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# Review on 5G over LTE

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***Abstract***

*The exponential growth of mobile data in macronetworks has driven the evolution of communications systems towards spectrally efficient, energy efficient, and fast local area communications. The mobile technology is an ever evolving concept. The world has seen various generations of mobile technology be it 1G, 2G, 3G or 4G. Here, an attempt has been made to provide a summary of evolution of mobile generations by comparing the standards, data rates, capacity, primary service, challenges and features provided by each generation and explaining how improvements have been made from earlier generation to the next one.The fifth generation of mobile technology i.e., 5G is seen as a futuristic notion that would help in solving the issues that are pertaining in the 4G. The main focus is on minimizing the latency of the application accounted different wireless and traffic characteristics.*

***Keywords:** 5G, technology, LTE, frequency band*

## INTRODUCTION

Mobile wireless communication networks have experienced a remarkable change in the recent years. The term mobile generation (G) generally refers to improvisation in the nature of the system, speed, technology, frequency, data capacity, latency, etc. Each generation has its standards, capacities and new features which differentiates it from the previous one. The first-generation mobile wireless communication network was analog in nature and was mainly used for voice calls only. The next generation 2G is a digital technology and a new feature called text messaging was introduced. Higher data rate, increased capacity and support for multimedia applications was implemented in the third-generation mobile technology. Later, the fourth generation (4G) integrated the features of 3G technology with fixed internet to support wireless mobile internet, to overcome the limitations of 3G. It also increases the bandwidth and reduces the cost of resources. 5G is the latest generation of cellular mobile communications. 5G promises to provide high data rate, better speeds, cost reduction, reduced latency and more coverage. 5G is 20 times faster than 4G. It has a minimum peak download speed of 20Gbps while 4G sits at just 1Gbps. Low latency is one of 5G's most important attributes and it is making the technology highly suitable for critical applications that require rapid responsiveness, such as remote vehicle control. It is observed that in 4G, latency varies from carrier to carrier and cell to cell. But with 5G, it takes less time for the signal to travel, which translates to low levels of latency. This highlights the fact that with 5G latency rates of under a millisecond is possible. Hence, 5G is approximately 60 to 120 times faster than 4G latencies.

## EVOLUTION OF 5G

Mobile wireless industry has started its technology creation, revolution and evolution since early 1970s. In the past few decades, mobile wireless technologies have experience 4 generations of technology revolution and evolution. 1G

emerged in early 1980s. It contains analogy system and popularly known as cell phones. It was basically used for phone calls. There was no facility of sending text or data transfer. It wasn't suitable for longer distance communication as it used small bandwidth which caused signal to become weak and noisy. 2G will arguably remain the breakthrough moment in the chronology of cellular wireless networking and telecommunications. It emerged in late 1980s and used digital signals for voice transmission and. It provides facility of SMS (Short Message Service) and uses the bandwidth of 30 to 200 KHz with speed of 64 kbps. After 2G, 2.5G system used GPRS, after which it was further evolved to EDGE networks with the introduction of 8PSK encoding. The symbol rate in EDGE remained the same as 270.833 samples per second, but each symbol carries 3 bits instead of one. Standard GSM was added with new extensions like GSM Evolution (EDGE), Enhanced GPRS (EGPRS), or IMT Single Carrier (IMT-SC) for Enhanced Data rates which improves data transmission rates. The third generation (3G) standards were created next. Again, multiple standards were developed, notably WCDMA by the 3GPP (The third generation partnership project) and cdma2000 by Qualcomm. Both have survived and are still used today. WCDMA was upgraded to HSPA, and cdma2000 was expanded with 1xRTT EV-DO releases A and B. Both are still widely deployed. Later, Long-Term Evolution i.e., LTE was created as an upgrade to the 3G standards. The cellular industry recognized its major as the next generation. LTE is now being implemented by all cellular operators. As defined by 3GPP, LTE is known as 3.9G technology, but marketed as 4G. The original 4G is designated as LTE-A. 5G refers to fifth generation which began from the late 2010s. Facilities that might be seen with 5G technology includes far better levels of connectivity and coverage benefits, and virtually every mobile carrier has embraced it. The main focus of 5G will be on world-wireless World Wide Web (WWWW). It is expected that 5G will have no limitation regarding speed, bandwidth with complete wireless communication architecture. The main features of 5G are:

- 5G highly supports to wireless World Wide Web (WWWW).
- 5G is more capable of providing high speeds and capacities.
- 5G provides a large broadcasting of data that is in gigabits per second.
- 5G provides faster bandwidths for services multi-media newspapers, online TV programs with high clarity (HD Clarity).
- Overall faster communication speeds than the previous generations.
- 5G also provides larger phone memory, dialling speed, clarity in audio/video.

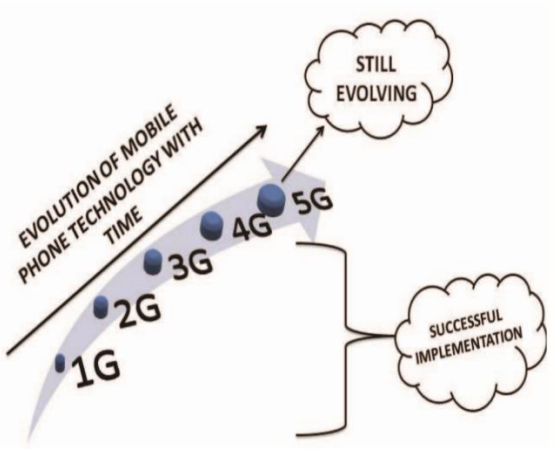


***Figure 1:*** *Evolution of mobile technology with time. [1].*

## CONCEPT OF 5G

The concept of 5G is based on the notions of a very high throughput speed network. 5G is expected to provide artificial intelligence capabilities to our handheld devices. 5G would also be having the support for:

1. Network local multi point distribution service.
2. Orthogonal frequency division multiplexing.
3. High altitude stratospheric platform station system.
4. Multifunctional services.

The basic architectural framework of 5G would look like as described in Fig. 2. The architecture of 5G would be incorporating the supports for very high resolution for smartphones and would also offer very large bandwidth.

The three basic servers installed are:

A. Cloud Server
B. Application Server
C. Data Server

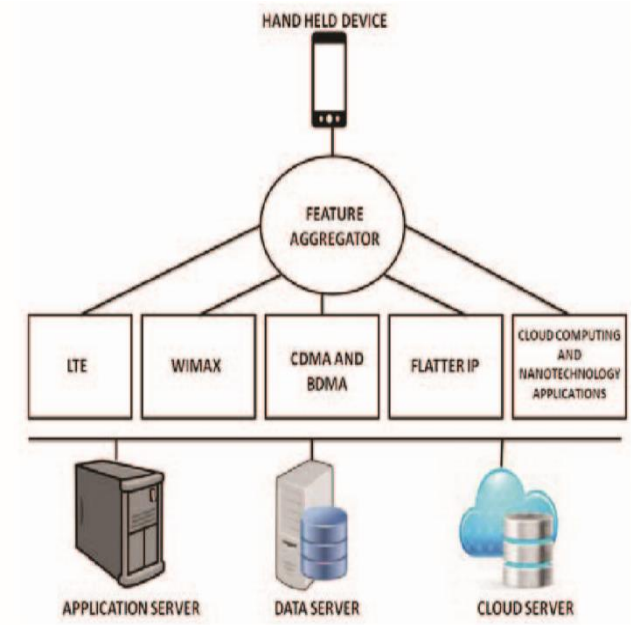


***Figure 2:*** *Futuristic architectural framework of 5G [2].*

The cloud server, application server and data server would be connected to the various features/components such as:

1. Wi-max
2. LTE
3. Cloud computing applications
4. Nanotechnology applications
5. CDMA and BDMA
6. Flatter IP network

These features are aggregated with the help of a feature aggregator. The feature aggregator is in turn connected to the hand-held devices (smartphones) to provide 5G capabilities.

## NR CELL SELECTION

An NR cell can be considered as a logical entity that consists of one or multiple transient receptor potential (TRP)s. For example, in a dense urban network, an NR cell can consist of many TRPs. As the user equipment (UE) moves, the network side determines a new optimal serving TRP set that follows the UE. The flexibly optimized serving TRP set can be transparent to the UE. Therefore, in order to provide a cell-centre-like experience for a UE, there should not be a rigid association with TRPs in the network. An NR cell can be used for providing synchronization signals and broadcast information, as well as assisting UE's initial access and inter-cell mobility [3].

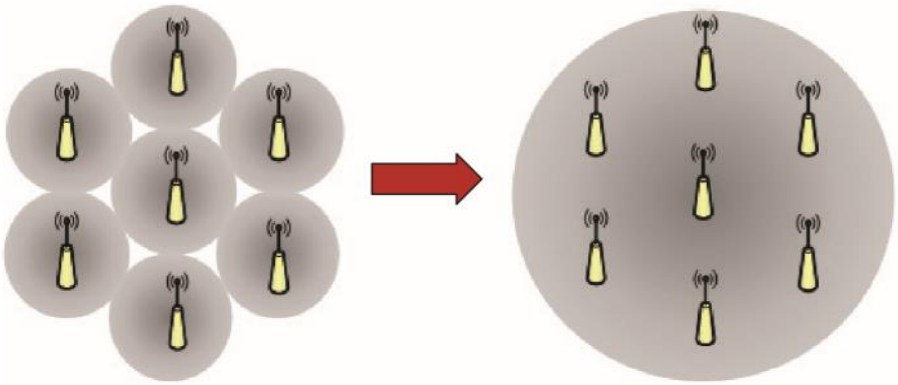

***Figure 3:*** *An NR cell can be configured to consist of single TRP (left) or many TRPs (right) depending on the deployment scenario.*

## COMPARISON OF 4G AND 5G

### Speed

For the business applications like video conferencing and cloud computing, LTE (4G) technology provides additional speed boost as it is very much important. 4G also allows for cost-effective, stable international calls on data calling services, such as Skype, even at peak times [7].

But in 5G, the communications will become tremendously fast that it almost becomes real-time providing mobile internet services for the sake of office services. As said by the Chinese tech giants Huawei, who initiated the research on 5G at first said that 5G technology will allow the mobile services to connect to any network or devices at any time anywhere, from people and communities to physical things, processes, content, working knowledge, timely pertinent information and goods of all sorts in entirely flexible, reliable and secure ways [7].

To give a picture of just how fast 5G will be, Huawei practically estimates the values that the download time for an eight gigabyte HD movie will be just six seconds, compared with seven minutes over 4G and over an hour with 3G.

### Stability and Portability

Greater network ability is ensured by 5G that help business critical mobile functions not to go offline and provide necessary speed to give employees a fully equipped virtual office anywhere. In the near future, 5G can be proven to be a cost-effective alternative to the fixed-line services like broadband services. Mobile data could prove to be the answer for businesses that operate outside the reach of broadband networks or suffer from slow fixed-line service. Because the cost of putting up mobile data masts is far lower than installing fibre optic cables, operators may well decide that 5G is speedy enough to be used to reach rural areas as an alternative to fixed lines [7].

### Latency

Nokia believes 5G will be a system that provides a "scalable and flexible service experience with virtually zero latency" – latency being the time needed for a packet of data to move across a network or series of networks. Combined with the anticipated growth of the internet of things (IoT) over the next decade, this means a more connected world of instantaneous information is just around the corner; industry experts predict 50 billion devices will be "connected" by 2020 [8].

### Broader Frequency Bands

Right now, 4G LTE technology is only capable of using lower frequency bands. Right now, it can only operate up to 6GHz, whereas the radio bands that 5G will be

able to handle anywhere between 30GHz and 300GHz. It's a huge upgrade, and it will bring huge improvements to mobile device use. Since it can operate at such a high frequency, consumers will get massive speed increases, and this is because it has the support for a huge capacity of data. In addition, because of the way 5G uses wavelengths, it will be able to provide super-fast data speeds to a lot more people. Current testing and research show that it will be able to handle up to an additional 1,000 devices per meter. That's a ton of extra devices it can handle [8].

**Information Security**

LTE is one of the most used standards for high speed wireless communication as far as the mobile phone devices are being concerned. Considering the MAC layer of the network architecture of 4G systems, LTE suffers from major security hurdles. These include unauthenticated user making use of the hand-held device, faulty geographical location tracking, denial of service attacks and data modification. 5G is more than just a technology. The 5G mobile technology is still evolving and hence there is a lot of scope for incorporating the security factors in its framework. The drivers have only been concentrating on the latency and throughput factors but we can modify them to provide better support for user's authentication. These drivers can be grouped into categories according to their use and then their privacy policies can be re defined. Other factors that can be added to it are the development of new security models for the delivery of a particular service. Since cloud computing forms a part of the 5G framework hence its privacy will also be maintained [8].

**LATENCY**

In recent years, we have seen numerous efforts in realizing the next generation of mobile wireless networks (i.e., 5G), which promisingly provides a new infrastructure for various use cases and emerging applications. To support the 5G KPIs (e.g., very high throughput or extremely low latency, etc.) as well as the evolvability (i.e., on the current 4G), not only the novel technologies for access and core

networks but also the new architectures are mandatory requirements. The recent release (i.e., release 15) of 3GPP, which is considerably the first 5G standard, specifies the non-standalone 5G NR (i.e., NSA 5G NR) [1], [2]. Notably, the 5G NR, which boosts through put and reduces latency in a small cell, will be anchored in an existing macro cell (i.e., LTE). With different carrier frequencies deployed at macro and small cell layers, the dual connectivity (DC) which allows a UE to simultaneously achieve data transmission on the both layers are promisingly a key technology.

***Table 1:*** *Differences between 4G (LTE) and 5G (NR).*

| **Parameters** | **4G** | **5G** |
|---|---|---|
| Deployment | Deployed | Expected by 2020 |
| MIMO | Low Order | High Order |
| Multiplexing | CDMA | CDMA &BDMA |
| Core concepts utilized | Wi-max and LTE | WWWW |
| Data Transmission speed | Medium to High | Very High |
| Resolution | High | Very High |

The dual connectivity is not totally a new concept. In fact, DC has been standardized in release 12 of 3GPP as a solution for efficient co-operation and integration of the macro and small cells. DC aims to improve user throughput performance by utilizing radio resources of two eNBs [3]. However, DC has not been widely

deployed in the current 4G LTE (i.e., probably due to the unpopularity of small cell in 4G). In the near future, the appearance of 5G NR served by the next generation eNB (i.e. gNB), as well as, the expected evolvability on the existing infrastructure (i.e., the current LTE networks), DC is going to be mandatory [4], [6]. In the 5G network, the macro cell serves the coverage for UEs while the small cell supports high throughput, low latency. Besides, the advanced transport layer protocol such as Multipath TCP can be deployed on top of the DC-enabled network to bring the benefit of DC to Internet applications (i.e. TCP/IP). The application data can be transmitted over different connections concurrently, potentially enhancing throughput and resilience. This paper focuses on the problem of concurrent transmissions over the eNB and gNB that exploits the DC benefit in the 5G small cell. The challenge arising from this scenario is minimizing the overall end-to-end delay since each connectivity has different wireless channel states and other network parameters (e.g., background traffic). Note that, the diverse conditions may degrade the performance gain achieved by the concurrent transmissions (e.g., the popular TCP protocol may incur the out-of-order issue.

## CONCLUSION

The expansion of mobile wireless communication is rapidly improving. 5G technology, although complex, is going to be a new mobile revolution in the world of wireless communications. Many new techniques and technologies that will be used in the new 5G cellular or mobile telecommunications system are still being developed and the overall standards are yet to be defined. However, as they develop, they will be incorporated into the new system and will be defined by the standard bodies. The strive to make a reduction in the number of technologies to a single global standard that is 5G, is in progress and hence is the goal. The work has already been in progress and may lead to 5G's commercial availability in the coming years. Attempts are made to become completely wireless, with high speed, increased bandwidth and reduction in cost and demanding uninterrupted access to information anytime and anywhere with better quality.

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