Convergence of LTE-A and DSRC Infrastructure for Intelligent Transportation System

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Abstract: In this paper, we focus on the design of similar physical layer for communication between DSRC(Dedicated short range Communication) and 4G-LTE-A. In LTE-A /DSRC communication, physical layer design which involves all the processing performed on peak data rates (1Gbps for low mobility and 100Mbps for high mobility) of about 1000 times above than the 2G and 3G standards. By using these enabling technologies, we can combine IEEE 802.11P (DSRC) vehicular safety standards and LTE-Advanced (Rel 10) to achieve such a performance of Intelligent transportation system(ITS).

Keywords:- 4G LTE-A, DSRC, IEEE 802.11p, ITS.

I. INTRODUCTION

In this paper we will analyze the LTE mobile communication standard, and particularly it’s Physical Layer, in order to accomplish the mathematical foundation of empowering LTE advanced technologies. Such as Orthogonal Frequency Division Multiplexing (OFDM) and Multiple Input Multiple Output (MIMO), to its attain to achieve a optimized performance.

In the empowering technologies of the LTE advanced standard with the joint signal processing of OFDM and MIMO is to achieve a better performance in Vehicular Communication. In point of interest to make models in MATLAB especially in physical layer of LTE PHY focused around these.

As a result of convergence of two different techniques is to provide the optimized data rates, improved coverage, improved spectral efficiency, minimum operating cost, low latency, multi user connectivity and significantly seamless integration of vehicular communication and LTE.

The evolution of 4G LTE mobile technology can be considered an evolution of existing third generation standards(3G). The evolution of wireless communication started from 1G is shown in figure 1.
In Figure 2. Describes the LTE-A working architecture and Those three evolved components are to enhance the overall system performances which includes peak data rates, low latency, improved coverage, multiple antenna support and seamless integration with 3G UMTS and WiMax.

In this paper, authors reviewed some of the latest trends in communication research as well as theoretical and mathematical considerations related to integration of Physical layer (PHY) design for such combined system. In LTE PHY layer is integrated with OFDM and MIMO technologies. The details of LTE-A physical layer is shown in figure 3.

III. DSRC FOR VEHICULAR COMMUNICATION

DSRC is one-way or two-way short- to medium-range wireless communication and it works with 5.9 GHz RF frequency. DSRC supports 1000 m range with vehicle speeds up to 120 mph. DSRC, which provides point-to-point communication has two modes of operations:

a. Ad hoc mode characterized by distributed multi-hop networking (vehicle-vehicle),

b. Infrastructure mode characterized by a centralized mobile single hop network (vehicle-gateway).

In 1999, the United states FCC Federal Communication Commission allocated at 5.9 GHz of 75MHz spectrum bandwidth for DSRC system which can be involved in vehicle-to-vehicle (V2V) and vehicle-to-roadside(V2R) communications. The DSRC channel structures are shown in figure 4[2,3,4,5,6,7]. The first channel of DSRC having 5 MHz transmission capacity is held. This held channel approximately 5.850 – 5.855 GHz can be utilized for other purpose which includes Spread Spectrum(SS) based Digital RADAR Technology[8].

IV. LTE/DSRC COMMUNICATION SYSTEM PHYSICAL LAYER

To improve the network stability and minimize the control overhead of node handovers, Bases on the factors of vehicle parameters and the CH selection protocol will evaluate the speed and destination of vehicle. In this paper we proposed a new approach of convergence of DSRC and LTE-A technology for future ITS.

We assume that all vehicles are integrated with both 4G LTE-A and DSRC radios. For short range car to car (within 1 Km) communication can be established by DSRC techniques. DSRC unit installed on car ( DSRC mobile unit) can communicate with other car in ad hoc mode. The DSRC/LTE communication system architecture is shown in figure 4.
For long distance communication (above 50 Km), one Mobile Unit (MU) communicates another unit through Road Side Units (RSU). LTE access point is installed in RSUs. It Provides IP-Connectivity between User Equipment (On Board Unit) and E-UTRAN. It Corresponds Radio Access network and Core Network, which are acting as Base Stations (BS). MUs, RSUs can support both LTE as well DSRC system. The diagram of physical layer design on DSRC-LTE communication is shown in figure 6.

![Figure 6. Physical layer Design on LTE-A and DSRC](image)

Table 1. DSRC and LTE-A Parameters

<table>
<thead>
<tr>
<th>Feature</th>
<th>802.11p DSRC</th>
<th>LTE-A</th>
</tr>
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<tbody>
<tr>
<td>Channel width</td>
<td>10 MHz</td>
<td>Up to 100 MHz</td>
</tr>
<tr>
<td>Frequency band(s)</td>
<td>5.86-5.92 GHz</td>
<td>450 MHz-4.99 GHz</td>
</tr>
<tr>
<td>Bit rate</td>
<td>3-27 Mbps</td>
<td>Up to 1 Gbps</td>
</tr>
<tr>
<td>Range</td>
<td>Up to 1 km</td>
<td>Up to 50 km</td>
</tr>
<tr>
<td>Capacity</td>
<td>Medium</td>
<td>Very High</td>
</tr>
<tr>
<td>Coverage</td>
<td>Intermittent</td>
<td>Ubiquitous</td>
</tr>
<tr>
<td>Mobility support</td>
<td>Medium</td>
<td>Very high (up to 350 km/h)</td>
</tr>
<tr>
<td>QoS support</td>
<td>Enhanced Distributed Channel Access (EDCA)</td>
<td>QCI and bearer selection</td>
</tr>
<tr>
<td>Broadcast/ Multicast support</td>
<td>Native broadcast</td>
<td>Through eMBMS</td>
</tr>
<tr>
<td>V2I support</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>V2V support</td>
<td>Native (ad hoc)</td>
<td>Potentially, through D2D</td>
</tr>
</tbody>
</table>

![Figure 7. OFDM Frame Structure](image)

Fig. 8 illustrate the OFDM Bit error ratio (BER), Downlink and Uplink sub frame transmitted by multiple signal subcarriers to the road side unit base stations. DSRC and LTE eNb frame set is composed of more than one subcarriers by generating OFDM symbols. In order to support the multiple subcarriers for multiple access scheme is the fact of multiple vehicular communication simultaneously.

**V. IMPLEMENTATION AND RESULTS**

Authors have implemented OFDM frame structure shown in fig.7 of DSRC and LTE-A, and evaluated the performance by calculating Bit Error ratio (BER).

![Figure 8. OFDM Bit Error Ratio(BER)](image)

**VI. CONCLUSION**

The development and integration of this physical layer design of LTE and DSRC proposed the potential improvement of ITS to increased Coverage, Higher data rates and optimize QoS Performance in vehicular safety communication. Authors designed the physical layer to combine DSRC and LTE aims to provide a highly efficient, Low latency, packet optimization and more secure service of future intelligent transportation system.

**REFERENCES**


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