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VoLTE v/s 4G: Performance Comparison and Causes

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***Abstract:** This paper presents the performance comparison of VoLTE & 4G on the basis of various parameters like download speed, upload speed, signal strength, network delay and packet loss. The analysis is done by an android application known as 'Speed Test' by Ookla. This app is a categorical way to test the speed and performance of internet connection. With the knowledge of download and upload speed, this application also measures the jitter and ping concerned with the respective network. In this paper, I'm going to conduct the comprehensive performance characterization of commercially deployed VoLTE and 4G network. The data reported in this study shows that VoLTE excels in most metrics such as download and upload speeds.*
***Index Terms:** VoLTE, LTE, IMS, UMTS, GSM.*

I. INTRODUCTION

This document has taken out empirical studies for the performance comparison analysis of VoLTE and 4G network.
The cellular communications industry has observed a substantial growth since the mid of 1990's. The burgeoned demand for higher speeds and better Quality of Experience (QoE) in mobile communications network is continually increasing since then. Long-Term Evolution (LTE) supports solely packet-switched network across associate degree all-IP system, whereas previous cellular networks GSM or UMTS support each packet- and circuit-switched network. In the starting of LTE preparation, all voice traffic is handled by inheritance Circuit-Switched (CS) networks, whereas knowledge traffic is handled by LTE packet-switched networks. Some solutions have been proposed in order to deliver voice services in LTE [4].

A. VoLTE

Voice over Long-Term Evolution (VoLTE) is a technology that enables transmission of voice calls over LTE network by using IP Multimedia Subsystem (IMS). VoLTE is bandwidth efficient and offer better speech quality than legacy technologies such as Universal Mobile Telecommunications System (UMTS) and Global System for Mobile communication (GSM). In this paper, I analyze the impact of radio propagation conditions, codec type implementation, and mouth-to-ear delays on VoLTE service performance.

B. 4G

The basic plan of 4G network is to produce services to users supported associate degree design that is packet primarily based i.e. IP based.
This means that each and every user connected to the net anytime and anyplace should have a singular IP address. The development and augmentation of 4G Networks and connected technologies in today's situation is imperative indicator of advancement within the field of wireless communication and technology.
This progress started back from 1970s once the experience simply learnt the way to crawl on the trail of development with the evolution of basic 1st generation networks.
1G or the primary generation wireless networks were supported analog technology, designed in 1970s.This generation used the essential cellular structures and architectures for the aim of mobile communications.
After the primary step of 1G within the path of progress, the second step was of the 2G or second generation networks that marked a metamorphosis from the analog
technology of 1G to the digital technology using digital signals.
2G networks created digital communications doable at low speeds with the introduction of GSM (Global Mobile System), TDMA, PDC (Personal Digital Cellular) and CDMA (Code Division Multiple Access).

Then came 2.5G and 3G in the 1990s with higher qualities of services and better communication speeds.2.5G acted as an interim between the 2G and the 3G services.

After the power of 3G of providing higher knowledge rates for fulfilling the information stern wants of users, the new leap in the telecommunication industry is that of 4G.

The first in operation 4G Network was established by Clearwire and Intel in Portland, Beaver State in Jan 2009, marking the start of a replacement era.

4G has much promises and expectations to keep.

The rest of the paper is organized as follows. In Section 2, I will be explaining the methodology of the research, in Section 3, we briefly introduce VoLTE & 4G technology and the key performance indicators to analyze the performance of both. In Section 4, a detailed performance comparison of VoLTE & 4G is done under different test scenarios. Conclusions of my work is drawn in Section 5.

II. METHODOLOGY

In this research paper, the studies are done for VoLTE and 4G networks with the help of an android app called Speed Test by Ookla. With the help of which all the comparison parameters like data transfer speeds, speech quality, network delay, etc. is going to be measured.

III. PERFORMANCE ANALYSIS

A. VoLTE

The Voice over LTE solution allows the operators to evolve from circuit switched (CS) based solution (Mobile Soft-switch solution, MSS) in WCDMA networks towards an IMS IP-based core network [1].

CS domain is not supported by LTE; consequently voice service is delivered as packet switched domain (PSD) through IP using the IP Multimedia Subsystem (IMS)-based standard. MSS and IMS use different switching nodes in the connectivity and control layer. However Mobile Media Gateway (M-MGw) can be used by MSS and IMS for transferring user data and signaling media payload according to 3GPP soft-switch layered architecture on connectivity network layer. MSS can handle voice calls via Wifi known as Generic Access Network (VOLGA) [2] and uses IP communication between UE and MSC server (MSC-S) being either over fixed or mobile broadband. MSS is also involved in Voice over LTE (VoLTE) when there is a need to roam between operators [3].

B. 4G

1) *4G Networks in India:* 4G services debuted first in India in 2012. Indian 4G LTE network is distributed under different LTE frequency bands spectrum. Indian telecom operators have received spectrum license to operate 4G LTE networks over following networks. If you're interested in purchasing a handset to access 4G connectivity, make sure the phone supports Bands 3, 5, and 40. Bands for various generations and
2) *4G Band:* A key a part of any itinerant specification is its operative frequency bands.

The supported frequency bands verify whether or not a precise phone is compatible with a precise network carrier.

It's not operator-specific and it's useful if you're selecting a phone to use in your home country or if you're ensuring your phone can add the country you are heading to.

2G capabilities: GSM 900, GSM 1800

3G capabilities: UMTS 900, UMTS 2100

4G capabilities: LTE 850 (5), LTE 1800 (3), LTE 2300 (40)

BAND 5 LTE FDD (850 Mhz), BAND 3 LTE FDD (1800 Mhz), is primarily used for 4G coverage in India, as the spectrum was already in use during the 2G era. Carriers that offer 4G on Band 3 include Aircel, Airtel, Idea, Reliance Communications, Reliance Jio, Telenor, Vodafone, and Videocon.

IV. PERFORMANCE COMPARISON OF VOLTE & 4G

A. On The Basis Of Download And Upload Speed

For the performance comparison of both the networks, I have measured the download and upload speeds with the help of an app called Speed Test by Ookla. This app measures the performance measures like download speed, upload speed, jitter, ping, etc.

The results are put together in the forms of tables to clearly define the comparison.

Table 2 Speed Test Readings for Download and Upload speeds for VoLTE

ITERATIONS	Connection Type	Download Speed	Upload Speed
1	LTE	11.42312	1.802304
2	LTE	19.06124	1.62736
3	LTE	7.493232	1.6972
4	LTE	6.013536	1.497064
5	LTE	3.191032	1.145464

As per the details aligned in Table1, the download and upload speeds of VoLTE network is measured for 5 iterations that shows a considerable consistency in the download and upload speed.
Another test was taken out for 4G network, the results of which are assembled below:

Table 3 Speed Test Readings for 4G

ITERATIONS	Connection Type	Download Speed	Upload Speed
1	LTE	1.572592	0.326288
2	LTE	4.263184	0.346632
3	LTE	2.872096	0.149864
4	LTE	1.921656	0.703504
5	LTE	2.355968	0.830624

As per the details aligned in Table3, the download and upload speeds of 4g LTE network is measured for 5 iterations which shows that the download and upload speeds are relatively poor as compared to the performance over VoLTE.

B. On The Basis Of Jitter And Ping

To measure the performance of volte and 4G LTE on the basis of network delay and ping, we first need to clear the basic knowledge about what jitter and ping actually is.
A brief explanation of jitter and ping is given below:

1) *Jitter:* Jitter in Packet Voice Networks. Jitter is defined as a variation in the delay of received packets. ... Due to network congestion, improper queuing, or configuration errors, this steady stream can become lumpy, or the delay between each packet can vary instead of remaining constant.
2) *Ping:* Ping is a networking utility program or a tool to test if a particular host is reachable. It is a diagnostic that checks if your computer is connected to a server. Ping, a term taken from the echo location of a submarine, sends data packet to a server and if it receives a data packet back, then you have a connection.

Table 4 Speed Test readings for Jitter and Ping for VoLTE and 4G LTE network

NETWORK	JITTER	PING
VoLTE	22 ms	54 ms
	15 ms	85 ms
	18 ms	83 ms
	7 ms	68 ms
	18 ms	83 ms
4G	15 ms	70 ms
	18 ms	75 ms
	17 ms	67 ms
	11 ms	67 ms
	18 ms	64 ms

By analyzing table 4, there was a significantly high network delay for both the networks which is comparatively similar in both cases whereas there was a considerable lag in case of VoLTE for delay in reaching the host as compared to 4G network.

C. Speech Quality Test Results for VoLTE

This section presents the differences in the call quality between end-to-end VoLTE call and a voice call which combines VoLTE with UMTS and GSM or employing CSFB and SRVCC. The speech quality is evaluated in real VoLTE and GSM/UMTS network deployments. Drive test measurements were performed using two measurement cars. In both cars are located mobile phones, A-party and B-party, where both mobiles are calling each other. Speech quality was measured by playing reference voice samples on talking side and recording the transmitted samples on listening side. POLQA wideband algorithm was applied to derive the average Mean Opinion Score (MOS) values. For each single call eight voice samples were recorded and total number of samples is showed in Table 5 [4].

TABLE5. Number of recorded samples for different Scenarios

Different call Scenario	Technologies		
	VoLTE-VoLTE	VoLTE-UMTS	VoLTE-GSM
Nr. Of recorded Samples	1394	1998	330

The cumulative distribution of speech quality between end-to-end VoLTE and VoLTE to UMTS/GSM calls is shown in Fig. 1. The results indicate that when both end users are using VoLTE technology, the obtained speech quality is impressive comparing with the case when one mobile is using legacy or performing CSFB to legacy. The small number of samples for VoLTE to GSM call scenario may not accurately quantify the real-word impact and can be further improved with more recorded samples. In VoLTE to VoLTE call scenario the average of speech quality is 4.11 MOS; while in VoLTE to UMTS/GSM is 3.35 MOS and 2.77 MOS respectively. Voice calls involving multiple technologies may result in using codecs in tandem. For example, in the case of VoLTE to GSM call, the output of AMR-NB codec voice data for purpose of interworking must be converted into another format e.g., Pulse Code Modulation (PCM), which further degrades voice quality [4].

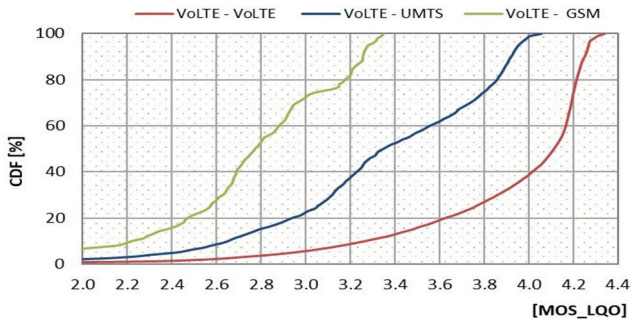

Fig.1. Cumulative Distribution Function (CDF) of speech quality for different call scenarios.

V. ANALYSIS

By analyzing all the test scenarios, the uploads and downloads speeds and various other parameters are measured by performing required measures but during the testing of speech quality for VoLTE, there was a seemingly one drop call after every 5 or 6 calls which show the incapability of call stability and connection reliability. Otherwise, the performance of VoLTE was considerably better.

VI. CONCLUSION

In this paper, I presented a study about Voice over LTE (VoLTE) and 4G network with focus on performance analysis based on upload speeds, download speeds, jitter , ping and speech quality over different networks.

First of all, both the networks were tested by calculating the speeds individually on the same app. Then both the networks were examined for finding the network delay and for the delay in reaching the host i.e. ping. Finally, the call reliability and call setup time for VoLTE and legacy calls was analyzed. Test results categorically indicate that VoLTE shows higher speeds in data transfer and there is an improvement in call setup time while the number of dropped calls is higher than in 4G technology.

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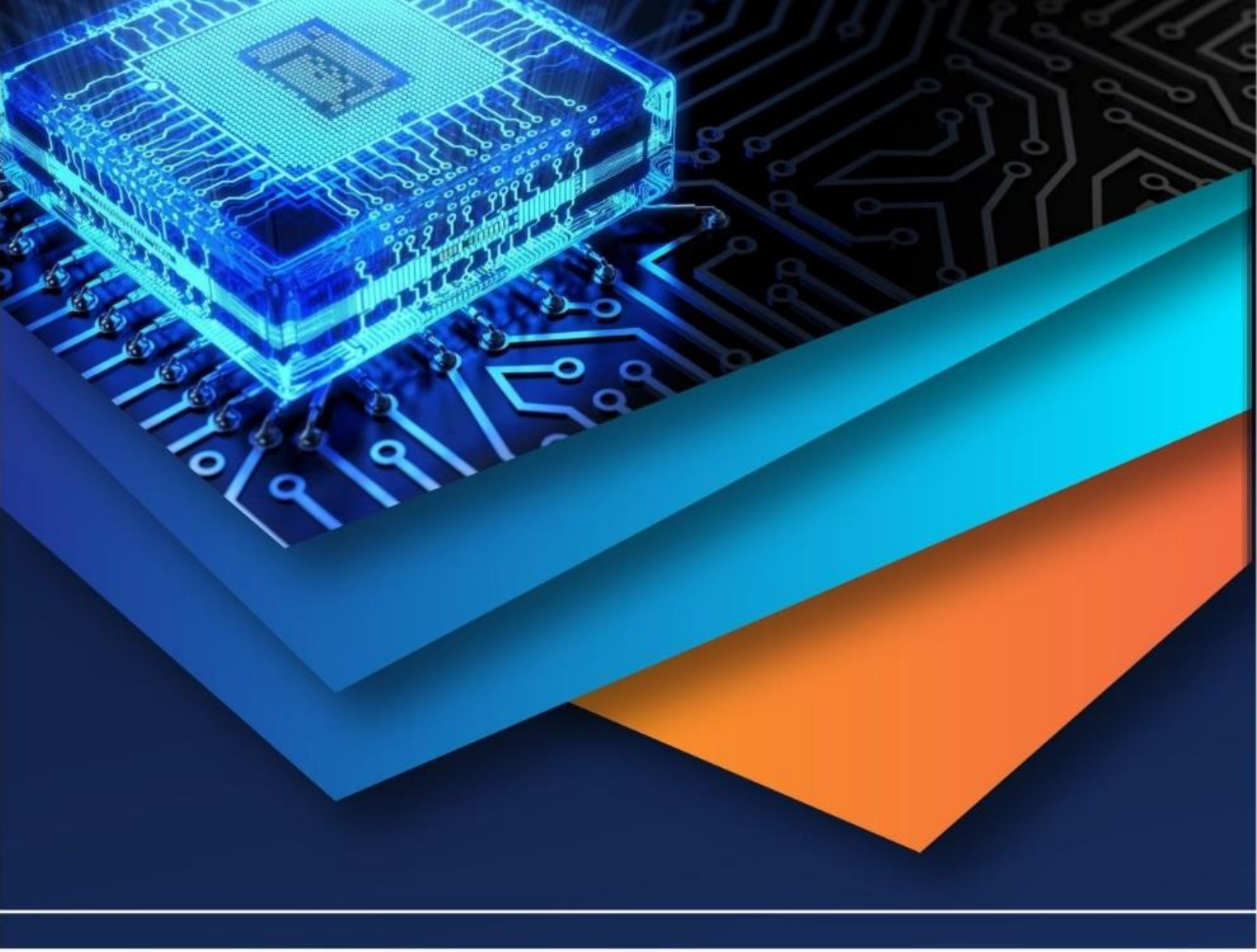

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