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# Analysis Of Whatsapp Voice Call Quality On 3G And 4G Networks

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***Abstract***

*The development of wireless communication technology has increased the use of Voice over Internet Protocol (VoIP) services, including WhatsApp voice calls. However, voice quality is strongly affected by network performance, particularly in rural areas such as Cigudeg District, Bogor Regency, where 3G and 4G coverage still varies due to infrastructure limitations. This study analyzes the quality comparison of WhatsApp voice calls over 3G and 4G networks based on latency, jitter, packet loss, and Mean Opinion Score (MOS). A descriptive quantitative method was applied through direct field testing for ten consecutive days at three observation periods, namely 09:00, 13:00, and 20:00. The measurement used a Samsung Galaxy A03 smartphone running Android 11, WhatsApp, and the PingTools application to record network parameters during testing. MOS values were estimated using the E-Model approach based on ITU-T recommendations. The results show that the 4G network provides better voice-call quality, with an average latency of 40-80 ms, jitter of 10-30 ms, and MOS values between 4.2 and 4.5. In contrast, the 3G network shows poor performance with very high latency, unstable jitter, and MOS below 2.5. Therefore, 4G is recommended for WhatsApp voice calls in Cigudeg District.*

***Keywords: WhatsApp; VoIP; 3G; 4G; Quality Of Service***

## INTRODUCTION

The rapid growth of mobile broadband has changed the way people communicate, especially through internet-based voice services such as WhatsApp calls. Voice over Internet Protocol (VoIP) applications depend not only on signal availability but also on Quality of Service (QoS) parameters such as latency, jitter, and packet loss. These parameters directly affect user perception because excessive delay can produce unnatural conversation flow, while jitter and packet loss may create broken or unclear audio.

Although 4G networks have become dominant in many areas, some rural and hilly regions still experience uneven coverage and may continue to rely on 3G connectivity. Cigudeg District, Bogor Regency, is one example of an area where 4G coverage is available but not always stable, while several locations still depend on 3G signals. This condition is relevant for investigation because WhatsApp is widely used by the community for daily communication, including voice calls.

Previous studies have evaluated VoIP and mobile communication quality using MOS, E-Model, latency, jitter, packet loss, and related QoS indicators. However, field-based comparison of WhatsApp voice-call quality between 3G and 4G in transitional rural areas is still limited. Therefore, this study aims to compare WhatsApp voice-call quality on 3G and 4G networks in Cigudeg District using latency, jitter, packet loss, and MOS as the primary evaluation parameters. The contribution of this study is a practical field evaluation that can support users and service providers in understanding the real condition of VoIP communication quality in areas with uneven telecommunication infrastructure.

## RESEARCH METHODS

This study used a descriptive quantitative method with direct field measurement. The research was conducted in Cigudeg District, Bogor Regency. Testing was performed using a Samsung Galaxy A03 smartphone with Android 11 and WhatsApp version 2.25.26.74. Network performance was measured using the PingTools application while WhatsApp voice-call testing was carried out under 3G and 4G network conditions.

Data collection was conducted for ten consecutive days. Each day consisted of three

measurement sessions at 09:00, 13:00, and 20:00 to represent morning, afternoon, and evening network conditions. The measured QoS parameters were latency in milliseconds, jitter in milliseconds, packet loss in percent, and estimated MOS. The use of different measurement times was intended to observe the effect of user traffic variation on network performance.

The research stages are summarized as follows:

- preparing the testing device, WhatsApp application, and PingTools application;
- selecting 3G and 4G network modes based on available signal conditions;
- conducting measurements for ten consecutive days at 09:00, 13:00, and 20:00;
- recording latency, jitter, packet loss, and MOS estimation data;
- comparing the average performance of 3G and 4G networks; and
- interpreting the quality category based on VoIP QoS and MOS references.

MOS was estimated using the E-Model approach. The total delay was calculated by combining latency and jitter as shown in (1).

$$d = \text{latency} + \text{jitter} \quad (1)$$

$$R = 94.2 - 0.024d - 0.11(d - 177.3)H(d - 177.3) - 2.5Ppl \quad (2)$$

$$MOS = 1 + 0.035R + R(R - 60)(100 - R) \times 7 \times 10^{-6} \quad (3)$$

Where d is the total delay in milliseconds, H(x) is the Heaviside function, Ppl is packet loss percentage, R is the transmission rating factor, and MOS is the predicted perceived voice quality score.

**Table 1. Research measurement design**

| Component | Description |
|---|---|
| Research location | Cigudeg District, Bogor Regency |
| Device | Samsung Galaxy A03, Android 11 |
| Application | WhatsApp version 2.25.26.74 and PingTools |
| Network type | 3G and 4G |
| Testing duration | 10 consecutive days |
| Observation time | 09:00, 13:00, and 20:00 |
| Parameters | Latency, jitter, packet loss, and MOS |

## RESULTS AND DISCUSSION

The measurement results show a clear difference between the 3G and 4G networks. The 4G network produced more stable values for latency and jitter, while the 3G network produced very high delay and unstable jitter. In VoIP communication, lower latency and jitter are important because voice packets must arrive consistently to maintain natural conversation quality.

**Table 1. Summary of WhatsApp voice-call quality on 3G and 4G networks**

| Network | Latency | Jitter | Packet loss | MOS category |
|---|---|---|---|---|
| 3G | approximately 900 ms on average; up to 2000 ms | unstable; hundreds of ms | no significant loss observed | < 2.5 (Poor) |
| 4G | 40-80 ms | 10-30 ms | no significant loss observed | 4.2-4.5 (Good) |

As shown in Table 2, the 4G network achieved a MOS value of 4.2-4.5, which indicates good perceived voice quality. This result is supported by the lower latency range of 40-80 ms and jitter of 10-30 ms. These values allow voice packets to be delivered more consistently, reducing the possibility of audio interruption during WhatsApp calls.

In contrast, the 3G network produced MOS values below 2.5, which indicates poor quality. The high latency, which averaged approximately 900 ms and reached up to 2000 ms in some observations, caused significant delay in two-way conversation. Although packet loss was not significant, the excessive delay and unstable jitter were sufficient to reduce the MOS value. This finding confirms that packet loss is not the only determinant of voice quality; delay and jitter can also strongly degrade user experience.

The time of measurement also influenced network performance. The 3G network experienced a

substantial quality decline at 20:00, which can be associated with higher user traffic during the evening. Meanwhile, the 4G network remained relatively stable across the three observation periods. This indicates that 4G has better capacity and stability for handling WhatsApp voice-call traffic in the observed area.

**Table 3. Effect of testing time on network quality**

| Testing time | 3G condition | 4G condition |
|---|---|---|
| 09:00 | relatively better than evening but still unstable | stable and suitable for voice calls |
| 13:00 | moderate degradation depending on signal condition | stable with low delay |
| 20:00 | quality decreased significantly due to traffic load | relatively stable |

**Parameter Analysis And Interpretation**

Latency is the most visible factor affecting conversational comfort. In the 4G measurements, the latency range of 40-80 ms was still within a practical range for interactive voice communication. This condition allows users to speak and respond without a noticeable pause. In the 3G measurements, the latency increased drastically and reached values that were no longer suitable for real-time conversation. Even when packet loss was small, very high latency created a delay between speakers and reduced the naturalness of the call.

Jitter represents the variation of packet arrival time. The 4G network produced relatively low jitter, which indicates that packet delivery was more stable. The 3G network produced unstable jitter, especially in the evening. For voice communication, unstable jitter may force the application to use a larger buffer or may produce gaps in audio. This explains why the 3G network had lower perceived quality even when the call connection was still active.

Packet loss during the observation was not dominant. However, packet loss should not be ignored because VoIP services are sensitive to missing packets. A small amount of packet loss can still be handled by the application through concealment mechanisms, but higher loss may cause broken voice, repeated syllables, or unclear audio. In this study, the low packet-loss condition indicates that the poor 3G result was mainly caused by delay and jitter rather than packet loss.

The MOS value provides a compact representation of perceived call quality. The 4G network achieved MOS values between 4.2 and 4.5, which fall into the good category. The 3G network produced MOS below 2.5, which reflects poor quality. This result confirms that the user experience in WhatsApp voice calls is not only determined by signal availability, but also by the stability of packet transmission during the call.

**Comparison With Previous Studies**

The findings are consistent with previous VoIP QoS studies which state that lower delay, lower jitter, and lower packet loss tend to improve MOS values. Earlier studies on VoIP and mobile networks also show that LTE or 4G networks generally provide better performance for real-time services than older mobile technologies because they offer better bandwidth capacity, lower transmission delay, and more stable packet delivery [5], [6], [11].

The result also supports the argument that field measurement is important because coverage availability does not always represent real service quality. In Cigudeg District, 4G coverage may already be available in many locations, but the quality can still vary depending on terrain, distance from base transceiver stations, user density, and time of usage. Therefore, direct QoS measurement remains necessary for evaluating the actual quality experienced by users.

**Practical Implications And Limitations**

From a practical perspective, users in Cigudeg District should prioritize 4G mode when making WhatsApp voice calls, especially during evening hours. For service providers, the high latency and unstable jitter found on 3G indicate the need for network optimization or migration support in locations that still depend on older infrastructure. Improving 4G signal stability in hilly areas can directly improve the quality of daily communication for local communities.

This study has several limitations. The measurement was conducted using one smartphone model, one application version, and one measurement tool. The study also did not include subjective listening tests from multiple respondents. Future studies should include additional devices, operators, measurement locations, and subjective MOS surveys so that the results can represent wider user conditions.

## CONCLUSION

This study concludes that the 4G network provides better WhatsApp voice-call quality than the 3G network in Cigudeg District. The 4G network produced lower latency, more stable jitter, and higher MOS values between 4.2 and 4.5, which are categorized as good. Meanwhile, the 3G network showed poor performance with very high latency, unstable jitter, and MOS values below 2.5, especially during evening measurements. Therefore, users in Cigudeg are advised to prioritize 4G networks for WhatsApp voice calls. Future research can expand the observation by involving more operators, wider measurement points, subjective MOS surveys, and comparisons with 5G or Wi-Fi networks.

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