# Micro-Project Report

**Title: - Prepare Report on Performance Analysis of 4G LTE , 4.5G, & 5G Network Technologies.**

**Rationale: -** Mobile technology is a form of technology that is mostly used in cellular communication and other related aspects. It uses a form of platform where by many transmitters have the ability to send data at the same time on a single channel One of the most important use of smart phones is that they ensure safety. Families can easily communicate with each other while away. To cap it up, mobile technology is here to stay and holds a lot more features in the future to meet even the most of our basic needs and to make life a lot easier.

* 1. **Course Outcomes Addressed: -**
  2. Select cellular Mobile system Standard.
  3. Maintain Wireless Network Technologies.
  4. Maintain Wireless Mobile Application.
  5. Interpret the Components of WLL Applications.
  6. Maintain ADHOC and Wireless Sensor Network.

## Literature Review: - In this Report we will Study About Different types of wireless mobile Technologies given as follows:-

## LTE Specifications.

## VOLTE

## VOLTE Call Setup .

## LTE KPIs.

## 4.5G Specifications.

## 5G Specifications.

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**LTE Specifications:-**

LTE Advanced Pro (LTE-A Pro, also known as 4.5G, 4.5G Pro, 4.9G, Pre-5G, 5G Project) is a name for 3GPP release 13 and 14. It is the next-generation cellular standard following LTE Advanced (LTE-A) and supports data rates in excess of 3 Gbit/s using 32-carrier aggregation. t also introduces the concept of [License Assisted Access](https://en.wikipedia.org/wiki/License_Assisted_Access), which allows sharing of licensed and unlicensed spectrum.Additionally, it incorporates several new technologies associated with [5G](https://en.wikipedia.org/wiki/5G), such as 256-[QAM](https://en.wikipedia.org/wiki/Quadrature_amplitude_modulation), Massive [MIMO](https://en.wikipedia.org/wiki/MIMO), [LTE-Unlicensed](https://en.wikipedia.org/wiki/LTE-Unlicensed) and [LTE IoT](https://en.wikipedia.org/wiki/LTE_IoT),[[8]](https://en.wikipedia.org/wiki/LTE_Advanced_Pro#cite_note-8)[[9]](https://en.wikipedia.org/wiki/LTE_Advanced_Pro#cite_note-9) that allow evolution of existing networks into supporting the [5G](https://en.wikipedia.org/wiki/5G) standard. Pre5G or 4.5G is essentially LTE Advanced or LTE Advanced Pro. LTE-Advanced is essentially 4G with peak data rates to 1Gbps and latency under 10 milliseconds. LTE Advanced Pro has peak data rates over 3Gbps and latency under 5 milliseconds-12 Mbps over early LTE/4G). LTE -A to its higher speeds, far greater spectrum efficiency and use of Heterogeneous network, can boost network capacity by 3x-5x (vs 4G). LTE Advanced will enhance customer experience via much lower latency. ... Wider spectrum bands will boost speeds. Peak speed: 4G is defined as 150 Mbps, 4.5G as 1 Gbps and above, and 5G as 10 to 20 Gbps. Connection numbers: A 4G network cell can carry several thousand, 4.5G uses CloT to carry 100,000, and 5G will be required to carry 1 million connections per square kilometer. During the past decade the wireless communications industry has increased drastically with over four billion subscribers (Figure 1.1). While the first generation (1G) analog cellular systems had only voice communication with limited roaming, the second generation (2G) digital systems offer better voice quality and higher capacity. Besides, roaming has become more widespread especially in European countries because of limited standards and common spectrum allocations (Beming & Frid 2007). The two most used second-generation (2G) cellular systems are GSM (global system for mobile communications) and CDMA (code division multiple access). The 2G systems like the 1G analog systems, were first designed to support voice communication and later, released of these standards also supported data transmission, despite the fact that the data rates were lower than those supported by dial-up connections. Although, in the last decades only a few selected people could use the service, because it was very expensive. Today, the mobile communications are used by a large part of the world population and it has become a part of everyone’s life. The amount of the subscribers is rising. That’s why the tasks of evolving mobile technologies are changed from being national or regional concern to wide complex task undertaken by global standards-developing organizations such as the Third Generation Partnership Project (3GPP).Mobile communication technologies are divided into the following generations:

* 1G being the analog mobile radio systems of the 1980s
* 2G the first digital mobile systems
* 3G the first mobile systems handling broadband data.

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**VOLTE :-**

VoLTE stands for 'Voice over Long Term Evolution'. Utilizing IMS technology, it is a digital packet voice service delivered over IP via an LTE access network. Voice calls over LTE are recognized as the industry-agreed progression of voice services across mobile networks, deploying LTE radio access technology. The implementation of VoLTE offers many benefits, both in terms of cost and operation. VoLTE:

* Provides more efficient use of spectrum than traditional Voice.
* Meets the rising demand for ‘Richer’, more reliable services.
* Eliminates the need to have Voice on one network and data on another
* Unlocks new revenue potential, utilizing IMS as the common service platform
* Can be deployed in parallel with video calls over LTE and RCS multimedia services, including video share, multimedia messaging, chat and file transfer
* Increases handset battery life by 40 per cent (compared with VoIP).
* Delivers an unusually crisp calling experience.
* Provides rapid call establishment time.

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### Superior call quality

The big advantage of VoLTE is that call quality is superior to 3G or 2G connections, as far more data can be transferred over 4G than 2G or 3G. Up to three times as much data as 3G and up to six times as much as 2G to be precise, making it easier to make out not only what the person on the other end of the line is saying, but also their tone of voice.

Essentially it’s an HD voice call and it’s a much richer experience overall.

### Improved coverage and connectivity

VoLTE can connect calls up to twice as fast as the current methods, and as 2G and 3G connections will still be available when there’s no 4G signal it simply means that there’s greater mobile coverage overall, as without VoLTE you wouldn’t be able to make or receive calls in places with a 4G signal but no 2G or 3G.

You might think that would be a rare occurrence, but some of the frequencies that 4G operates on, such as the 800MHz spectrum, have far greater reach than 2G or 3G spectrum, so you’ll be able to get signal further away from a mast or in buildings which other signals struggle to penetrate. Indeed, Three is fully relying on its 800MHz spectrum for VoLTE calls.

However, while 2G and 3G services have largely remained so far they aren’t as necessary as they used to be, and much of the spectrum used for 2G in particular could potentially be repurposed to increase capacity on 4G or 5G networks.

### Better battery life

Smartphone users could also find their battery life increased with VoLTE, as without it whenever you make or receive a call your phone has to switch from 4G to 2G or 3G, since 4G calls aren’t supported, and then once the call is finished your phone switches back again. All that switching, plus the need to search for a different signal each time, can give the battery a significant hit.

### Faster data

As you don’t have to switch to 3G when making a call with VoLTE, that means you can also keep using 4G for other functions on your phone while on a call. That’s handy if you’re multi-tasking. For example, browsing the web at the same time or downloading an app.

### Works with Wi-Fi

4G Calling also offers the ability to seamlessly move between that and Wi-Fi Calling, without the call cutting out, so if you move away from one signal type you can continue on the other.

### Video calling

It’s also theoretically possible to make video calls over 4G, much like a Skype call, except you’d just use your mobile number and be able to use the regular dialer and call interface, so you can make and receive video calls from anyone else with VoLTE, rather than relying on separate accounts.

In fact you may have noticed that Skype and other existing video call services often seem to have superior audio quality to voice calls. That’s because like VoLTE they use more data as part of a similarly named VoIP system, so you can expect your voice calls to sound more like Skype calls when using VoLTE, but they won’t hit your battery life as much as Skype does.

Not only could video calls become native to the dialer, but other Rich Communication Services (or RCS’s) could as well, such as file transferring, real time language translation, and video voicemail, and there may be applications which haven’t even been thought up yet.

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## Fig. VOLTE.

**VOLTE Call Setup: -**

Voice over LTE (VoLTE) is the standard for voice call setup in LTE networks. When VoLTE is deployed, phones will not need to fallback to 3G for voice calls. VoLTE uses IMS signaling to setup voice calls. The following VoLTE call flow describes the IMS call setup and release. Voice over Long-Term Evolution (VoLTE) is a high-speed [wireless communication](https://en.wikipedia.org/wiki/Wireless_communication) standard for [mobile phones](https://en.wikipedia.org/wiki/Mobile_phone) and data terminals, including [Internet of things](https://en.wikipedia.org/wiki/Internet_of_things) (IoT) devices and wearables.

VoLTE has up to three times more voice and data capacity than older [3G](https://en.wikipedia.org/wiki/3G) [UMTS](https://en.wikipedia.org/wiki/UMTS_frequency_bands) and up to six times more than [2G](https://en.wikipedia.org/wiki/2G) [GSM](https://en.wikipedia.org/wiki/GSM). It uses less bandwidth because VoLTE's packet [headers](https://en.wikipedia.org/wiki/Header_(computing)) are smaller than those of unoptimized VoIP/LTE.[[1]](https://en.wikipedia.org/wiki/Voice_over_LTE#cite_note-elkin-1) VoLTE calls are usually charged at the same rate as other calls. To be able to make a VoLTE call, the device, its firmware, and the mobile telephone provider must all support the service in the area, and be able to work together. VoLTE has been marketed as [HD Voice](https://en.wikipedia.org/wiki/HD_Voice) by some carriers, but this is not the same

as the VoLTE standard. Beginning in August 2012, [MetroPCS](https://en.wikipedia.org/wiki/MetroPCS) launched the world's first commercial VoLTE services in [Dallas, Texas](https://en.wikipedia.org/wiki/Dallas,_Texas), in the [United States](https://en.wikipedia.org/wiki/United_States), alongside the first VoLTE phone, the LG Connect 4G.[[5]](https://en.wikipedia.org/wiki/Voice_over_LTE#cite_note-5) In May 2014, [Singtel](https://en.wikipedia.org/wiki/Singtel) introduced the world's first commercial "full-featured" VoLTE service in Singapore, only in combination with [Galaxy Note 3](https://en.wikipedia.org/wiki/Samsung_Galaxy_Note_3), it was subsequently expanded.[[6]](https://en.wikipedia.org/wiki/Voice_over_LTE#cite_note-VoLTE_Asia-6) In June 2014, [KT](https://en.wikipedia.org/wiki/KT_Corporation) showcased the world's first cross-border [roaming services](https://en.wikipedia.org/wiki/Roaming) based on Voice over LTE. The South Korean [operator](https://en.wikipedia.org/wiki/Mobile_network_operator) partnered with [China Mobile](https://en.wikipedia.org/wiki/China_Mobile) to develop VoLTE roaming services. Voice over LTE (VoLTE) is a digital packet technology that uses 4G LTE networks to route voice traffic and transmit data. This voice service is the standard for high-speed wireless communications in devices such as smart phones, data terminals, IoT devices and wearables.

* **LTE KPIs:-**

He most common KPIs which can be based on either network statistics or drive testing are random access setup success rate, call setup success rate (CSSR), evolved radio access bearer (E‐RAB) drop rate and intra‐LTE handover success rate. ... Key performance indicator (KPI) data provide candidate information required for effective network planning, performance analysis and optimization.

However, inadequate KPI data could limit efficient network planning leading to escalating operational cost, and this could adversely affect the subscribers of the network In this article, analysis of some selected KPIs of an operational 4G LTE network is presented. The tested KPIs include the RSRP, RSRQ, RSSI, SINR, PCC PHY DL Throughput, and the PDCP DL Throughput. These KPIs were measured at a 4G LTE frequency of 1876.6MHz with 10MHz bandwidth. 1 – Revenue per client/member (RPC) The most common, and probably the easiest KPI to track is Revenue Per Client – a measure of productivity. ...

We analyze three of the main KPI indicators: mobility, integrity and availability. The data obtained from the measurements and analysis show high performance of the 4G/LTE TK network. Key performance indicator (KPI) data provide candidate information required for effective network planning, performance analysis and optimization. However, inadequate KPI data could limit efficient network planning leading to escalating operational cost, and this could adversely affect the subscribers of the network. To this end, this article presents radio frequency (RF) measurements and evaluation of KPIs taken at 1876.6MHz with a bandwidth of 10MHz, for an operational 4G LTE network in Nigeria. The measurements campaign specifically examine the behavior of the RSRP, RSRQ, RSSI, SINR, PCC PHY DL Throughput, and the PDCP DL Throughput. Huawei Technologies Modem E392 was used for the propagation measurements, and RF measurements cover three evolved node base stations (eNodeBs) with average heights of 25 m. The geographical coordinates of the sites are as follows: Site 1 (Latitude 6.43543333; Longitude 3.44539667), Site 2 (Latitude 6.55639500; Longitude 3.36693333), and Site 3 (Latitude 6.51879500; Longitude 3.39911000). The E392 4G (LTE) Modem is capable of propagation measurements at the various LTE frequency bands, enables LTE download Speed of 100 Mbit/s, supports LTE upload Speed of 50 Mbit/s, utilizes LTE 2x2 MIMO (Multiple Input Multiple Output), and supports 64QAM (Quadrature Amplitude Modulation). The Drive Test (DT) Software version-Genex prove V16, and Genex Assistance V16 were deployed, and the test car carried a test terminal station, a GPS, a Windows supported Computer, and the accompanying drive test system.

**4.5G Specifications:-**

Pre5G or 4.5G is essentially LTE Advanced or LTE Advanced Pro. LTE-Advanced is essentially 4G with peak data rates to 1Gbps and latency under 10 milliseconds. LTE Advanced Pro has peak data rates over 3Gbps and latency under 5 milliseconds NEW DELHI: Telecom service providers next-generation leap has an apparent challenge staring at [4.5G](https://telecom.economictimes.indiatimes.com/tag/4.5g) technology-powered device ecosystem with low-to-mid tier smartphones lacking support for the newer technology.  
  
“Device availability is a biggest challenge today. We are doing everything on network side. Consumers wouldn’t benefit from standard bands or newer technology, and our investments may go waste,” a leading telco executive who do not wish to be named told Telecom.  
  
“We are going to the regulator and device ecosystem and asking them to work alongside and even ahead of us and bring necessary enhancements early,” he added.

The 4.[5G](https://telecom.economictimes.indiatimes.com/tag/5g) technology or LTE-Advanced Pro, is expected to play a crucial role in the transition from 4G to 5G with the Manoj Sinha-led telecom department making efforts for technology leapfrog. However, the existing ecosystem bottleneck may make newer technology adoption unexciting.  
  
India’s ace carrier [Bharti Airtel](https://telecom.economictimes.indiatimes.com/tag/bharti+airtel) has though commercially deployed 4.5G based on Massive MIMO technology on 2300 Mhz band spectrum in select regions including Bengaluru and Kolkata together with Chinese vendor Huawei while Vodafone Idea Limited (VIL) and Reliance [Jio](https://telecom.economictimes.indiatimes.com/tag/jio) are conducting pilots to commercially launch 4.5G soon.  
  
“We have added 4x4 Multiple-Input, Multiple-Output (MIMO) technology but it doesn't apparently support affordable smartphones available today. Network functionality should also be there in devices,” the person quoted above said.  
  
Incumbents, in a run up to the government-promoted fifth-generated or 5G technology field trials in 2019 and expected commercial deployments starting 2020 are, however, eyeing to deploy 4.5G technology before embracing 5G with full throttle.

## An executive at one of the top three mobile chipset makers said that the company has already done 4.5G proof-of-concepts with service providers and device vendors but there was an outward lack of enthusiasm among the latter. Queries to mobile handset lobby groups— Indian Cellular Association (ICA) and The Mobile Association(TMA) didn’t elicit any response. Device ecosystem readiness must be addressed before launching any new technology by telos, and it will be a key prerequisite if 4.5G were to target a mass market,” Deepak Kumar, Founder Analyst of B&M Nxt said. The availability of affordable 4.5G devices, Kumar said, would be vital for the market to take off and operators would need to work more closely with the device makers on the front. Singhal said that the commercial 4G networks are being upgraded to enable 4.5G capabilities worldwide, and it features higher downlink or 1 Gbps speed, improved efficiency and support for new use cases. Since 2017, various global original equipment makers have introduced smartphones in the premium category that support 4.5G technology, according to the London-based professional services firm.

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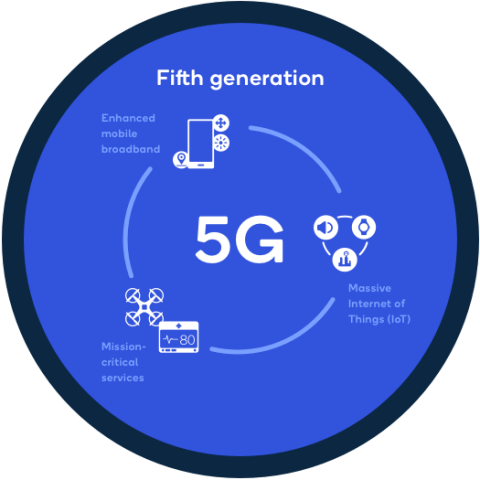
**5G Specifications :-**

5G is the 5th generation mobile network. It is a new global wireless standard after 1G, 2G, 3G, and 4G networks. 5G enables a new kind of network that is designed to connect virtually everyone and everything together including machines, objects, and devices.5G wireless technology is meant to deliver higher multi-Gbps peak data speeds, [ultra-low latency](https://www.qualcomm.com/news/onq/2019/05/13/how-5g-low-latency-improves-your-mobile-experiences), more reliability, massive network capacity, increased availability, and a more uniform user experience to more users. Higher performance and improved efficiency empower new user experiences and connects new industries.

* **First generation - 1G**  
  1980s: 1G delivered analog voice.
* **Second generation - 2G**  
  Early 1990s: 2G introduced digital voice (e.g. [CDMA](https://www.qualcomm.com/invention/stories/world-changing-technology)- Code Division Multiple Access).
* **Third generation - 3G**  
  Early 2000s: 3G brought mobile data (e.g. CDMA2000).
* **Fourth generation - 4G LTE**  
  2010s: 4G LTE ushered in the era of mobile broadband.

1G, 2G, 3G, and 4G all led to 5G, which is designed to provide more connectivity than was ever available before.5G is a unified, more capable air interface. It has been designed with an extended capacity to enable next-generation user experiences, empower new deployment models and deliver new services. With high speeds, superior reliability and negligible latency, 5G will expand the mobile ecosystem into new realms. 5G will impact every industry, making safer transportation, remote healthcare, precision agriculture, digitized logistics — and more — a reality speeds will range from ~50 Mbit/s to over a gigabit/s.[[21]](https://en.wikipedia.org/wiki/5G#cite_note-21) The fastest 5G is known as mm Wave. As of July 3, 2019, mm Wave had a top speed of 1.8 Gbit/s[[22]](https://en.wikipedia.org/wiki/5G#cite_note-auto-22) on AT&T's 5G network.

5G can be significantly faster than 4G, delivering up to 20 Gigabits-per-second (Gbps) peak data rates and 100+ Megabits-per-second (Mbps) average data rates. 5G has more capacity than 4G. 5G is designed to support a 100x increase in traffic capacity and network efficiency. 5G has lower latency than 4G.



**Actual Methodology Followed: -**

* + 1. First we make Proposal.
    2. Then we all group members will discuss about the topic.
    3. Then we search information about Different Wireless Network Technologies.
    4. Then we make report.
    5. Report was made by Tushar Bisen Achal Bante and Priya Mourya .

## Actual Resources used: -

|  |  |  |  |
| --- | --- | --- | --- |
| **S. No.** | **Name of Resources** | **Specifications** | **Qty.** |
| 01 | Computer System | Ram-4 Gb Processor-i3 8th Gen | 01 |
| 02 | Software | MS Word | ---- |

**Applications of Micro-Project: -**

* + An LTE Advanced base station installed in Iraq for provisioning of broadband wireless Internet service.
  + **5G Applications** in the Real World: With high capacity and ultra-low latency, **5G** will give artificial intelligence (AI) and IoT applications a major boost across a range of industries and use cases. Consumers will see changes including more immersive gaming and improved retail experiences.
  + High Speed Mobile Data Networks.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **S.No.** | **Detail of Activity** | **Planned Start date** | **Planned Finish date** | **Name of Responsible Team Members** |
| 01 | Making Report | 23-04-2021 | 26-04-2021 | Achal Bante |
| 01-05-2021 | 10-05-2021 | Priya Mourya |
| 11-05-2021 | 16-05-2021 | Tushar Bisen |

**References:-**

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* <https://www.researchgate.net/>
* <https://blog.3g4g.co.uk/>