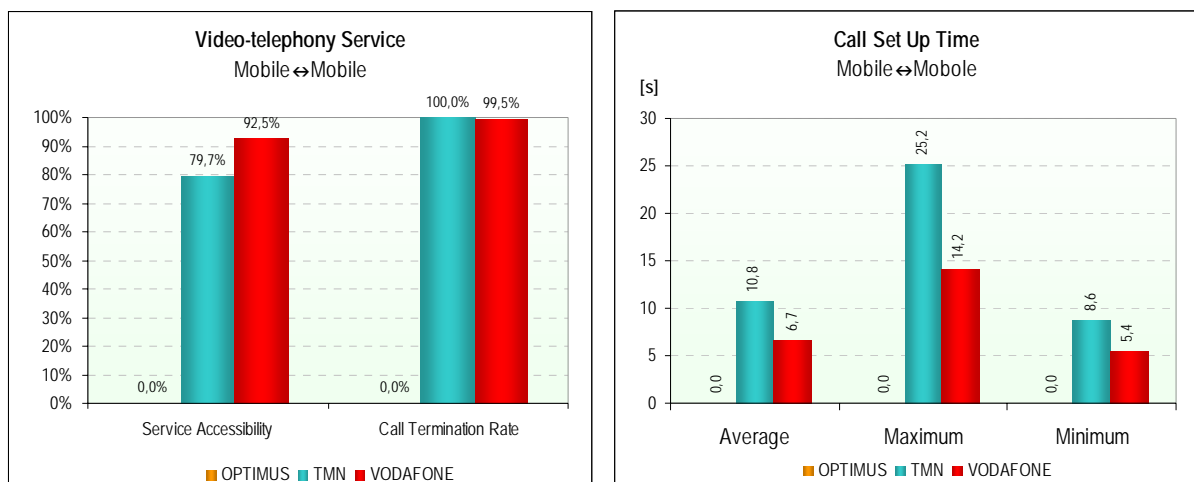


Figure 17 – *Service Accessibility*, *Call Termination Rate* and *Call Set Up Time* indicators, on the Urban Agglomerations of the A. R. of the Azores.

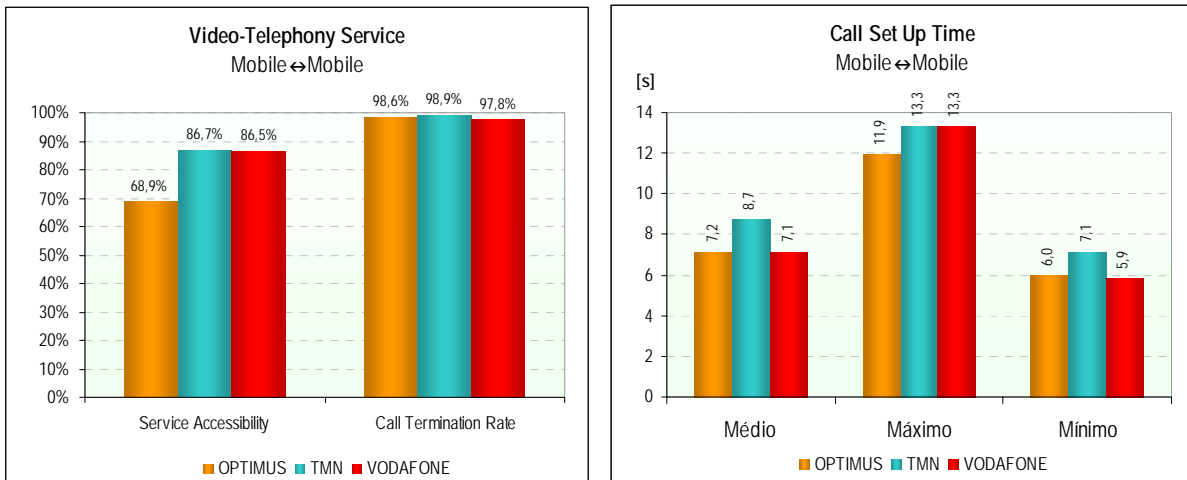


Figure 18 – *Service Accessibility, Call Termination Rate and Call Set Up Time* indicators, on the Urban Agglomerations of the A. R. of Madeira.

On major roads, *Service Accessibility* presents very low values; in the Azores they are even below 50% for all the studied operators (Figure 19). In the Madeira archipelago, TMN recorded the best performance, with 83.2%, while OPTIMUS and VODAFONE stood at 65.1% and 54.7%, respectively (Figure 20).

The *Call Termination Rate* indicator presents considerably higher levels than the *Service Accessibility* indicator (Figure 19 and Figure 20). The lowest level, 89.3%, was recorded by operator VODAFONE in the Autonomous Region of Madeira.

As with the urban agglomerations, the *Call Set Up Time* indicator presents good results (Figure 19 and Figure 20).

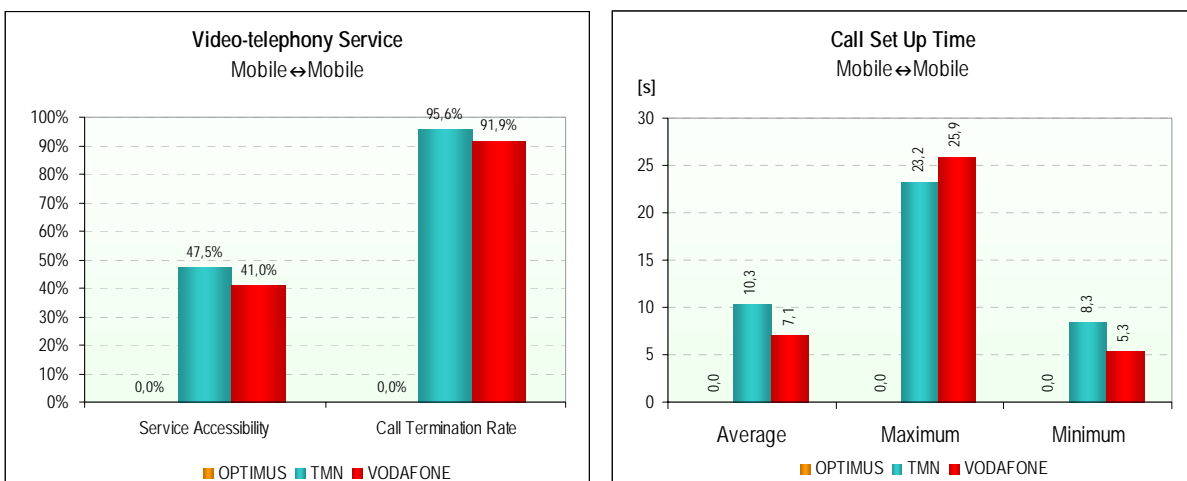


Figure 19 – *Service Accessibility, Call Termination Rate and Call Set Up Time* indicators, on the Major Roads of the A. R. of the Azores

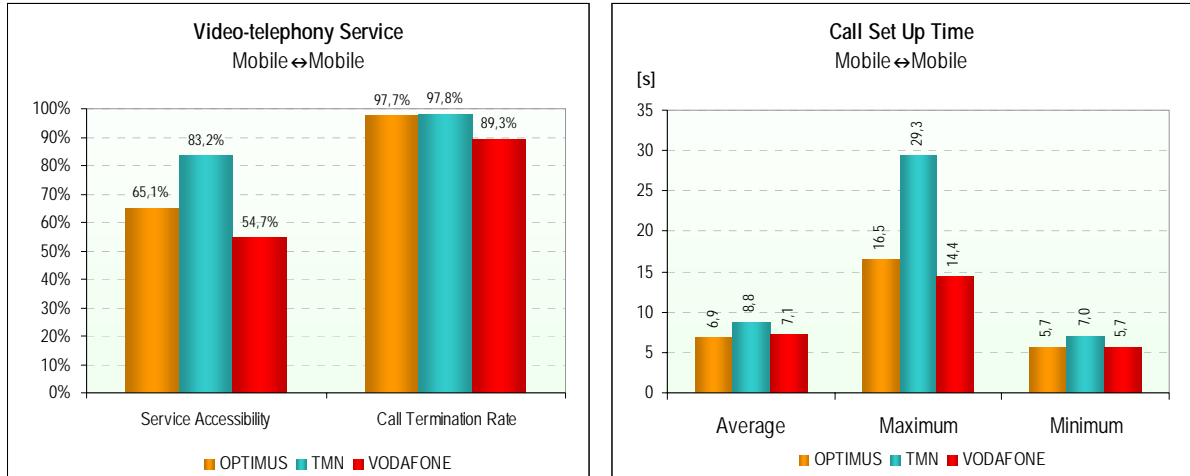


Figure 20 – *Service Accessibility, Call Termination Rate and Call Set Up Time* indicators, on the Major Roads of the A. R. of Madeira.

Normally ended video-telephony calls (120 seconds duration) present a good *Audio Quality* and acceptable *Video Quality*, on average. No major differences are recorded among operators or between urban agglomerations and major roads (Figure 21, Figure 22, Figure 23 and Figure 24).

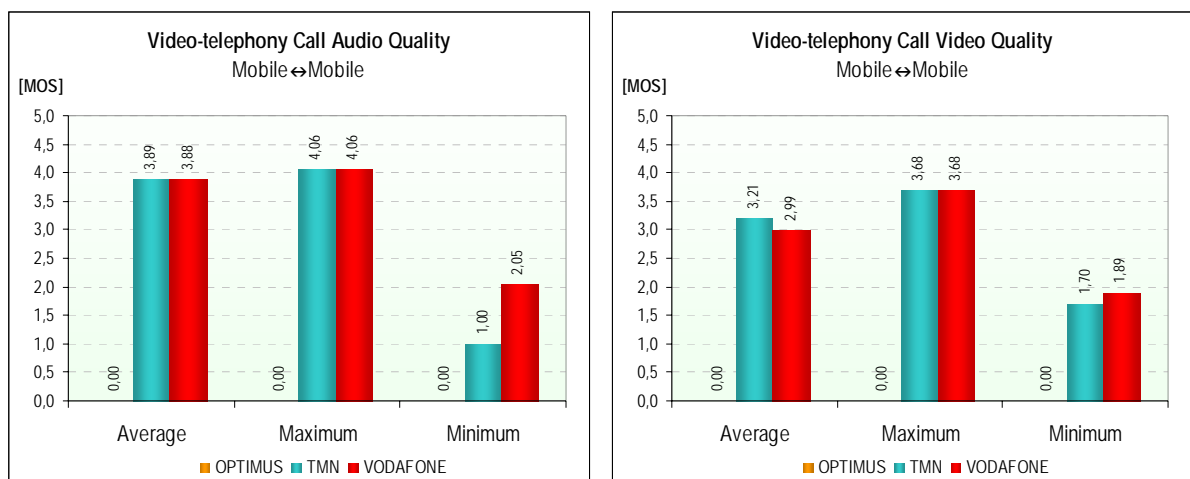


Figure 21 – *Call Audio Quality and Call Video Quality* indicators, on the Urban Agglomerations of the A.R. of the Azores.

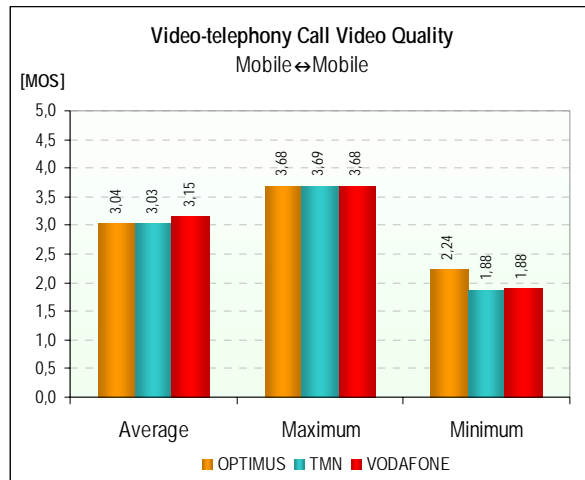
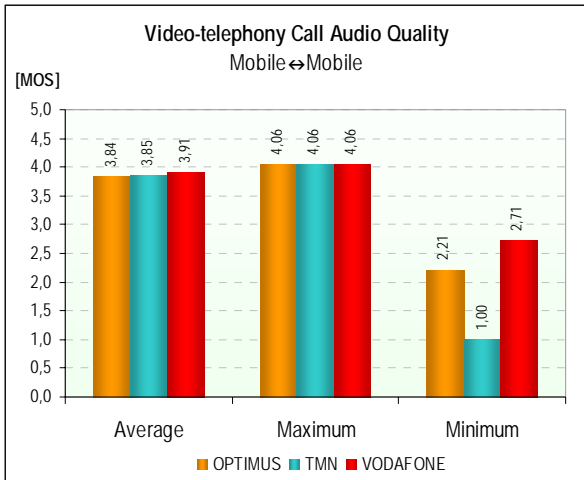


Figure 22 – Call Audio Quality and Call Video Quality indicators, on the Urban Agglomerations of the A.R. of Madeira.

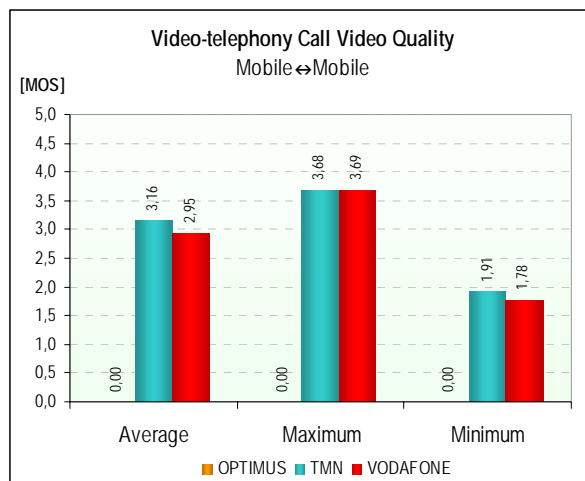
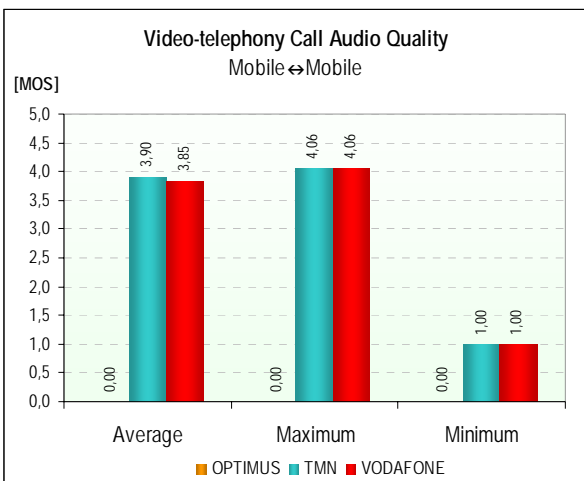


Figure 23 – Call Audio Quality and Call Video Quality indicators, on the Major Roads of the A.R. of the Azores.

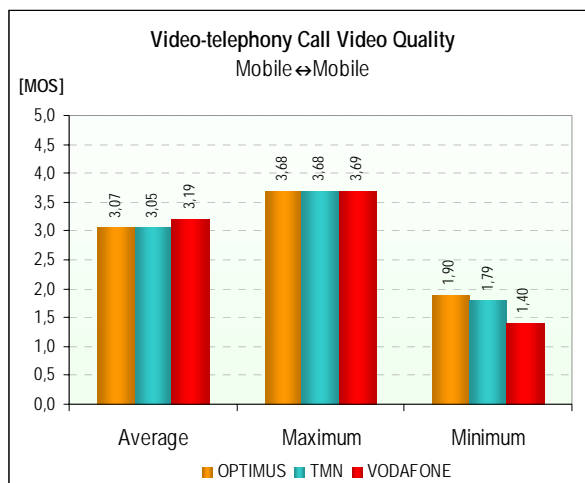
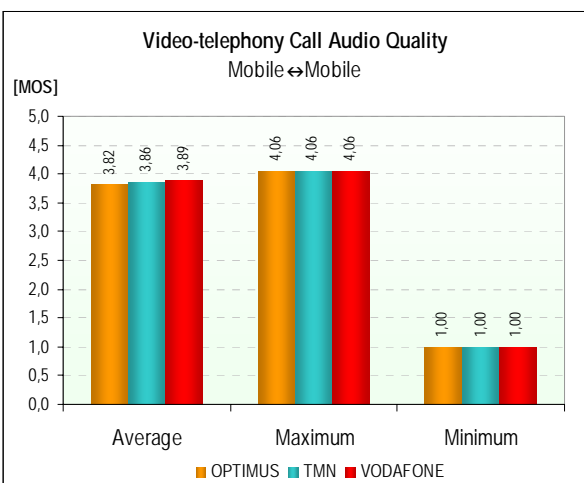


Figure 24 – Call Audio Quality and Call Video Quality indicators, on the Major Roads of the A.R. of Madeira.