

# 4G: The Future Mobile Technology and its Implementation in Cars

Pranav Sharda<sup>1</sup>

<sup>1</sup>Department of Electronics and Communication, GNDU, Regional Campus, Gurdaspur, India

<sup>1</sup>shardapranav73@gmail.com

**Abstract**— The prime objective of this paper is to provide the thorough understanding of the fourth generation(4G) technology along with its implementation aspect. Initially the concept of 4G has been discussed and afterwards the implementation of 4G in cars is taken up. The main focus is on the real time features that are offered by 4G and how those features could be realized in the design of a 4G based LTE connected car. Amongst all the cellular generations observed so far 4G has differentiated itself from others on the basis of its unbelievable features and reliability

**Keywords**— 4G, OFDM, MIMO, LTE.

## I. INTRODUCTION

The term 4G is used broadly to include several types of broadband wireless access communication systems. 4G is basically described as a MAGIC—Mobile multimedia, anytime anywhere, Global mobility support, integrated wireless solution, and customized personal service. The future 4G infrastructures will consist of a set of various networks using Internet Protocol(IP) as a common protocol so that users are in control because they will be able to choose every application and environment. Based on the developing trends of mobile communication, 4G will have broader bandwidth, higher data rate, and smoother and quicker handoff and will focus on ensuring seamless service across a multitude of wireless systems and networks [1],[7]. The key concept is integrating the 4G capabilities with all of the existing mobile technologies through advanced technologies. Application adaptability and being highly dynamic are the main features of 4G services of interest

## II. SERVICES OFFERED BY 4G

*Wi-Fi hotspot:* The hotspot supports up to eight devices on LTE network, which consistently has a stronger signal than iPhone.

*Weather Forecast:* This may be more valuable on long trips or in places where dramatic weather changes quickly occur

*Picture navigation:* Select a picture from hundreds of images or a smartphone picture, and the application sends the address to the navigation system, which then guides you there.

*Personalized news:* As with other included infotainment services when you reach a complete stop, you can read a full screen. This might be useful to pass time while parked and waiting, but do not try it in stop-and-go traffic. Then again, if you're parked and waiting, you will probably be able to find what you're looking for faster on your smartphone.

*Fuel prices:* The system displays the lowest nearby gas station prices, then guides you to the station you select. Moreover, when you are in an unknown area, there is an on-screen alert that tells you when fuel is low, then guides you to the closest gas station.

*Parking:* This helps you find open parking spaces and lots which can be very helpful in an unfamiliar place. The application also includes a Car Finder, which tells you the last place you left your car and how long it's been there and guides you back to your vehicle on a map [2],[8],[9].

## III. KEY 4G TECHNOLOGIES

### A. Orthogonal Frequency Division Multiplexing

Orthogonal Frequency Division Multiplexing (OFDM) is a multicarrier modulation technique in which a single high data rate bit stream is divided into number of parallel lower data rate streams and each is modulated onto a separate sub-carrier. OFDM not only provides clear advantages for physical layer performance but also enables to exploit the time domain, the space domain, the frequency domain and even the code domain to optimize radio channel usage[3]. It is also compatible with other enhancement Technologies, such as smart antennas and multiple-input and multiple-output(MIMO) radar antenna. OFDM modulation can also be employed as a multiple access technology i.e. Orthogonal Frequency Division Multiple Access. In this case, each OFDM symbol can transmit information to/from several users using a different set of sub carriers (sub channels).



### B. Software Defined Radio

Software Defined Radio (SDR) benefits from today's high processing power to develop multi-band, multi-standard base stations and terminals. Several infrastructure gains are expected from SDR. For example, to increase network capacity at a specific time (e.g. during a sports event), an operator will reconfigure its network adding several modems at a given Base Transceiver Station (BTS) [4]. SDR makes this reconfiguration easy. In the context of 4G systems, SDR will become an enabler for the aggregation of multi-standard pico/micro cells. SDR enables:

- New features and capabilities to be added to existing infrastructure without requiring major new capital expenditures.
- The use of a common radio platform for multiple markets, significantly reducing logistical support.

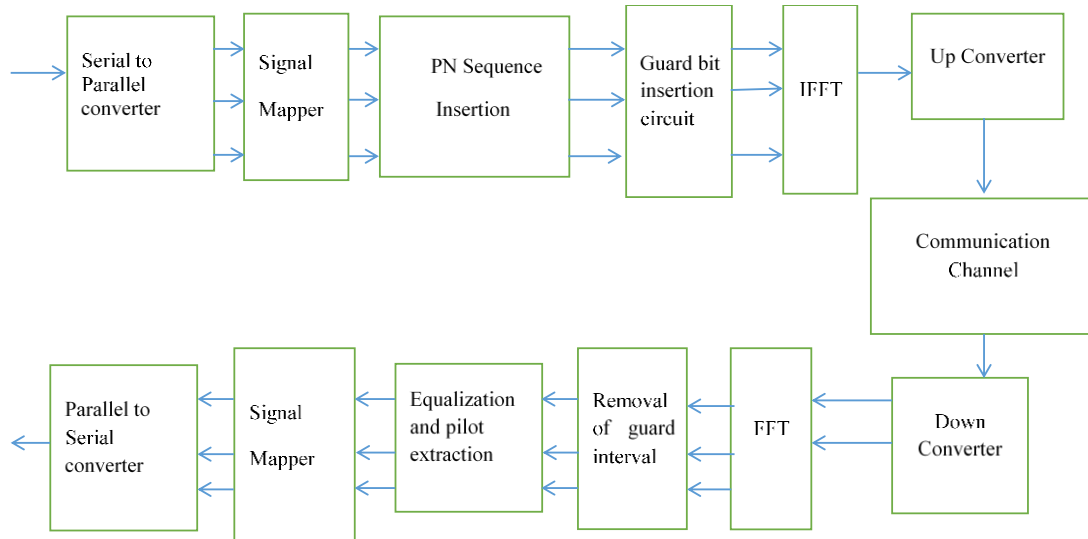
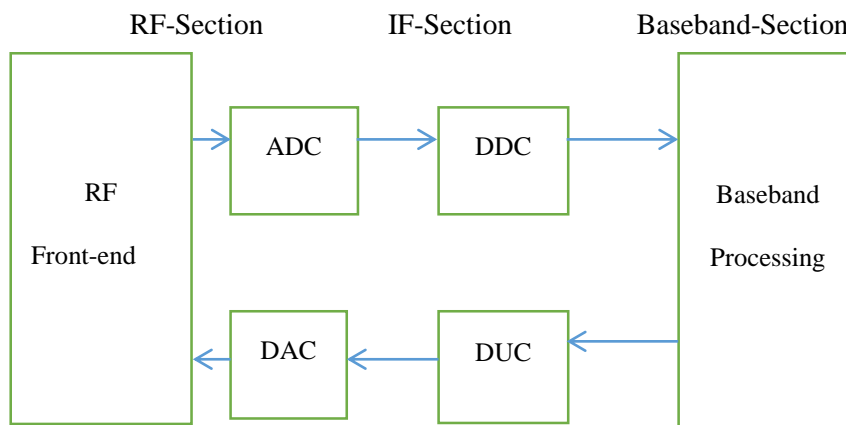


Fig.1 OFDM Transceiver Block Diagram



ADC-Analog to Digital Converter  
 DDC-Digital Down Converter  
 DUC-Digital Up Converter  
 DAC-Digital to Analog Converter

Fig.2 An Ideal Software Radio Receiver

### C. Multiple-Input-Multiple Output

Multiple-input-Multiple Output (MIMO) uses signal multiplexing between multiple transmitting antennas (space multiplex) and time or frequency. It is well suited to OFDM, as it is possible to process independent time symbols as soon as the OFDM waveform is correctly designed for the channel. This aspect of OFDM greatly simplifies processing [4]. The signal transmitted by  $m$  antennas is received by  $n$  antennas. In principle, MIMO is more efficient when many multiple path signals are received.



#### IV. IMPLEMENTATION OF 4G IN CARS

Suppose we want to Implement 4g in cars and desire to get the multimedia applications. This can be done with the concept of Long Term Evolution(LTE). Let us have a view of LTE concept, services offered by a LTE connected car and the design methodology for a LTE connected car.

##### A. Concept of LTE

LTE is popularly called a 4G technology. It is an all-IP technology based on orthogonal frequency-division multiplexing (OFDM), which is more spectrally efficient — meaning it can deliver more bits per Hertz. The LTE standard has been defined with as much flexibility as possible so that operators can deploy it in all current existing frequencies as well as new spectrum [5] [6]. Operators can deploy the technology in as little as 1.4 MHz or as much as 20 MHz of spectrum and grow the network as demand for data services grows. LTE will also appear in a number of different spectrum bands around the world, including the new 2.6 GHz band, which is perfect as a capacity band LTE can also be deployed in reframed GSM bands in 900 MHz and 1800 MHz with improvements in capacity, speed, and latency. LTE will not only make accessing applications faster, but will enable a wealth of new applications previously available only on a wired Internet connection. The wall between wired and wireless will come down. [10] [12]

##### B. Services offered by a LTE Connected Car

*Video on demand:* An endless catalog of video content, including movies, recorded TV programs and user-generated content. New content can be rented or purchased in-car for media playback there or paused and finished at home.

*Gaming:* Multi-player games can be played within the vehicle or with players anywhere in the world.

*Audio Library:* An endless music catalog is accessible from the cloud.

*Home Control:* Direct connection from the concept car to home automation and security systems to manage climate control systems, lighting, etc. or monitor home or business IP security cameras with streaming video feeds.

*Enhanced communications services:* Calls and messaging services with a hands-free experience and access to social networks available to anyone in the car.

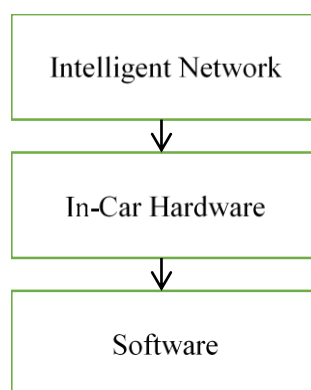
*E-Commerce:* Web browsing and access to one of the many applications to buy right from the car [5] [6] [11].

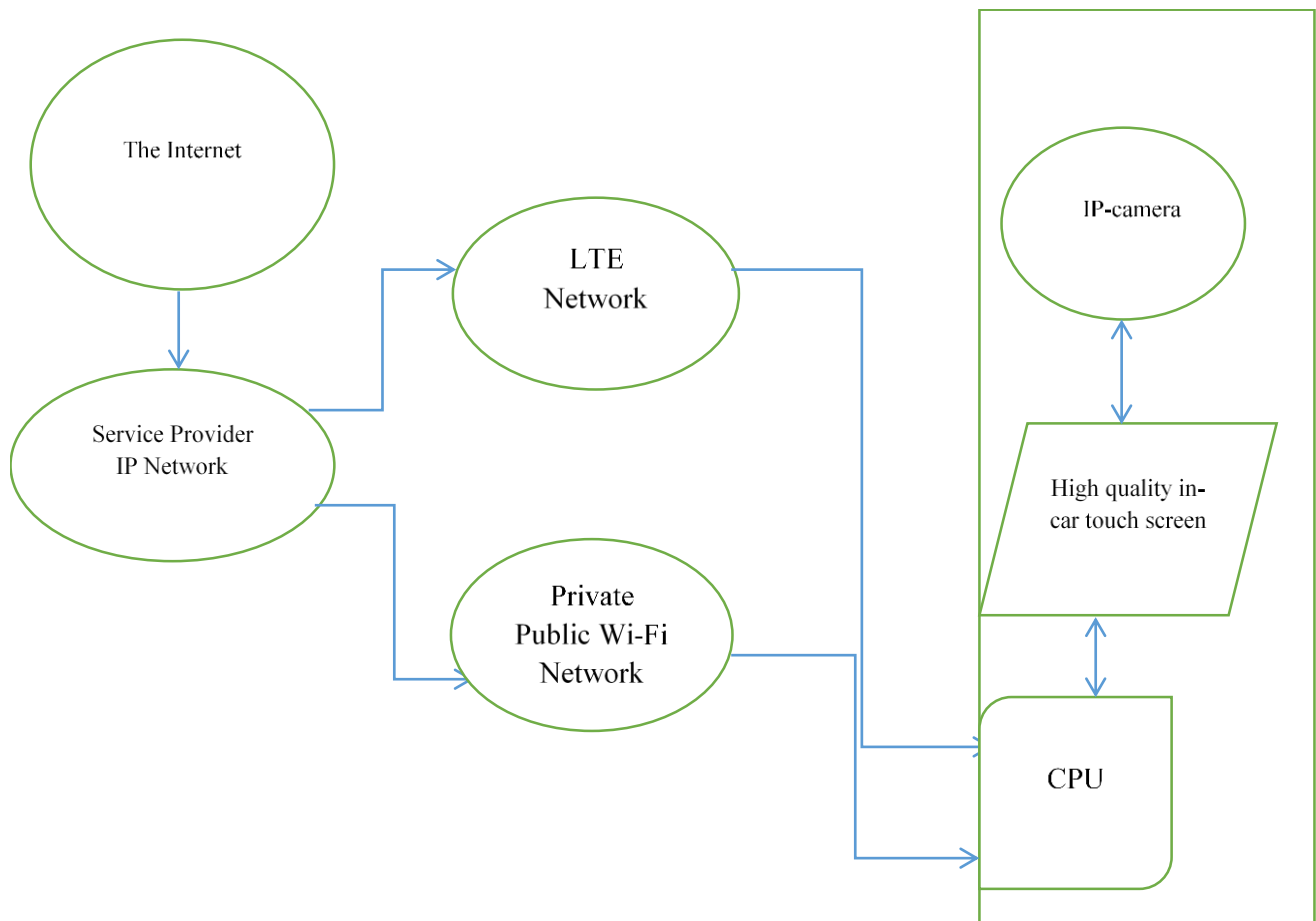
##### C. Design of a LTE Connected Car

The design of a LTE connected car can be realized with the design methodology shown below. Firstly, the connectivity has to be initiated from a cloud computing network i.e. the Internet. And from the internet we can have access to various multimedia applications such as audio, video-streaming and gaming etc.

Further a dedicated connection has to be provided by the service provider to a user inside the LTE connected car in order to access all the online available services. This service provider IP network is connected to the internet and also to the LTE network and private/public Wi-Fi Network. The use of the LTE network is to provide the online services at a faster rate and efficiently. The CPU inside the LTE connected car performs processing of the various received signals from the LTE network and the delivers the features demanded by the user sitting inside the car. With the help of IP-camera inside the car, the monitoring could be done on the high quality in-car touch screen such as watching an online movie or online gaming could also be done.

##### D. Flowchart for the design of a LTE Connected Car





*LTE Connected Car*

*Fig.3 Intelligent network + in-car hardware + software=LTE Connected Car*

## V. CONCLUSION

This paper presented how 4G technology can be implemented in cars. This technology enables us to incorporate existing technologies such as cloud computing with the 4G technology. The design models to make this implementation possible have been included in this paper. While this technology is evolving speedily, it would still take its time to emerge as the most popular network. Mobile carriers and users interested in investing in 4G would do well to analyze and understand its pros and cons before adopting this new technology.

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