3GPP Long Term Evolution

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ABSTRACT

Mobile communication technology evolved rapidly over the last few years due to increasing demands such as accessing Internet services on mobile phones with a better quality of the offered services. In order to fulfill this, wireless telecommunication industry worked hard and defined a new air interface for mobile communications which enhances the overall system performance by increasing the capacity of the system along with improving spectral efficiencies while reducing latencies.

For this, one technology, is called Third Generation Partnership Project Long Term Evolution (3GPP LTE), emerged with an aim of providing voice, data, video and multimedia services on mobile phones at high speeds and cheap rates.

In this paper, I have conducted a detailed study of 3GPP LTE by focusing on its first layer, i.e. Physical. The study specifically includes system architecture, radio aspects of the air interface (such as frequency band, radio access modes, multiple access technologies, multiple antenna technologies and modulation).

Introduction:

The long-term evolutionary access technology called Long Term Evolution (LTE) is quickly becoming the network technology of choice for 4G (4Generation) deployments around the world. As users demand for mobile broadband services continues to rise, LTE and its ability to cost-effectively provide very fast, highly responsive mobile data services appears to be the right technology at the right time

LTE is a 3GPP standard that provides for an uplink speed of up to 75Mbps (Megabits per second) and a downlink speed of up to 300 Mbps. LTE will bring many technical benefits to cellular networks. Bandwidth will be scalable from 1.25 MHz to 20MHz. This will suit the needs of different network operators that have different bandwidth allocations, and also allow operators to provide different services based on spectrum. LTE is also expected to improve spectral efficiency in 3G networks, allowing carriers to provide more data and voice services over a given bandwidth[1] .

Standards :

The overall goal of Fourth Generation (4G) systems is to provide a converged network compatible with the NGN (Next Generation Network) vision of convergence. This kind of network integrates mobility management, security and quality of service management mechanisms for both fixed and mobile broadband accesses, independent of the access technology. Though the Release 8 version of LTE does not strictly meet the ITU's (International Telecommunication Union) definition of a 4G system, its architecture and underlying technologies provide a solid foundation for the Release 10 (R10) LTE-Advanced system which does describe a fully-compliant 4G system [1][2].

3GPP LTE Technologies :

OFDM : The basic idea of orthogonal frequency division multiplexing (OFDM). is to divide the transmitted bitstream into many different substreams and send these over many different subcarriers. Typically the subcarrier are orthogonal under ideal propagation conditions, The number of substreams is chosen to insure that each subcarrier has a bandwidth less than the coherence bandwidth (BC) of the channel, so the subcarrier experience relatively flat fading. Thus, the ISI on each subchannel is small [1][2]

SC-FDMA : Single Carrier Frequency Division Multiple Access (SC-FDMA) is a promising technique for high data rate uplink communication and has been adopted by 3GPP for it next generation cellular system, SC-FDMA is a modified form of OFDM/A with similar throughput performance and complexity. This is often viewed as DFT-coded OFDM where time-domain data symbols are transformed to frequency-domain by a discrete Fourier transform (DFT) before going through the standard OFDM modulation. Thus, SC-FDMA inherits all the advantages of OFDM. SC-FDMA brings additional benefit of low peak-to-average power ratio (PAPR) compared to OFDM making it suitable for uplink transmission by user-terminals. SC-FDMA is a new multiple access technique that utilizes single carrier modulation, DFT spread orthogonal frequency multiplexing, and frequency domain equalization [1][2][3].

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MIMO : Multiple Input, Multiple Output systems (MIMO). Multiple antenna technology can be used to increase the data rate (spatial multiplexing) instead of improving robustness (spatial diversity). In practice; both methods are used separately or in combination, depending on the channel condition [1].

Smart Antenna : Smart Antenna is known as Adaptive Antenna System (AAS). Smart Antenna constructs the channel model and attains channel knowledge by using signal processing techniques in order to steer the beam towards the desired subscriber while transmitting null steering towards the interferer [1]**.** The null steering cancels out undesired portion of the signal and reduces the gain of radiation pattern obtained from adaptive array antenna in the direction of interference source. This is achieved by using beamforming and null steering towards desired user and interferer respectively. The process of combining the radiated signal and focusing it in the desired direction is called Beamforming [3]. SAS is divided as follows.

System Architecture :

System Architecture Evolution (SAE) is the evolution associated with the core network along with the radio access technology, indicated as LTE. SAE was developed to satisfy the requirements of LTE and provide improved data capacity, reduced latency and cost (capital expenditure and operational expenditure), and support for packet switch configuration. Hence LTE architecture consists of two main parts: EUTRAN (EUTRA Node) and EPC (Evolved Packet Core). These two nodes together comprise an Evolved Packet System (EPS). EPS routes the IP packet with a given Quality of Service (QoS), called an EPS bearer, from the Packet Data Network Gateway (P-GW) to User Equipment (UE). Figure 4.1 illustrates the overall Architecture of EPS [3][2].

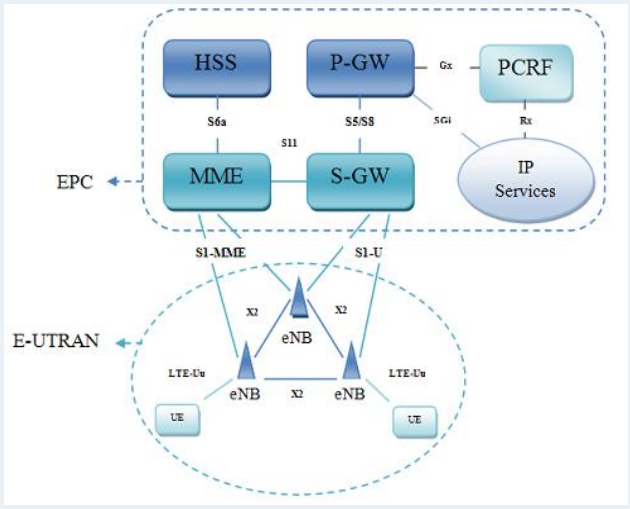

Figure. EPS Architecture

Conclusion

- LTE is a highly optimized, spectrally efficient, mobile OFDM/MIMO solution built from the ground up for mobility, and it allows operators to offer advanced services and higher performance for new and wider bandwidths.
- LTE is based on a flattened IP-based network architecture that improves network latency, and is designed to interoperate on and ensure service continuity with existing 3GPP networks. LTE leverages the benefits of existing 3G technologies and enhances them further with additional antenna techniques such as higher-order MIMO.
- LTE system as a break with the past. It marks the start the transition to 4G technologies and networks.
- The main characteristic of LTE physical layer is that the Downlink is Different from the Uplink based on that we conclude the following table .

References :

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