ANALYSIS FOR SPECTRUM ENHANCHMENT TO LONG TERM EVALUATION (LTE) CELLULAR SYSTEM

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ABSTRACT

This article an overview of Long Term Evolution (LTE) —the leading technologies for next-generation mobile broadband. the data bestowed here can facilitate readers perceive however the two technologies dissent, why Verizon Wireless selected LTE, and what benefits LTE offers customers. the subsequent govt. outline provides a fast summary of the paper's contents and its subject material. The remaining sections get in bigger technical detail concerning LTE .

Keyword : - *Long Term Evaluation, Broadband , Orthogonal Frequency Division Multiplexing, MIMO, LTE-Advance, Enhanced MIMO .*

1. INTRODUCTION

Driving the evolution of wireless broadband technology is customers' increasing expectations for speed, bandwidth, and global access. Customers want more information, such as business and consumer applications, and entertainment available through their mobile devices, but with greater speeds. For wireless carriers to achieve greater speeds and pervasive connectedness, their networks need to start behaving more like landline IP-based networks. This line of thinking represents a fundamental shift in perspective—from mobile services to broadband connections—for customers and service providers alike. Enter the fourth-generation (4G) wireless network. Unlike earlier wireless standards, 4G technology is based on TCP/IP, the core protocol of the Internet. TCP/IP enables wireless networks to deliver higher-level services, such as video and multimedia, while supporting the devices and applications of the future.

Verizon Wireless chose LTE over Wi-MAX as the technological foundation for its 4G wireless broadband network. The company believes that LTE offers a number of significant technological and business advantages over Wi-MAX that make it a superior networking standard. Verizon Wireless customers want to be truly untethered with advanced communication devices that provide a similar immersive experience as found in today's wired networks—whether it's downloading or uploading large files, video, gaming, downloading music, or social networking. They want to be able to communicate in new and innovative ways whenever and wherever they choose around the globe. For these reasons, Verizon Wireless believes LTE is the best technology with the global scale needed to deliver such experiences.

2. LTE STANDARDS

The two competing bodies involved in churning out 4G wireless technologies [ADA07b] 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.

The High Level requirements for a 4G technology were identified as:
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 (i.e., 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.

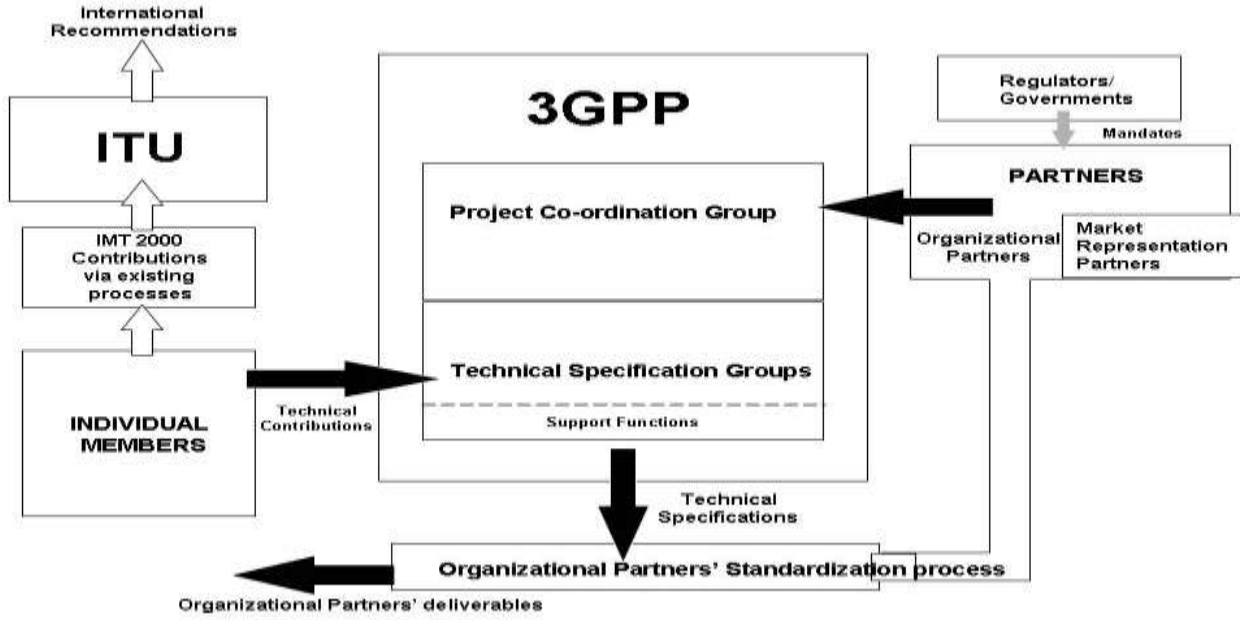

Fig.1: 3GPP Overview [3GPP]

The technical specifications approved by 3GPP for the LTE project include the use of Orthogonal Frequency Division Multiplexing (OFDM) and advanced antenna technologies such as MIMO (Multiple Input Multiple Output). It specifies downlink peak speeds of 326Mbps and uplink peak speeds of 86Mbps, both in a 20 Mhz bandwidth. It also mandates the roundtrip latency between the base station and handsets to 10-milliseconds. The specification documents extend numerous documents and thousands of pages and the information provided above is just a summary of the final results. The 3GPP2 [3GPP2] is the Asian-North American effort for achieving similar capabilities for their CDMA2000 group of specifications and called by the brand-name of UMB. 3GPP2 organization is very similar to the 3GPP organization being a collaborative effort between 5 standards development

organization from Asia(China, Japan, North Korea) and North America and multiple Market Representation Partners, providing market advice to the SDO's. The technical specifications approved by 3GPP2 for UMB include and OFDMA based air interface with Frequency 7 of 15 Division Duplexing. The specifications specify downlink peak data rates of 275 Mhz and uplink peak data rates of 75 Mbps on a scalable bandwidth of 1.25-20 Mhz. It also supports the use of advanced antenna systems such as MIMO and Beam forming antennas.
It can be noticed that the technical specification of LTE and UMB are very similar to each other and are based on the same underlying technologies of OFDM and AAS(Advanced Antenna Systems). Both these standards represent a shift towards an All IP network and as such an All IP network has been specified as a part of the System Architecture Evolution (SAE), the core network architecture for LTE.
In the next section we shall discuss about the various technical challenges and discuss in detail the key technologies which make the transition from 3g to 4g possible.

3. TECHNOLOGY ADOPTED

In this section, we first discuss the two generic technologies of OFDM and MIMO that are adopted by both standards (LTE and UMB) as:

3.1 OFDM

Also OFDM is one of the key technologies which enable non-line of sight wireless services making it possible to extend wireless access system over wide-areas. It is a variant of the Frequency Division Multiplexing scheme in which the frequency channel is divided into multiple smaller sub-channels. In FDM, sub-channelization requires provisioning of guard bands between two sub-channels to avoid interference between them. OFDM (as shown in Figure 2) divides the frequency bandwidth in narrow orthogonal sub-parts called sub-carriers. A sub-channel is an aggregation of a number of these sub-carriers. The sub-carriers include data carriers, pilot carriers and a DC. The data carriers are used to carry data, the pilot carriers are used for channel sensing purposes and the DC mark the centre of the channel. Each subcarrier is modulated with conventional modulation scheme such as Quadrature Amplitude Modulation or Phase Shift Keying at a low symbol rate. Each user is provided with a integer number of sub-channels which is composed of a number of sub-carriers. User data is carried parallely on each sub-carrier at a low rate. The combination of the parallel sub-carriers at the destination provide for the high data rates.
Since the sub-carriers carry data at a low rate and thus higher symbol time it is more resilient to multi-path effects, thus making it more suitable for wide-area non-line of Sight wireless access technology. Also, the use of overlapping orthogonal sub-carriers without guard bands make it more efficient than FDM scheme. OFDM resembles CDMA in that it is also a spread-spectrum technology in which energy generated at a particular bandwidth is spread across a wider bandwidth making it more resilient to interference and "jamming". However, unlike CDMA, OFDM allows adaptive assignment of sub-carriers to sub-channels based on channel conditions making it more robust and achieving higher spectral efficiency than CDMA.

The Multi-User version of OFDM is called OFDMA(Orthogonal Frequency Division Multiple Access).

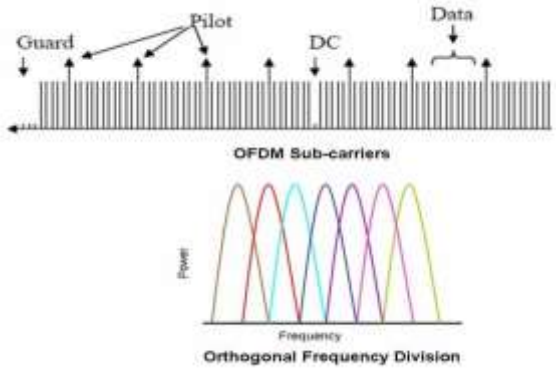

Fig -2: OFDM

3.2 MIMO

Multiple Input Multiple Output (MIMO) is one of the most popular Advanced Antenna Technologies which is supported both by LTE and UMB. The salient features of MIMO is that it offers higher throughput for a given bandwidth and higher link range for a given power value. A detailed discussion of the MIMO technology is beyond the scope of this survey and we provide a cursory glance at the key features of the technology. In MIMO the transceiver and receiver have multiple antennas giving MIMO multiple flavors based on the number of antennas present on each side. However, the key idea is that a transmitter sends multiple streams on multiple transmit antennas 9 of 15 and each transmitted stream goes through different paths to reach each receiver antenna as shown in Figure 3.The different paths taken by the same stream to reach multiple receivers allow canceling errors using superior signal processing techniques. MIMO also achieves spatial multiplexing to distinguish among different symbols on the same
frequency. MIMO thus helps in achieving higher spectral efficiency and Link reliability.

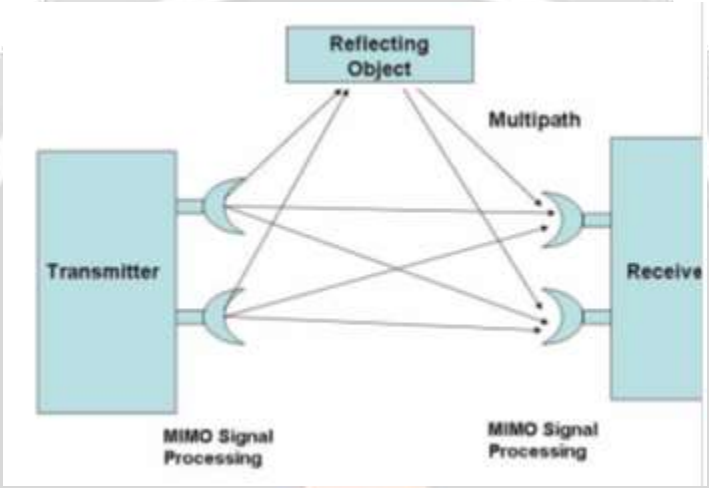

Fig.-3: MIMO

4. ENHANCED MIMO

Multiple-Input Multiple-Output (MIMO) is a key technique in any modern cellular system that refers to the use of multiple antennas at both the transmitter and receiver sides. Base stations and terminals are therefore equipped with multiple antenna elements intended to be used in transmission and reception to make MIMO capabilities available at both the downlink and the uplink. Next-generation cellular systems will have to provide a large number of users with very high data transmission rates, and MIMO is a very useful tool towards increasing the spectral efficiency of the wireless transmission.

Enhanced MIMO is considered as one of the main aspects of LTE-Advanced that will allow the system to meet the IMT-Advanced rate requirements established by the ITU-R. The majority of the MIMO technologies already introduced in LTE are expected to continue playing a fundamental role in LTE-Advanced, namely beam forming, spatial multiplexing and spatial diversity. However, further improvements in peak, cell-average, and cell-edge throughput need to be obtained to substantially increase performance.
The aforementioned techniques require some level of channel state information (CSI) at the base station so that the system can adapt to the radio channel conditions and significant performance improvement can be obtained. TDD systems this information is easily gathered from the up-link, provided the channel fading is sufficiently slow, due to the fact that the same carrier frequency is used for transmission and reception. On the other hand, due to the asymmetry of FDD systems, feedback information over the reverse link is required. Full CSI could cause an additional overhead that might be excessive, so quantization or statistical CSI are preferable in practice. In addition,

terminal mobility can pose serious difficulties to the system performance as the channel information arriving to the eNB may be out-dated.

Multi-antenna techniques in a multi-user scenario have the role of delivering streams of data in a spatially multiplexed fashion to the different users in such a way that all the degrees of freedom of a MIMO system are to be utilized. The idea is to perform an intelligent Space- Division Multiple Access (SDMA) so that the radiation pattern of the base station is adapted to each user to obtain the highest possible gain in the direction of that user. The intelligence obviously lies on the base stations that gather the CSI of each UE and decide on the resource allocation accordingly.

The enhanced MIMO concept is conceived as an adaptive multi-mode framework where the demand of higher data rates and wider coverage is accommodated by selecting the appropriate MIMO scheme according to the current system requirement. The adaptation strategy is chosen based on all the different channel measurements that are gathered at the base station through a low rate feedback mechanism. Additionally, LTE-Advanced will allow several of the above-mentioned MIMO technologies to be combined in what is known as extended or advanced pre-coding. Fig. 4.1 shows the idea behind this concept, and Fig. 4.2 illustrates the main three operating modes.

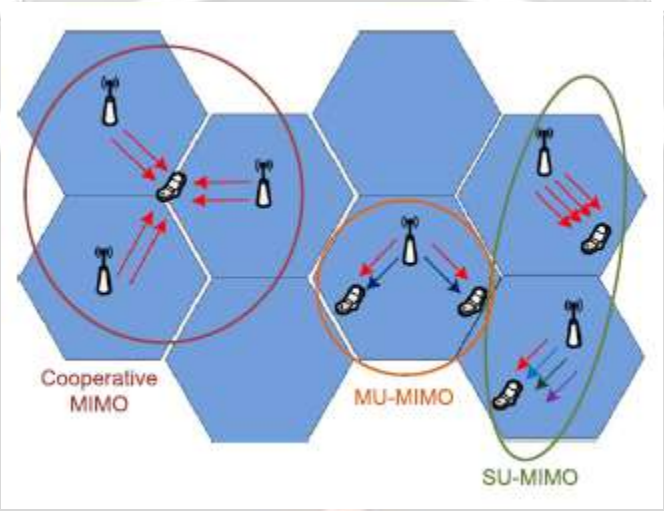

Fig.-4.1: LTE-Advanced main MIMO modes.

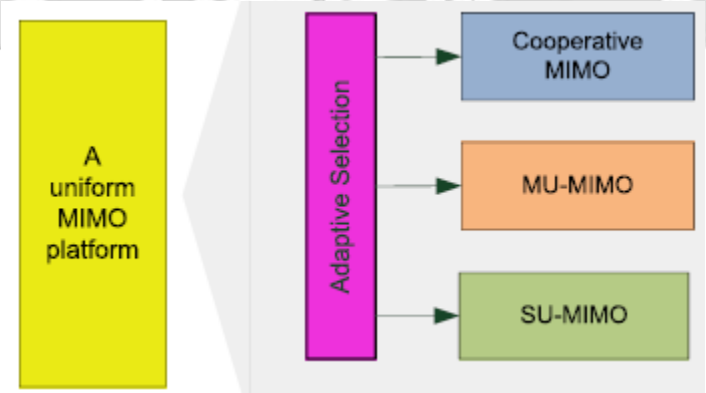

Fig.-4.2: MIMO adaptive switching scheme.

5. CONCLUSION

LTE Release 8, will be fully specified in 3GPP Release 10. It has already been submitted as 3GPP's 4G candidate radio interface technology to ITU-R. We have described its main technologies: carrier aggregation, enhanced MIMO, cooperative multipoint transmission and reception, and relays. For each one, we have examined their benefits, challenges, and some existing approaches to tackle these challenges. However, several issues in each of them are still open and require further research.

It is the combination of these technologies, and not just a single one, that will enable achieving the target performance requirements established by IMT-Advanced. The development and integration of this elements will not end with 3GPP Release 10, but will provide the starting point for their implementation. In addition to the elements that we have examined in this paper, it is also expected that the use of femtocells, self-organizing networks, and energy management systems will drive the evolution of current and future mobile wireless networks.

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