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Emerging Trends in MIMO

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Abstract- **The communication business is one among the quickest growing industries. MIMO is that the use of multiple antennas at each the transmitter and receiver to boost communication performance. It's one among many types of sensible antenna technology. MIMO technology has attracted attention in wireless communications, as a result of it offers vital will increase in knowledge output and link vary range requiring extra information measure or transmit power. This is often achieved by higher spectral potency and link reliableness or diversity (reduced fading). Due to these properties, MIMO is a vital a part of trendy wireless communication standards like IEEE 802.11n (Wi-Fi), IEEE 802.16e (Wi-MAX), 3GPP long run Evolution (LTE), 3GPP HSPA+, MIMO-OFDM and 4G systems to come back.**

I. INTRODUCTION

Wireless networks are experiencing a awfully substantial increase within the delivered quantity of data as a result of variety of rising applications that embrace machine-to-machine communications and video streaming. This terribly great amount of data exchange is predicted to continue and rise within the next decade around, presenting a awfully significant challenge to designers of wireless communications systems. This constitutes a serious drawback, not solely in terms of exploitation of accessible spectrum resources, however additionally concerning the energy potency within the transmission and process of every info unit (bit) that should well improve. The Wireless INTERNET of the future (wiof) can have thus to consider technologies which will supply a considerable increase in transmission capability as measured in bits/Hz however don't need enhanced spectrum bandwidth or energy consumption. Multiuser multiple-antenna wireless systems with a awfully sizable amount of antennas, called massive multi-input multi-output (MIMO) systems. The introduction of LTE was driven by the industry's pursue a lot of economical technology that would facilitate deliver ever quicker mobile broadband services. Compared with basic HSPA networks, LTE delivered this improvement by providing the state of the art combination of latest air interface base technology (OFDMA/SC-FDMA), larger flexibility for utilizing spectrum like as an example support of 20 MHz bands and TD-LTE for exploitation odd spectrum, similarly as a chest to support additional enhancements like MIMO and better Order Modulation. Multiple-antenna or multi-input multi-output (MIMO) wireless communication devices that use antenna arrays with a awfully large number of antenna components that are called massive MIMO systems have the potential to beat those challenges and deliver the specified data rates, representing a key enabling technology for the WIoF.

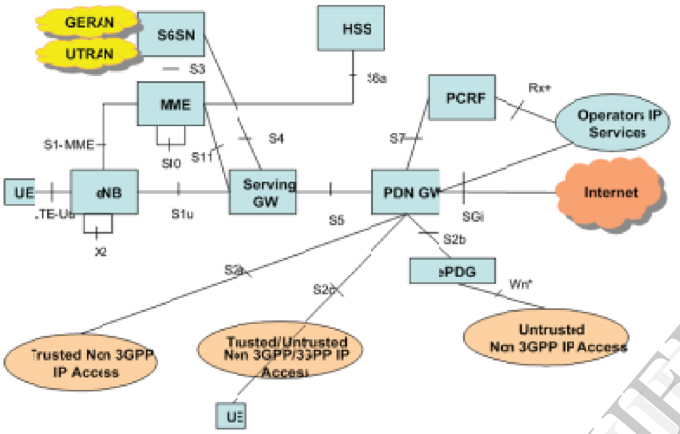
II. TECHNOLOGIES BEHIND MIMO

A) LTE

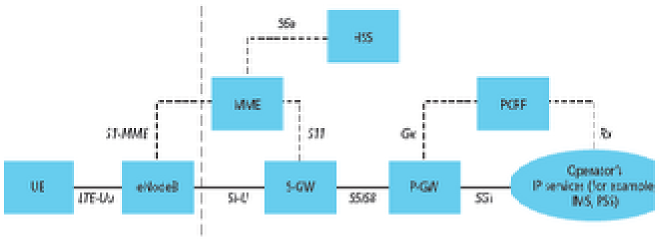
LTE (Rel-8/Rel-9) was developed as associate evolution path from GSM and WCDMA for providing higher output at cheap price, exploiting OFDMA as the deciliter and SC-FDMA because the UL multiple access technology to support the ascendible information measure from one.4MHz up to 20MHz. LTE Rel-8 and Rel-9 were finalized in March 2009 and March 2010 respectively. Downlink MIMO and diversity antenna techniques were supported from the beginning of Rel-8. Rel-9 more deployed the options of twin layer beamforming, SON, positioning and MBMS over LTE. LTE operates on the oftenness and therefore the cellular network to transmit voice and information. The best radius of a cell that one base station may supports is up to 100km. It uses pre-coded version of OFDM for transmission and traditional OFDM for the downlink. OFDM or Orthogonal Frequency Division Multiplexing transmits information in closely spaced carriers to transmit information, enhancing spectrum flexibility and cost-efficiency. what is more, LTE networks has backwards compatibility with the previous technologies like GSM and UMTS that produces low disbursement and wide coverage potential as a result of it may operate without separation wherever LTE coverage cannot reach. Enabling seamless passing from associate LTE base station to the prevailing deployed networks reflects well on higher service and price potency

B) THE ARCHITECTURE OF LTE NETWORK & WORKING PRINCIPLE

LTE is a commonplace for wireless data technology associated an evolution of the GSM/UMTS standard. the most goals of LTE is to extend the capability and spectral potency rates of wireless data networks, improve spectrum potency, improve coverage, reduced latency and packet-optimized system that support multiple Radio Access. Thus, so as to realize the goals, the design of the network if totally different from the previous wireless information transfer network, GPRS. So, in post, a comprehensive summary of the specification and basic rule of LTE network goes to be mentioned. Basically, the LTE commonplace solely supports packet switch with its all-IP network. the explanation why LTE is intended just for packet switch is as a result of it aims to produce seamless web Protocol (IP) property between user instrumentation (UE) and therefore the packet information network (PDN), with none disruption to the top users' applications throughout quality. Attributable to this characteristic, voice calls and text message natively (which area unit usually handled by circuit-switched networks like GSM and CDMA). In LTE design, Evolved UTRAN (E-UTRAN) is a crucial role that is that the air interface of LTE upgrade path for mobile networks meantime it's in the midst of associated evolution of the non-radio aspects underneath the term "System design Evolution" (SAE), which has the Evolved Packet Core (EPC) network. Along LTE and SAE comprise the Evolved Packet System (EPS). Besides that, LTE network uses associate eNodeB (evolved node B, basically associate LTE base station), a MME (Mobile management entity), a HSS (home subscriber server), a SGW (serving gateway), and a PGW (a packet information network gateway). These are thought of as a part of the EPC except eNodeB.



First, allow us to explore EPS very well, the subsequent figure showing those components in EPS network



In LTE, main task of EPS is to supply the user with science internet protocol connectivity to a PDN for accessing the web, moreover as for running service like voice IP (VoIP). an EPS bearer is usually related to a QoS. Multiple bearers are often established for a user so as to supply completely different QoS streams or property to different PDNs. Figure on top of shows the spec, together with the network parts and therefore the standardized interfaces. At a high level, the network is comprised of the CN (EPC) and therefore the access network E-UTRAN. Whereas the CN consists of the many logical nodes, the access network is formed of basically only one node, the evolved NodeB (eNodeB) that connects to the UEs. Every of those network parts is interconnected by means that of interfaces that are standardized so as to permit multi-vendor ability. This offers network operators the likelihood to supply completely different network parts from different vendors. In fact, network operators could select in their physical implementations to separate or merge these logical network parts looking on business commercial.

The core network (called EPC in SAE) is liable for the management of the UE and establishment of the bearers. The most logical nodes of the EPC are:

- PDN gateway (P-GW)
- Serving gateway (S-GW)
- mobility Management Entity (MME)

C) LTE-A

LTE Advanced may be a mobile communication commonplace. it had been formally submitted as a candidate 4G system to ITU-T in late 2009. it absolutely was approved by the ITU as meeting the necessities of the IMT-Advanced commonplace, and was finalized by 3GPP in March 2011. it's standardized by the third Generation Partnership Project (3GPP) as a significant improvement of the future Evolution (LTE) standard.

LTE-Advanced was developed to satisfy or exceed the ITU necessities for IMT Advanced, that is meant be a on the far side 3G system that considerably improves the support of wireless mobile information applications. LTE-Advanced includes all work from 3GPP Rel-10 forwards that keeps evolving with multiple sections to match to the increasing market requirements: LTE-A (Rel-10/Rel-11) is that the initial phase of LTE-Advanced and was developed for IMT-Advanced certification and additional coverage improvement. Most notably, it offers support for wider bandwidths with carrier aggregation up to a hundred MHz and higher-order spacial multiplexing with up to 8x8 MIMO in decilitre and 4x4 MIMO in UL. Rel-10 was completed in June 2011, as 3GPP IMT-Advanced (commonly called 4G) candidate proposal to ITU. Rel-11 was frozen in March 2013, with additional enhancements specifically on coverage also as general CA and Multiantenna transmissions, SON and voice over LTE The coverage improvement in Rel-11 was centered on co-channel network readying, with 2 key features: Coordinated Multi-Point (CoMP) transmission/scheduling in decilitre and reception in UL offer higher UE expertise at cell edge, applicable to networks with a fiber backhaul between transmission points and centralized processing; eICIC/FeICIC supports network-coordinated CRS interference cancellation between co-channel macro cells and little cell cells. Additionally, LTE-A also enabled the initial support for relays, reduction of drive tests (MDT) and Machine-type communication (MTC).

III. 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 beamforming, 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 uplink 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 outdated. 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.

A) DOWNLINK MIMO TRANSMISSION

The characteristics of the downlink single-site MIMO transmission are summarized in this section. The number of antennas in both transmission and reception is increased: a 4 × 4 MIMO antenna configuration would become the baseline while a maximum configuration of 8 × 8 MIMO could be set to achieve high peak rates. Operation in both open-loop and closed-loop modes is possible in combination with diversity and spatial multiplexing, i.e. feedback information may or may not be sent back by the UE depending on the radio conditions and the UE mobility. Closed-loop transmit diversity is a new feature of LTE-Advanced intended for scenarios with low mobility and bad channel quality. In order to minimize intra-cell interference, MU-MIMO will be based on one or two of the following approaches: a set of fixed beams, a user-specific beam technique, or a combination of both. Solutions under consideration for the two cases are briefly described in the following, although this is still an open issue. Grid-of-Beams (GoB) is a concept widely accepted for the fixed-beam approach and is depicted in Fig.5.9. A limited set of possible precoding vectors is associated one to-one with the set of beams so that radio resources in time and frequency are shared among different users without severe interference. The system can operate in both open loop and closed-loop modes by using UE feedback in the former case and deriving the selected beam from the uplink in the latter one. This scheme is suitable for high mobility and requires pilots dedicated to each beam to determine the one with the highest received power. User-specific beamforming is an approach that does not employ predefined procoder sets in order to provide the base station with more freedom to control or nearly null intra-cell interference. Instead, the base station may freely adjust downlink transmission weights depending on the channel conditions.

These techniques are known as non codebook-based techniques. The idea of LTE-Advanced is to extend the single-user dedicated beamforming concept of LTE to multiple users (i.e. SDMA) while supporting spatial multiplexing, and transmit diversity at the same time. The most common precoding technique for this case is zero-forcing (ZF), a suboptimal strategy that can easily be implemented in practice by choosing the weight vectors as the pseudo-inverse of the composite channel matrix of the users to avoid interference among user streams. Dirty Paper Coding (DPC) is another multi-user precoding strategy based on interference pre-subtraction that achieves optimal performance in the downlink but suffers from high computational burden when the number of users is large. Precoding based on maximization of signal-to-leakage ratio is another candidate approach to design the beamforming vectors that does not impose a restriction on the number of available transmits antennas and so is Block Diagonalization (BD). Any of these techniques could be used to implement user-specific beamforming. These kind of non-codebook-based precoding schemes require the terminal to make an estimate of the overall beam formed channel, as LTE already established. This is enabled through the inclusion of UE-specific reference signals that are equally precoded before transmission as the user data so that the terminal is capable of estimating the overall beam formed channel. Additionally, the number of transmit antennas used for non-codebook transmission is not constrained by the number of available cell-specific reference signals which must not interfere with each other. LTE-Advanced needs to specify new reference signals in addition to the common reference signals (CRS) defined in Release 8 of LTE. Besides in-band channel estimation, other measurements need to be considered in order to enable adaptive multi-antenna transmission.

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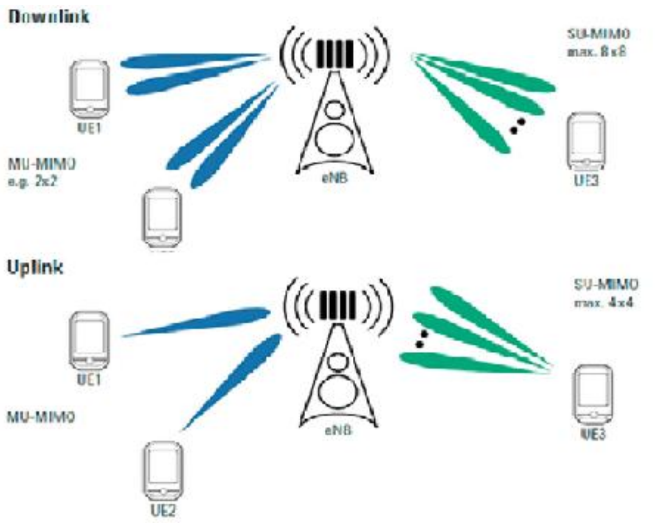

B) UPLINK MIMO TRANSMISSION

The LTE-Advanced uplink should provide significant improvements over LTE Release 8 in cell-edge, cell average, and peak data rates. The favorable characteristics of Single-Carrier Frequency Division Multiple Access (SCFDMA) of LTE Release 8 have reassured LTE-Advanced to keep the same access method, which basically consists of an additional DFT precoding phase preceding the conventional OFDMA. However, the inclusion of SU-MIMO in combination with a higher-order MIMO is seen as one of the key techniques to achieve significant technology advancement. The baseline MIMO configuration for LTE Advanced is changed to 2 × 2 MIMO and a maximum configuration of 4×4 MIMO should be available, enabling a spatial multiplexing of up to four layers. This feature allows a large increase in the peak spectrum efficiency, getting to achieve 15 bits/s/Hz with 64-QAM. Codebook-based precoding plays an essential role in the uplink.
Two main alternatives have been under discussion in 3GPP: wideband (WB) precoding and frequency selective (FS) precoding. The former scheme applies the same precoding vector on the whole frequency band while the latter may select a different precoder on each resource block. After multiple discussions, it has been agreed that WB precoding is more suitable since FS does not provide any gain over WB for an equal amount of feedback. Codebooks are designed so that the cubic metric (CM), a parameter defined as the cubic power of the signal of interest compared to a reference signal, is kept low. The CM is used for describing practical amplifier design. This way, the peak-to-average power ratio (PAPR) is more emphasized in the uplink and the favorable SC-FDMA properties are maintained. Dynamic rank adaptation is also introduced in Release 10 to obtain further performance improvements. Link Adaptation will be supported in addition to some advanced receiver implementation such as Successive Interference Cancellation (SIC).
Optional layer shifting (LS) in combination with HARQ-ACK spatial bundling has also been proposed. In order to introduce additional spatial diversity gain a transmit antenna switching (TAS) scheme may be introduced where code symbols belonging to the same stream are transmitted on different antennas on a slot-by-slot basis. The required channel quality feedback for multiple streams is therefore reduced since all the spread data streams pass through similar channel conditions. Further, instead of associating one HARQ process per layer, two layers could share a single HARQ process by generating a single ACK for both layers, which would be true only when both transport blocks have been decoded properly. Different transmit diversity schemes supporting SUMIMO are being studied for the uplink. The challenge is to find suitable transmission schemes for all uplink channels maintaining backwards compatibility and low CM properties. Both open-loop and closed-loop schemes have been proposed. Open-loop schemes differentiate between the Physical Uplink Control Channel (PUCCH) and the Physical Uplink Shared Channel (PUSCH) since it seems unfeasible to find an optimal scheme for both channels.
Many contributions have centered their attention on this topic. For PUCCH, Orthogonal Resource Diversity (ORT) or Precoder Switching Diversity (PVD) have been proposed, while Space–Time Block Coding (STBC) or Space Frequency Block Coding (SFBC) are candidate schemes for PUSCH. Further, an alternative slow closed-loop precoding exploiting spatial correlation among transmit antennas has been proposed in. As mentioned above, in the development of these new technologies the backwards compatibility needs to be taken into account. Support for legacy devices must be granted at least on part of the component carriers. Therefore, an additional complexity arises from the need to keep multiple solutions and the achievable gains have to be compared against this extra complexity.

IV. ADVANTAGES AND KEY FEATURES

Some benefits that area unit applicable to the fourth Generation mobile communications are applicable to LTE-A. With average transfer speeds of four hundred Kbps to 700 Kbps, the network offers enough information measure to modify cellular phone users to surf and transfer information from the net. LTE-A ought to considerably lower the bit-cost for the end-users and also the total value of possession for the operators. At a similar time, LTE-A should meet new rising challenges like energy-efficient Radio Access Network (RAN) style, increase the flexibilities of network deployments, and off load networks from localized user communications. Regardless of the actual technology, the forthcoming technology will be in a position to permit the complete ability among heterogeneous networks and associated technologies, so providing clear benefits in terms of:
1. Coverage: The user gets best QoS and widespread network coverage as there is network accessibility at any given time.
2. Bandwidth: Sharing the resources among the varied networks can scale back the issues of spectrum limitations of the third generation.

A) KEY FEATURES

1. Friendliness and Personalization: User friendliness exemplifies and minimizes the interaction between applications and also the user. because of a simple transparency that enables the person and also the machine to move naturally (for example, the combination of recent speech interface could be a nice step to realize this goal).

2. Heterogeneous Services: Services that are heterogeneous in nature (for example, differing types of services like audio, video etc.) like quality and accessibility might not be constant as a result of the non uniformity of the network. as an example, a user in proximity of the shopping center however out of the coverage of a Wi-Fi will still receive pop-up advertisements exploitation the multi-hop unplanned network setup in his surroundings. thus the dynamics of the network atmosphere will modification the amount of users, terminals, topology, etc.

V. FUTURE SCOPE

LTE-B (Rel-12/Rel-13) the second section of LTE-Advanced, is being developed for capability boosting of a minimum of a thirty fold increase as an extra improvement of LTE-A. As of now a days, the mobile computing macro social technological trend shows no signs of subsiding as social networking gain large world wide acceptance. Indeed, successive trend in social networking, video sharing, along with mobile computing can still place huge pressure on the cellular infrastructure. it is anticipated that a minimum of a thirty fold increase in capability further as extra services that may enhance the user experience is needed. Consequently on September 2012 3GPP initiated work on Rel-12 that along with Rel-13 can kind the premise for LTE-B. Not solely can LTE-B change the mobile cellular system to still supply glorious social networking expertise, it'll will lower the value and energy consumption per little bit of transmission. it's designed to change the cellular network to satisfy future challenges including

• Exhaustion of this network information capability, including? the trend towards endlessly increasing use of exacting multimedia system services.

• The end users expertise expectation can demand present broadband access with a grip free expertise.

• New applications like, are, machine to machine communication, WebRTC and Highlight that are being developed, can drive the necessity for the support of the many new services.

• Trend of deep convergence of Multi-RAT, Multi-Band and Multi-Layer network with economical and convenient network operations.

Rel-12 of LTE-B is planned to span from September 2012 to June 2014, whereas Rel-13 is anticipated to complete the standardization of LTE-B till the beginning of the work to satisfy new needs and new spectrum targets which will be outlined by the ITU at WRC15.

A) LTE-B REQUIREMENTS

LTE-A system will support terribly high peak rate and peak spectral potency with up to eight antenna ports transmission and up to 100MHz carrier aggregation, that which is incredibly hard to please for terminals and can lead to solely slow penetration within the returning years. Instead, LTE-B would target the performance improvement to the standard type issue of terminals which will be common commercially within the coming back years. to satisfy the new challenges within the returning decade, LTE-B advances the subsequent areas:

- Capacity boosting to attain network capability 30x over LTE Rel-8 system to accommodate the expected large will increase in increases.
- No-Edge Network to supply stable access all over and higher user experiences with quite 10x output at cell edge compared to LTE Rel-8 system.
- Enhancing support or gap fully new business opportunities, e.g. machine kind of communications, cluster and demanding communications, proximity services.

B) LTE-B KEY FEATURES

LTE-B is principally centered on the enhancements on many classes as below, most of that were already kicked off from this Rel-12 scope:

- General enhancements, primarily for multi-antenna technologies.
- LTE-Hi: LTE Hotspot enhancements and little cells
- Multi-RAT Operations.
- Services and Enablers of recent Services.

C) TENTATIVE BENFITS OF LTE-B

LTE-B is expected to provide 30 times capacity to LTE system by a combination of multiple technologies, including: HetNet deployment with Macro-assistant coordinated small cells that are enhanced in physical and high layers, 3D MIMO technology, LTE-centric multi-RAT operations, etc. By the above evolved technologies and enhancements, the LTE-B could well address the upcoming challenges and achieve the requirements. By the evolution of HetNet to multi-layer deployment with increased number of Picos (taking the example of 12 Picos within one Macro cell area) and the application of coordination transmission among macro and Picos, the network capacity could be increased as much as nearly 9 times compared to LTE homogeneous network.

Additional around 30% gain can be achieved by introduction of CoMP. After increasing two Pico cell dedicated carriers and by invoking the fast carrier selection and inter-cell listening for interference avoidance and coordination, the network capacity could be further increased to 25 times. Additionally, if the spectrum efficiency enhancement techniques, e.g., higher order modulation (256QAM) and overhead reduction (sparse DM-RS pattern), are applied, the network capacity could achieve 30 times compared to LTE system. Meanwhile, the cell edge throughput could achieve as

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much as 12 times with respect to LTE. If the MIMO enhancement on 4Tx and/or 3D BF is employed, the network capacity and coverage could be further enhanced.

VI. CONCLUSION

LTE-Advanced, the backward-compatible improvement of LTE unharness eight, are going to be totally per 3GPPunharness ten. it's already been submitted as 3GPP's 4G candidate radio interface technology to ITU-R. the event and integration of this component won't finish with 3GPP unharness ten, however can offer the start line for his or her implementation. it's additionally expected that the employment of femtocells, self-organizing networks, and energy management sys- tems can drive the evolution of current and future mobile wireless networks.

We introduced MIMO options of LTE, that area unit downlink SU-MIMO, transmit diversity, closed-loop rank-1 precoding, MU-MIMO, dedicated beamforming, and any delineated technical backgrounds for specifying those technologies. transmission feedback mechanisms for support of downlink MIMO technologies were additionally represented to produce higher understanding regarding LTE system operation.

VII. REFERENCES

[1] ITU-R, Circular letter 5/LCCE/2, Tech. Rep., March 2008.

[2] ITU-R, Acknowledgment of candidate submission from 3GPP proponent under step 3 of the IMT-Advanced process (3GPP technology), Tech. Rep., October.

[3] ITU-R, Acknowledgment of candidate submission from IEEE under step 3 of the IMT-Advanced process (IEEE technology), Tech. Rep., October.

[4] ITU-R, Acknowledgment of candidate submission from China (People's Republic of) under step 3 of the IMT-Advanced process (3GPP technology), Tech. Rep., October.

[5] ITU-R, Requirements related to technical performance for IMTAdvanced radio interface(s), Report M.2134, 2008.

[6] 3GPP, TR 36.913 Requirements for further advancements for Evolved Universal Terrestrial Radio Access (E-UTRA) (LTE-Advanced), Tech. Rep., December 2009 [Online]. Available: http://ftp.3gpp.org/specs/ html-info/36913.htm.

[7] 3GPP, Overview of 3GPP release 8 v.0.1.1, Tech. Rep., June 2010.

[8] 3GPP, TS 36.323 Packet Data Convergence Protocol (PDCP) specification, Tech. Rep., December 2009 [Online]. Available: http://www. 3gpp.org/ftp/Specs/html-info/36323.htm.

[9] 3GPP, TS 36.322 Radio Link Control (RLC) protocol specification, Tech. Rep., March 2010 [Online]. Available: http://www.3gpp.org/ ftp/Specs/html-info/36322.htm.

[10] 3GPP, TS 36.321 Medium Access Control (MAC) protocol specification, Tech. Rep., March 2010 [Online]. Available: http://www.3gpp. org/ftp/Specs/html-info/36321.htm.

[11] 3GPP, TS 36.331 Radio Resource Control (RRC), Tech. Rep., March 2010 [Online]. Available: http://www.3gpp.org/ftp/Specs/htmlinfo/36331.htm.

[12] T. Tjelta, A.L. Lillebo, E.O. Evenstad, ITU-R world radiocommunication conference 2007, Telektronikk 1 (2008)144–159.[Online]. Available: http://www.telenor.com/telektronikk/volumes/ pdf/1.2008/Page_144-159.pdf.

[13] 3GPP, TR 36.912 Feasibility study for further advancements for EUTRA (LTE-Advanced), Tech. Rep., June 2010 [Online]. Available: http://www.3gpp.org/ftp/Specs/html-info/36912.htm.