Enhancement of Information Rate in Wireless communication by LTE-Advance

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ABSTRACT
Long Term Evolution Advanced (LTE-Advanced) is the next step in LTE evolution and allows operators to improve network performance and service capabilities through smooth deployment of new techniques and technologies. LTE-Advanced uses some new features on top of the existing LTE standards to provide better user experience and higher throughputs. In this paper new methodology is adopted for enhancement in LTE advance for better result. In this paper a physical layer modeling is discussed for changing of the performance of the LTE.

Index Terms—LTE, LTE-Advance ,CRC, OFDM etc.

INTRODUCTION

We live in the era of a mobile data revolution. With the mass-market expansion of smartphones, tablets, notebooks, and laptop computers, users demand services and applications from mobile communication systems that go far beyond mere voice and telephony. The growth in data intensive mobile services and applications such as Web browsing, social networking, and music and video streaming has become a driving force for development of the next generation of wireless standards. As a result, new standards are being developed to provide the data rates and network capacity necessary to support worldwide delivery of these types of rich multimedia application.

LTE (Long Term Evolution) and LTE-Advanced have been developed to respond to the requirements of this era and to realize the goal of achieving global broadband mobile communications. The goals and objectives of this evolved system include higher radio access data rates, improved system capacity and coverage, flexible bandwidth operations, significantly improved spectral efficiency, low latency, reduced operating costs, multi-antenna support, and seamless integration with the Internet and existing mobile communication systems. In some ways, LTE and LTE-Advanced are representatives of what is known as a fourth generation wireless system and can be considered an organic evolution of the third-generation predecessors. On the other hand, in terms of their underlying transmission technology they represent a disruptive departure from the past and the dawn of what is to come. To put into context the evolution of mobile technology leading up to the introduction of the LTE standards, a short overview of the wireless standard history will now be presented. This overview intends to trace the origins of many enabling technologies of the LTE standards and to clarify some of their requirements, which are expressed in terms of improvements over earlier technologies.

II OVERVIEW OF WIRELESS STANDARDS

In the past two decades we have seen the introduction of various mobile standards, from 2G to 3G to the present 4G, and we expect the trend to continue (see Fig. 1). The primary mandate of the 2G standards was the support of mobile telephony and voice applications. The 3G standards marked the beginning of the packet-based data revolution and the support of Internet applications such as email, Web browsing, text messaging, and other client-server services. The 4G standards will feature all-IP packet-based networks and will support the explosive demand for bandwidth-hungry applications such as mobile video-on-demand services.

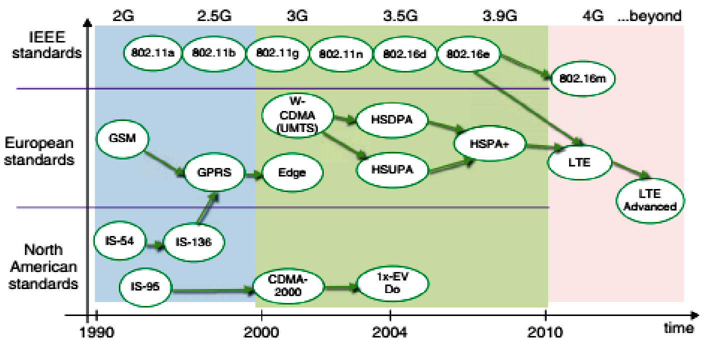


Figure 1 Evolution of wireless standards in the last two decades.

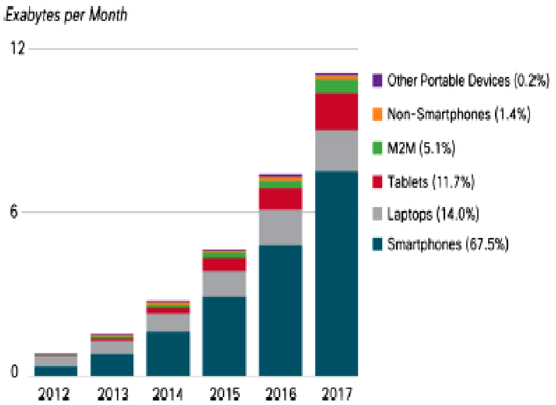


Figure 2. Mobile data traffic growth [1]

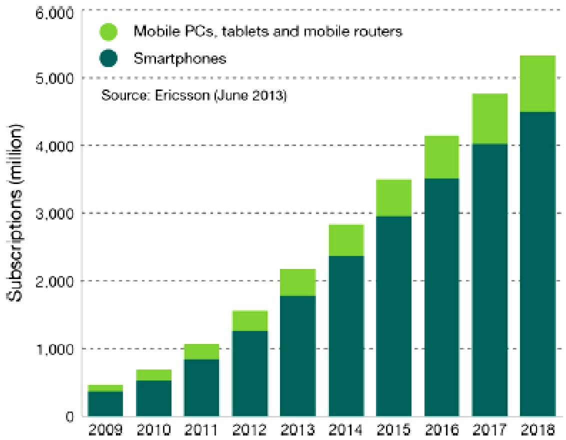


Figure 3. Subscriptions with cellular connection [2]

Wireless mobile data traffic has increased tremendously in the last few years and is expected to increase 13-fold between 2012 and 2017 [1].The leading driver for this increased growth of wireless data traffic, especially in cellular communications, is Smartphone as shown in Fig. 2 [1] and Fig. 3 [2]. This increasing demand is pushing the existing wireless mobile networks towards their limits, causing a reduction in data throughput, decreasing the availability of resources and increasing data transmission delay.

Long term evolution of 3G (LTE) is one of the strongest candidates proposed by the 3rd Generation Partnership Project (3GPP) for deploying globally as the next generation of wireless mobile networks (i.e. 4G). LTE has been the fastest developing mobile system to date and as of July 2014, 318 operators have commercially launched LTE systems worldwide [3]. The LTE expansions forecast illustrated in Fig. 3 [2] indicates that the LTE deployment trend will continue to increase in the coming years. LTE standardization was started in 3GPP release 8 with basic features such as Multiple Input Multiple Output (MIMO) support. The next release of LTE (i.e. release 9) did not introduce major changes in the radio capability of the LTE systems. Some complementary features, e.g. positioning and enhanced Multimedia Broadcast Messaging Service (MBMS) were enabled, but the offered data rates and capacity remained unchanged. In release 10 (also referred to as LTE-Advanced), significant modifications have been made in the radio capabilities and the peak and achievable data rates improved significantly.

LTE-Advanced is meant to fulfill the requirements of International Telecommunication Union-Radio communication sector (ITU-R) for International Mobile Telecommunication-Advanced (IMT-Advanced). The Key IMT-Advanced requirements are summarized as follows [4]:

- 100 Mbps and 1 Gbps peak data rates for high and low mobility cases respectively;
- Minimum 40MHz transmission bandwidth (and up to 100 MHz is under consideration);
- Interworking with other radio access technologies and systems;
- Enabling high quality mobile services;
- Capability of worldwide roaming;
- Up to 350 km/h mobility support;
- Voice Over IP (VoIP) capacity from 30 to 50 users/sector/MHz depending on the scenario;
- Spectral efficiency from 0.7 to 3 bits/Hz/cell depending on the scenario;
- Cell edge user spectral efficiency from 0.015 to 0.1 bps/Hz depending on the scenario;

Main features and techniques deployed in LTE-Advanced physical layer can be summarized as follows [5–13]:

- More transmission bandwidth using carrier aggregation (CA);
- Using more antennas and enhanced antenna techniques in the uplink and downlink transmission
- (MIMO enhancement);
- Cooperation between cells and coordinated multi point (CoMP) transmission and reception;
- Using small cells and relays;

MIMO is a key technology in wireless communications that has potential to increase the channel capacity by using multiple transmitter and receiver antennas. The term comes from the fact that the transmission antennas are handled as the input to the propagation channel (which is the air interface), whereas receiver antennas are the output of it. The very basic ideas behind MIMO were introduced in 1970 [14], but MIMO technology had not been deployed in wireless communications till 1990. This feature is currently used in IEEE 802.11n, 802.16d/e systems and supported by LTE release 8. It has already been deployed widely in LTE networks and further enhancements were proposed in release 10. In LTE-Advanced, Single User MIMO (SU-MIMO) is extended to support eight transmit antennas while in release 8, the maximum number of transmit antennas is four. In [15], performance evaluation of a single carrier LTE Advanced system using 8 by 8 MIMO and 20 MHz of bandwidth shows that in an indoor scenario the median throughput of 335 Mbps can be achieved. The eight transmit antennas at the base station can also be deployed in the transmission diversity scenarios [16]. General review of the multi antenna transmission techniques in 3GPP technologies from GSM to LTE-Advanced is presented in [17]. References [18-20] focus on MIMO techniques in LTE Advanced system. Furthermore, LTE-Advanced brings some enhancements of Multi User MIMO (MUMIMO). MU-MIMO can increase the network capacity, which is not achievable in SUMIMO systems [21]. Many studies on different aspects of LTE-Advanced MU-MIMO such as performance evaluation [22–28], interference and channel estimation [29–31], feedback and signaling design and improvement [32–35], scheduling [36–38], beam forming [39,40], techniques to improve the throughput [41], and its deployment alongside other LTE-Advanced features such as CA [42,43] and CoMP [44] have been done.

III OFDM FOR LTE-ADVANCE

OFDM is simply defined as a form of multi-carrier modulation where the carrier spacing is carefully selected so that each sub carrier is orthogonal to the other sub carriers. Two signals are orthogonal if their dot product is zero. Orthogonality can be achieved by carefully selecting carrier spacing, such as letting the carrier spacing be equal to the reciprocal of the useful symbol period. In complex baseband notation, a basic OFDM signal *x(t)* during the time interval $mT_u \le t < (m+1)T_u$ can thus be expressed as

$$x(t) = \sum_{k=0}^{N_c-1} x_k(t) = \sum_{k=0}^{N_c-1} a_k^{(m)} e^{j2\pi k\Delta ft} \qquad [1]$$

where $x_k(t)$ is the k^{th} modulated subcarrier with frequency $f_k = k \cdot \Delta f$ and $a_k^{(m)}$ is the, in general complex, modulation symbol applied to the k^{th} subcarrier during the m^{th}OFDM symbol interval, i.e. during the time interval $mT_u \le t < (m+1)T_u$ .OFDM transmission is thus block based, implying that, during each OFDM symbol interval, Nc modulation symbols are transmitted in parallel. The modulation symbols can be from any modulation alphabet, such as QPSK, 16QAM, or 64QAM.

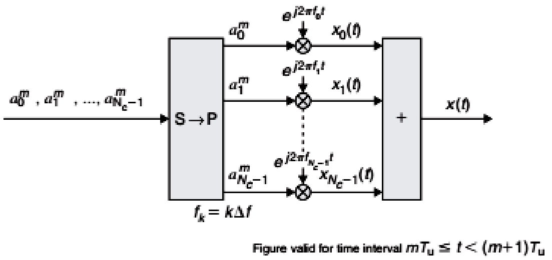


Figure 4. OFDM modulation for baseband of transmission

The term orthogonal Frequency Division Multiplex is due to the fact that two modulated OFDM subcarriers $x_{k1}(t)$ and $x_{k2}(t)$ are mutually orthogonal over the time interval $mT_u \le t < (m+1)T_u$, i.e

$$\int_{mT_u}^{(m+1)T_u} x_{k1}(t)x_{k2}^*(t)dt = \int_{mT_u}^{(m+1)T_u} a_{k1}a_{k2}^* e^{j2\pi k1\Delta ft} e^{-j2\pi k1\Delta f} dt = 0 \qquad [2]$$

For $k_1 \ne k_2$

Thus basic OFDM transmission can be seen as the modulation of a set of orthogonal $\varphi_k(t)$ where

$$\varphi_k(t) = \begin{cases} e^{j2\pi k1\Delta ft} & 0 \le t < T_u \\ 0 & otherwise \end{cases} \qquad [3]$$

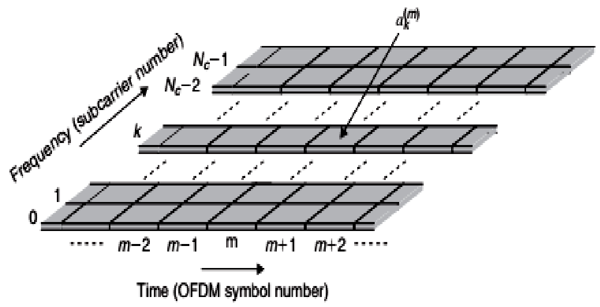


Figure 5. OFDM time-frequency grid

To confirm this, consider a time-discrete (sampled) OFDM signal where it is assumed that the sampling rate f_s is a multiple of the subcarrier spacing Δf , i.e. $f_s = 1/T_s = N \cdot \Delta f$. The parameter N should be chosen so that the sampling theorem is sufficiently fulfilled. As $N_c \cdot \Delta f$ can be seen as the nominal bandwidth of the OFDM signal, this implies that N should exceed N_c with a sufficient margin.

With these assumptions, the time-discrete OFDM signal can be expressed as:

$$x_n = x(nT_s) = \sum_{k=0}^{N_c-1} a_k e^{j2\pi k\Delta fnT_s} = \sum_{k=0}^{N_c-1} a_k e^{j2\pi kn/N} = \sum_{k=0}^{N_c-1} a_k' e^{j2\pi kn/N} \qquad [4]$$

Where,

$$a_k' = \begin{cases} a_k & 0 \le k < N_c \\ 0 & N_c \le k < N \end{cases} \qquad [5]$$

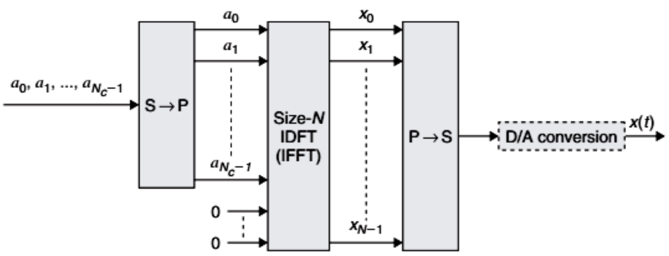


Figure 6. OFDM Modulation by means of IFFT processing

IV SIMULATION & RESULT

Figure7 illustrates the PHY model for the LTE downlink transmission. First, the data is multiplexed and encoded in a step known as Downlink Shared Channel processing (DLSCH). The DLSCH processing chain involves attaching a CRC code for error detection, segmenting the data into smaller chunks known as sub-blocks, undertaking channel-coding operations based on turbo coding for the user data, carrying out a rate-matching operation that selects the number of outputbits to reflect a desired coding rate, and finally reconstructing the code-blocks into code-words. The next phase of processing is known as physical downlink shared channel processing. In this phase, the codeword first become subject to a scrambling operation and then undergo a modulation mapping those results in a modulated symbol stream. The whole simulation is processed in the MATLAB environment.

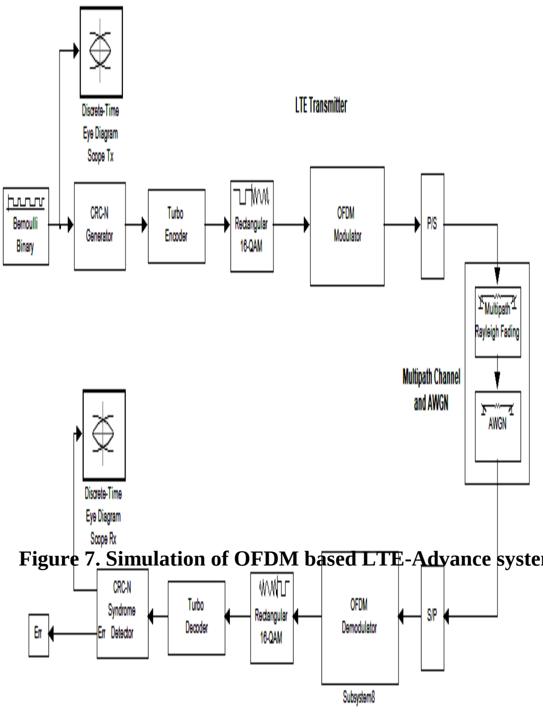
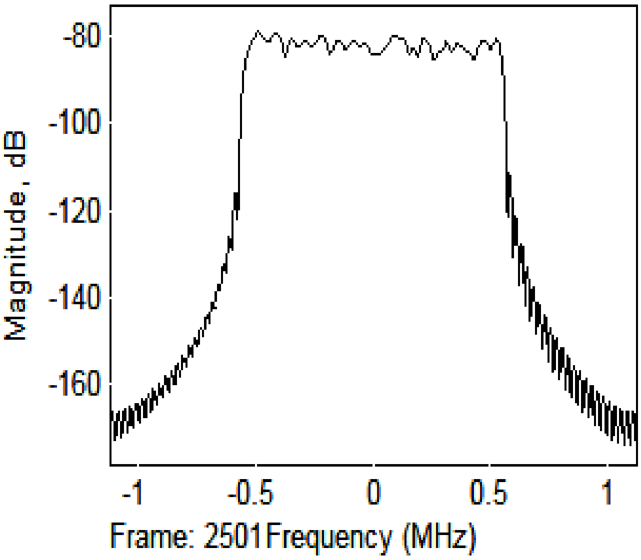
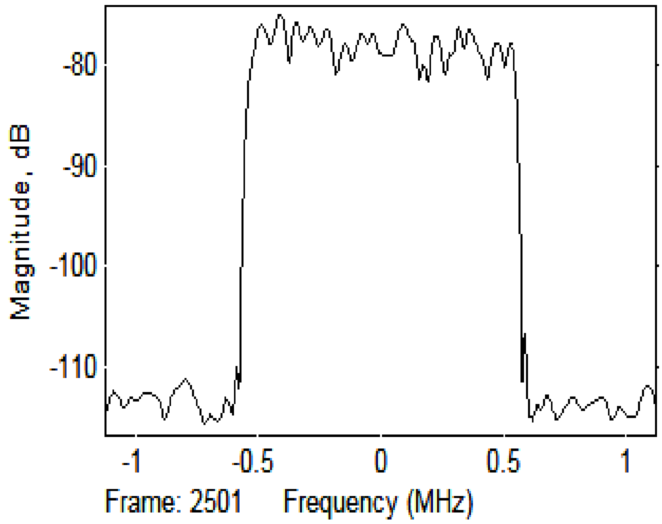


Figure 7. Simulation of OFDM based LTE-Advance system





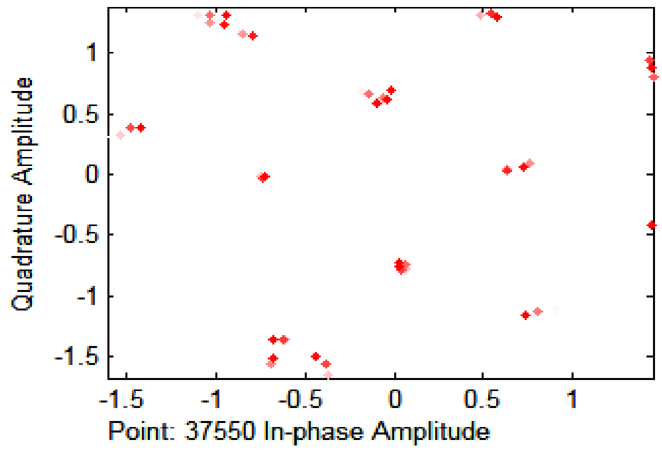


Figure 8 (a) Transmitted Signal of OFDM
(b) Received Signals after fading Receiver
Figure 9 (a) Scattering Plot of Received Signal without Channel Estimation
(b) Scattering Plot of Received Signal with Channel Estimation

Figure 8 and 9 shows the results generated by the LTE-Advance physical model.

V Conclusion

LTE (Long Term Evolution) and LTE-Advanced have been developed to respond to the requirements of this era and to realize the goal of achieving global broadband mobile communications. The goals and objectives of this evolved system include higher radio access data rates, improved system capacity and coverage, flexible bandwidth operations, significantly improved spectral efficiency, low latency, reduced operating costs, multi-antenna support, and seamless integration with the Internet and existing mobile communication systems. In this paper shows the physical modeling of the OFDM based LTE-Advance architecture. The result verified the maintaining of the orthogonality of the system with high data rate.

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