Research Paper Engineering

LTE and LTE Advanced

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ABSTRACT

Long Term Evolution (LTE) is the latest buzzword on everyone's lips, Long Term Evolution (LTE), commonly referred to as 4G or next generation wireless communications is the new standard for nationwide public safety broadband. but are you as conversant with the LTE architecture as you would like to be, or more importantly need to be? Would you like to find out more about LTE, but have little time to devote to it? If so, this paper will help get you up to speed in no time. Overview of the 3GPP Release 8 LTE network architecture and interfaces. This standard will allow access to digital technologies and deliver expanded capabilities to public safety practitioners in the field. LTE is the avenue for bringing public safety fully into the digital age.

Keywords : LTE, 4G, 3GPP, Digital Technologies

I. Introduction

In contrast to the circuit-switched model of previous cellular systems, Long Term Evolution (LTE) has been designed to support only packet-switched services. It aims to provide seamless Internet Protocol (IP) connectivity between user equipment (UE) and the packet data network (PDN), without any disruption to the end users' applications during mobility. The LTE standard supports fast speeds and holds great promise for first responders, yet there are limitations to using the associated technology in the public safety arena. The transition to LTE will not be as simple as flipping a switch. It will involve an extensive and complex build-out as well as an implementation process that will unfold over the years to come. It will require a great deal of coordination and adjustment among current public safety broadband users now operating across a patchwork of commercially and publicly supported networks on non-contiguous bands of spectrum.

2. ARCHITCTURE

In March 2005, a feasibility study on LTE was launched. The main focus of this Study was to decide what architecture the new system should have and what multiple access techniques were to be used. The LTE network architecture can be seen in Figure 2.1. The main conclusions drawn from the feasibility study [25.05] can be summarized in terms of requirements and targets as follows:

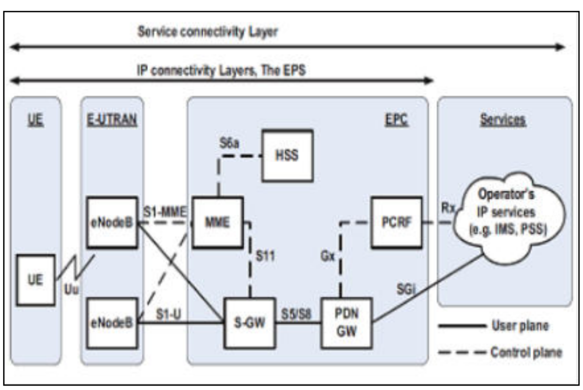

Figure 2.1 LTE Multiple Access Schemes

The multiple access schemes in LTE uses Orthogonal Frequency Division Multi Access (OFDMA) and uplink uses Single Carrier Frequency Division Multiple Access (SC-FDMA). These multiple access solutions provide orthogonally between the users, reducing the interference and improving the network capacity. The resource allocation in the frequency domain takes place with a resolution of 180 kHz resource blocks both in uplink and in downlink.

The frequency dimension in the packet scheduling is one reason for the high LTE capacity

3. SYSTEM REQUIREMENTS FOR LTE AND LTE-ADVANCED

Table 1 gives the system requirements for the Rel. 8 LTE. The Rel. 8 LTE supports scalable multiple transmission bandwidths including 1.4, 3, 5, 10, 15, and 20MHz. One of the most distinctive

Features is the support for only the packet-switching (PS) mode. Hence, all traffic flows including real-time service with a rigid delay requirement such as voice services is provided in the PS domain in a unified manner. The target peak data rate is 100 Mbps in the downlink and 50 Mbps in the uplink. The target values for the average or cell edge user throughput and spectrum efficiency are specified as relative improvements from those of High-Speed Downlink Packet Access (HSDPA) or High-Speed Uplink Packet Access (HSUPA) in the downlink and uplink, respectively. Here, the average cell spectral efficiency corresponds to capacity, and the cell edge user throughput is defined as the 5% value in the cumulative distribution function (CDF) of the user throughput. Both are very important requirements from the viewpoint of practical system performance in cellular environments. In particular, improvement in the cell-edge user throughput is requested to mitigate the unfair achievable performance between the vicinity of the cell site and cell edge. After extensive discussions in the 3GPP meetings, it was verified that the requirements and targets for the Rel. 8 LTE were achieved by the specified radio interface using the relevant techniques.

Table 1 Major System Requirement for Rel.8LTE[3]

Major System Requirement for Rel.8 LTE [3]

Bandwidth	Support of scalable bandwidths (1.4, 3, 5, 10, 15, and 20 MHz)	
Peak data rate	DL	100 Mbps
	UL	50 Mbps
Spectrum efficiency (vs. Rel. 6 HSDPA/HSUPA)	DL	3 – 4 times
	UL	2 – 3 times
User throughput (vs. Rel. 6 HSDPA/HSUPA)	DL	3 – 4 times (average) 2 – 3 times (cell edge)
	UL	2 – 3 times (average) 2 – 3 times (cell edge)

4. LONG TERM EVOLUTION STANDARD

Long Term Evolution „LTE" has become a widely known brand name for the 3GPP-defined successor technology of third-generation mobile systems. LTE stands for Long Term Evolution and originally denoted a work item in 3GPP aimed at developing a successor to the third-generation radio technology.

Gradually it came to denote first the new radio technology itself, then also encompassed the radio access network (→ EUTRAN), and is now also used for the entire system succeeding third generation mobile systems (→ SAE, →EPS) including also the evolved core network (→ EPC), as a quick search for the term LTE on the 3GPP home page [3GPP] will reveal. The 3GPP LTE also called release 8 specification defines the basic functionality of a new, high performance air interface providing high user data rates in combination with low latency based on MIMO, OFDMA and an optimized system architecture evolution (SAE) as main enablers [4].

5. KEY ENABLING TECHNOLOGIES AND FEATURE OF LTE

This paper provides technical information about two main LTE enabling technologies. The areas covered range from basic concepts to research grade material, including future directions. The three main LTE enabling technologies are:

5.1 LTE Downlink System Model

One of the key differences between 3G systems and LTE is the use of orthogonal frequency division multiplexing as shown in Figure 5.1, OFDM offers a lot of advantages first of all, by using a multiple carrier transmission technique, the symbol time can be made substantially longer than the channel delay spread, which reduces significantly or even removes the inter symbol interference (ISI). In other words, OFDM provides a high robustness against frequency selective fading. Secondly, due to its specific structure, OFDM allows for low complexity implementation by means of Fast Fourier Transform (FFT) processing. Thirdly, the access to the frequency domain (OFDMA) implies a high degree of freedom to the scheduler. Finally, it offers spectrum flexibility which facilitates a smooth evolution from already existing radio access technologies to LTE. In the frequency division duplexing (FDD) mode of LTE each OFDM symbol is transmitted over subcarriers of 15 or 7.5 kHz.

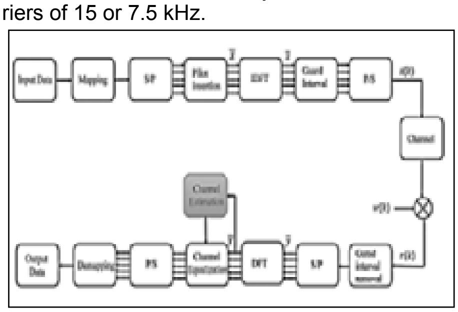

Figure 5.1 OFDM Base Band Systems

5.2 LTE Uplink System Model

An SC-FDMA uplink transmitter is shown in Figure 5.2; SC-FDMA is used rather than OFDM. SC-FDMA is also known as DFT-spread OFDM modulation. Basically, SC-FDMA is identical to OFDM unless an initial FFT is applied before the OFDM modulation. The objective of such modification is to reduce the peak to average power ratio, thus decreasing the power consumption in the user terminals [6].

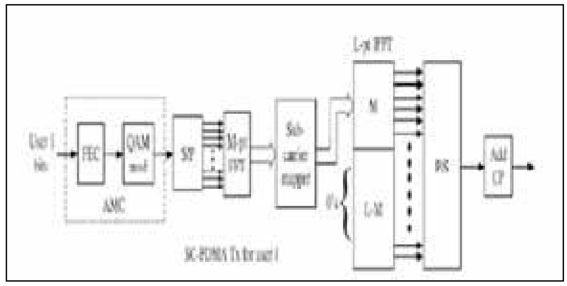

Figure 5.2 SC-FDMA uplink transmitter for user where user is allocated subcarriers 1,2,…….M of I Total Subcarriers

5.3 Multiple-Input Multiple-Output (MIMO)

The transmission diversity allows us to improve the link performance when the channel quality cannot be tracked at the transmitter which is the case for high mobility UEs. The transmission diverity is also useful for delay-sensitive services that cannot afford the delays introduced by channel-sensitive scheduling.

6. Future services over 4G networks

The high data rates coupled with service centric approaches in ensuring high QoS awareness, fast handoff techniques, wide area mobility etc pave the way for multiple innovative and high end services over the wireless Network infrastructure which were not possible before. Some of the services which were identified to be a true test of the success of these technologies can be listed as follows.a. Laptops, PDA's and fixed broadband services: The most intuitive set of services that can be provided are related to all the fixed wired DSL internet services that we have today, except that they shall be provided wireless and shall support mobility. Also with the strong QoS support in these technologies, the operators shall be allowed to plan business strategies on various sectors based on the average throughputs of that sector.

b. Premium VOD(Video On Demand)/MOD(Music On Demand) Services: With High data rates and differentiated QoS services operators can provide premium multimedia based services such as video - on-demand and music-on-demand to subscribers who wish to avail of such services. The selling point of such services would be superior quality coupled with ease of mobility.

c. Multimedia Upload and Exchange services: The high uplink data rates of UMB and LTE allow for multimedia upload and exchange services such as file sharing, mobile blogging, social networking etc.

d. Consumer Electronics: The high data rates combined with mobility of UMB and LTE shall also spur a growth in development of newer and better consumer electronic goods leveraging these advantages. Better gaming consoles, vehicular entertainment systems, portable multimedia players, digital cameras with network capabilities and the likes of such shall be introduced which shall add value to the technology.

e. Business Applications for Vertical Markets: LTE and UMB shall allow operators to provide services to vertical business markets through business applications like Video conferencing to enterprise customers, video surveillance services to homes etc. The gamut of services that can be provided through LTE and UMB are only restricted by one's imagination. The above mentioned categories only represent the tip of the ice-berg. The limitless applications that can be supported through a truly mobile broadband infrastructure adds value to such technology and encouragement towards the efforts.

7. SUMMARY AND DISCUSSION

Through this paper, a detail description is presented related to the technologies precedent to LTE technology (Release 8). According to the comparison of LTE with different existing technologies, LTE will provide wireless subscribers with significant advantages in traditional and nontraditional wireless communication over those currently provided via existing 3G technologies. LTE offers scalab l bandwidths, from 1.4 up to 20 MHz, together with support for both FDD paired and time division duplexing (TDD) unpaired spectrum. LTE will be available not only in the next-generation mobile phones, but also in notebooks, ultra-portables, cameras, camcorders, MBRs, and other devices that benefit from mobile broadband. While LTE Advanced helps in integrating the existing networks, new networks, services, and terminals to suit the escalating user demands. The technical features of LTE Advanced may be summarized with the word integration. LTE-Advanced will be standardized in the 3GPP specification Release 10 and will be designed to meet the 4G requirements as defined by ITU. LTE-Advanced as a system needs to take many features into consideration due to optimizations at each level which involve lots of complexity and challenging implementation. Numerous changes in the physical layer can be expected to support larger bandwidths with more flexible allocations and to make use of further enhanced antenna technologies. Coordinated base stations, scheduling, MIMO, interference management, and suppression will also require changes in the network architecture.

8. CONCLUSIONS

In conclusion, both LTE and LTE Advanced offer high speed access to internet, with high speed internet connection on mobile, where users can enjoy voice calls, video calls, and high speed downloads or uploads of any data and watch internet TV in live or on demand services. The main targets for this evolution are increased data rates, improved spectrum efficiency, improved coverage, reduced latency and packet optimized system that support multiple Radio Access Technologies. The paper has presented a study on evolution LTE toward LTE-Advanced in terms of LTE enabling technologies (Orthogonal Frequency Division Multiplexing (OFDM) and Multiple-Input Multiple- Output (MIMO)), also focused on LTE Advanced technologies (MIMO enhancements for LTE-Advanced, carrier aggregation, peak data rate, mobility and coordinated multi-point transmission (CoMP). LTE-Advanced is a very flexible and advanced system, further enhancements to exploit spectrum availability and advanced multi-antenna techniques.

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