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A Study on Long Term Evolution (LTE) Technology in Mobile Computing

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***Abstract:* -- Mobile computing is a technology that allows transmission of data, voice and video via a computer or without having to be connected to a fixed physical link.LTE refers to a standard for smooth and efficient transition toward more advanced leading-edge technologies to increase the capacity and speed of wireless data networks .LTE is often used to refer to wireless broadband or mobile network technologies.**

***Index Terms*—Long Term Evolution, LTR, wireless standards, Techniques & Technology, advantages**

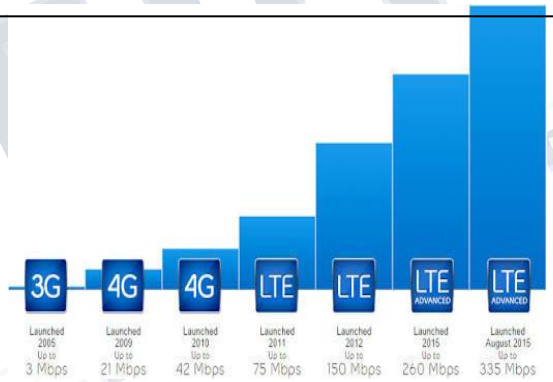
I. INTRODUCTION

Mobile computing technology is human computer interaction by which a computer is expected to be transported during normal usage, which allows for transmission of data, voice and video. Mobile computing involves mobile communication, mobile hardware, and mobile software. Communication issues include ad hoc networks and infrastructure networks as well as communication properties, protocols, data formats and concrete technologies. Hardware includes mobile devices and device components. Mobile software deals with the characteristics and requirements of mobile applications.

II. LONG TERM EVOLUTION

LTE refers to a standard for smooth and efficient transition toward more advanced leading-edge technologies to increase the capacity and speed of wireless data networks.**LTE** is often used to refer to wireless broadband or mobile network technologies.

Long Term Evolution (LTE) is a 4G wireless broadband wirless technology developed by the Third Generation Partnership Project(3GPP), an industry trade group.3GPP engineers named the technology "**Long Term Evolution**" because ir represents the next step(4G).



In progression from GSM, a 2G standard, to UMTS, the 3G technologies based upon GSM.LTE provides significantly increased peak data rates, with the potential for 100 Mbps downstream and 30 Mpbs upstream, reduced latency, scalable bandwidth capacity, and backwards compatibility with existing GSM and UTMS technology. Future developments to cloud yield peak throughout on the order of 300Mbps.

The upper layer of LTE are based upon TCP/IP, which will likely result in all IP network similar to the current state of wired communications. LTE will support mixed data ,voice ,video and messaging traffic.LTE uses OFDM (Orthogonal Frequency Division Multiplexing) and ,in later releases , MIMO (Multiple Input Multiple Output) antenna technology. Wireless Local Area Network (WLAN) standard.

The Higher signal to noise ratio (SNR) at the receiver enabled by MIMO, along with OFDM, provides

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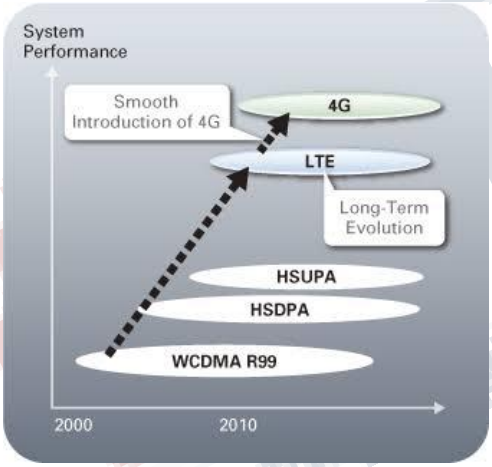
improved coverage and throughput, especially in dense urban areas.

LTE seheduled to be launched commercially in 2010 by Verizon Wireless and AT&T Wireless. T-Mobile and Alltel have also announced plans to roll out 4G capabilities based on LTE. These networks will complete with clearwire's WiMAX for both enterprise and consumer broadband wireless customers. outside of the US telecommunication market, GSM is the dominant mobile standard, with more than 80% of the world's Cellular phone users. As a result of HSDPA and then LTE are the likely wireless broadband technologies of choice for the most users. Nortel and other infrastructure vendors. and focusing significant research and development efforts on the creation of LTE base stations to meet the expected demand. When implemented , LTE has the potential to bring pervasive computing to a global audience , with a wire-like for mobile users everywhere.



III. 4G WIRELESS STANDARDS :

The two competing bodies involved in churning out 4G wireless technologies (ADA07) are the 3GPP in Europe and the 3GPP2 in North America. The 3GPP is marketed under the brand name of Long Time Evolution or LTE and is working on the 4G technology which is to succeed the 3G technology of UMTS. The 3GPP2 project is marketed under the brand name Ultra Mobile Broadband or UMB and their effort is to make transition to 4G from the existing CDMA2000 family of standards in North America.

IV. THE HIGH LEVEL REQUIRMENTS FOR A 4G TECHNOLOGY

The high level requirements for a 4G technology are as follows:

1. Higher spectral Efficiency
2. Reduced cost per bit
3. Increased Service Provisioning by lowering the cost and increasing efficiency and experience
4. Open Interfaces as against closed technologies of the past
5. Power consumption efficiency
6. Scalable and flexible usage of frequency bands

The 3rd Generation Partnership project was established in December 1998, and is a collaborative agreement to bring together a number of Telecommunications standard bodies known as "Organizational Partners" (3GPP). The stated aim of the collaboration is to "co-operate for the production of a complete set of globally applicable Technical Specifications for a 3rd Generation Mobile System based on the evolved GSM core networks and the radio access technologies supported by 3GPP partners (UTRA both FDD and TDD modes). The 3GPP organization is based on a layered hierarchy with a "Technical specifications" Group working under the directions of a "Project Coordination" group to role out technical specifications as shown in Figure 2 (adapted from reference). The "Market Representation Partners" is an organization invited by the Organization Partners to advice them about market requirements and strategies. Individual members make technical contributions to the "Technical specifications Group". The "Organizational Partners" shall have joint ownership and copyright to the technical specifications churned out of the project.

V. TECHNICAL CHALLENGES AND TECHNOLOGIES ADOPTED :

In this section, we first discuss the two generic technologies of **OFDM** and **MIMO** that are adopted by the standard (LTE) and then look into the details System Architecture Evolution- the proposed architectural framework proposed specifically for LTE.

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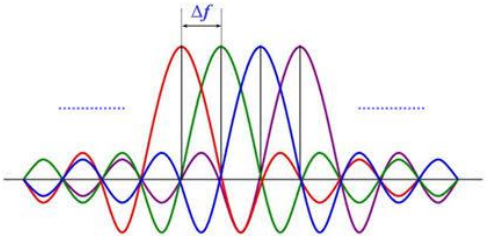
❖ **OFDM :-**



The Orthogonal Frequency Division Multiplexing (OFDM) transmission scheme is the optimum version of the multicarrier transmission scheme. In the past, as well as in the present, the OFDM is refered in the literature Multi-carrier, Multi-tone and Fourier Transform.

The concept of using parallel data transmission and frequency multiplexing was published in the mid 1960s. After more than thirty years of research and development, OFDM has been widely implemented in high speed digital communications. Due to recent advances of digital signal Processing (DSP) and Very Large Scale Integrated circuit (VLSI) technologies, the initial obstacles of OFDM implementation such as massive complex computation, and high speed memory do not exist anymore.

The use of Fast Fourier Transform (FFT) algorithms eliminates arrays of sinusoidal generators and coherent demodulation required in parallel data systems and makes the implementation of the technology cost effective.

- The OFDM concept is based on spreading the data to be transmitted over a large number of carriers, each being modulated at a low rate. The carriers are made orthogonal to each other by appropriately choosing the frequency spacing between them.
- In contrast to conventional Frequency Division Multiplexing, the spectral overlapping among sub-carriers are allowed in OFDM since Orthogonality will ensure the sub- carrier separation at the receiver, providing better spectral efficiency and the use of steep band pass filter was eliminated.

❖ **MIMO :-**

Multiple Input Multiple Output (MIMO) It is an antenna technology that is used both in transmission and receiver equipment for wireless radio communication. There can be various MIMO configurations. For example, a 2x2 MIMO configuration is 2 antennas to transmit signals (from base station) and 2 antennas to receive signals (mobile terminal).

MIMO takes advantage of multi-path and it uses multiple antennas to send multiple parallel signals (from transmitter). In an urban environment, these signals will bounce off trees, buildings, etc. and continue on their way to their destination (the receiver) but in different directions. "Multi-path" occurs when the different signals arrive at the receiver at various times. With MIMO, the receiving end uses an algorithm or special signal processing to sort out the multiple signals to produce one signal that has the originally transmitted data. Multiple data streams transmitted in a single channel at the same time and Multiple radios collect multipath signals Delivers simultaneous speed, coverage, and reliability improvements.

MIMO involves Space Time Transmit Diversity (STTD), Spatial Multiplexing (SM) and Uplink Collaborative MIMO.

- **Space Time Transmit Diversity** (STTD)-The same data is coded and transmitted through different antennas, which effectively doubles the power in the channel. This improves Signal Noise Ratio (SNR) for cell edge performance.
- **Spatial Multiplexing** (SM)-the "Secret Sauce" of MIMO. SM delivers parallel streams of data to CPE by exploiting multi-path. It can double (2x2 MIMO) or quadruple (4x4) capacity and throughput. SM gives higher capacity when RF

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conditions are favorable and users are closer to the BTS.

- **Uplink Collaborative MIMO Link**-Leverages conventional single Power Amplifier (PA) at device. Two devices can collaboratively transmit on the same sub-channel which can also double uplink capacity.

VI. TECHNIQUES IN LTE

- LTE devices use several modulation techniques to modulate data and control information. These modulation techniques include: QPSK (2 bits per symbol), 16QAM (4 bits per symbol), and 64QAM (6 bits per symbol). All of these modulation techniques are supported in the downlink direction; and all but 64QAM, which is optional, are supported in the uplink direction.
- A modulation technique is selected based on the measured signal to interference plus noise ratio (SINR). Each modulation scheme has a threshold SINR. Subscribers located farther from the eNodeB (with lower SINR values) use a more robust modulation scheme (lower throughput), while subscribers closer to the eNodeB (with higher SINR values) can use less robust modulation schemes (higher throughput).
- Both the eNodeB and the UE measure signal quality using the Reference Signals. The Reference Signals carry a known (pseudo-noise) bit pattern at a boosted power level.

VII. DISTINCTIVE ADVANTAGES OF 4G TECHNOLOGY :

In the evolution from 3G to 4G wireless broadband services, the move to Long Term Evolution (LTE) technology. In terms of services, **LTE 4G technology has three distinctive advantages over 3G**:

- LTE provides better spectrum utilization to support more users per cell.
- LTE is a pure packet technology and carries the assumption that a migration to VoIP will provide the primary LTE voice service framework.
- LTE provides considerably higher data bandwidth, which means more data capacity per user, as well as more total data capacity per cell.

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