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Efficient Energy Saving Antenna Management for LTE Advanced-Mimo System

Najnin Sultana and Monjurul Haque
Daffodil International University, Dhaka, Bangladesh

Abstract: For purpose of saving cost the generation of wireless mobile communication evolved into LTE system by using MIMO-OFDM technology. But for the higher data rate it expenses higher energy. So, an efficient antenna management system is needed to be designed to save energy per bit transmission. In MIMO, there are multiple RF channels for transmitting data which consumes much energy. In the case of LTE Release 10 which supports peak data rate of 1 Gbps, it consumes more than that. For urban macro environment, the energy cost is too high for higher data rate. So, an algorithm for adaptive selection of subset of antennas is designed to minimize the optimal transmitting power and to calculate the required minimum energy per bit for both two ended system and one ended system with continuous streaming of data. We employ MATLAB based simulation to verify the energy efficiency benefit of antenna management system. The result shows that the antenna management can achieve 25% one-end energy per bit reduction to the front end of MIMO network interface from static MIMO system which keeps all antenna actives.

Key words: Energy per bit, beamforming, LTE, BLER, BER, 2D gaussian process, shadowing fading

INTRODUCTION

LTE (Long-Term Evolution) commonly marketed as 4G LTE is a standard for wireless communication of high-speed data for mobile phones and data terminals. It is based on the GSM/EDGE and UMTS/HSPA network technologies, increasing the capacity and speed using a different radio interface together with core network improvements. The standard is developed by the 3GPP (3rd Generation Partnership Project) and is specified in its release 8 document series with minor enhancements described in release 9 and 10. The LTE advanced standard formally satisfies the ITU-R requirements to be considered IMT advance. The LTE specification provides downlink peak rates of 300 Mbit sec^{-1}, uplink peak rates of 75 Mbit sec^{-1} and QoS provisions permitting a transfer latency of <5 m sec in the access RA network. LTE has the ability to manage fast-moving mobiles and supports multi-cast and broadcast streams. LTE supports scalable carrier BW from 1.4-20 MHz and supports both FDD and TDD.

The IP-based network architecture called the (EPC). LTE uses Orthogonal Frequency Division Multiple Access (OFDMA) on the downlink which is well suited to achieve high peak data rates in high spectrum bandwidth. The main motivation of LTE is cost reduction than 3G by using MIMO-OFDM system instead of CDMA. In this study, an algorithm has been developed for managing MIMO antennas in LTE Release 10 system to reduce energy per bit.

Literature review: For achieving higher data rates and higher order of modulation, mobile operators need a large amount of power cost. A general consensus is that energy consumption by telecommunication equipments may reduce drastically. In the era of global warming now a days, it is good practice by all vendors to reduce energy consumption which in turn also beneficiary for competitive carbon lean economy. Among all kinds of devices, BTS accessories consume more power. Mobile terminal equipments are designed with energy efficient battery. So, there are many techniques and energy efficient algorithms are proposed to minimize the BTS energy consumption. A green antenna switching system with GAS algorithm has been proposed which can save 14-16% energy from classical always on MIMO system (Pace, 2012). To achieve 25% energy saving there should be some performance degradation. In LTE Rel 8 system multiple antenna ports transmit cell specific reference signals to UE. The downlink physical control channels (PDCCH, PCFICH and PHICH) always use cell specific antenna port as demodulation reference. In order to demodulate this downlink control channels the UE need to obtain knowledge about the number of cell-specific antenna ports the cell has. A system level evaluation of an antenna muting approach for LTE shows 50% less energy consumption in low traffic scenario without any significant degradation (Skillermark and Frenger, 2012). MIMO technologies are considered as a leading candidate for the next-generation wireless broadband, due to their capability to significantly increase

Corresponding Author: Najnin Sultana, Daffodil International University, Dhaka, Bangladesh

link capacity (Paulraj *et al*., 2004; Gesbert *et al*., 2003; Zheng and Tse, 2003). They have been adopted by current and emerging mobile wireless standards such as 802.11 n, WiMAX and LTE. The simultaneous use of multiple antennas by MIMO network interfaces incurs significant circuit power consumption due to multiple active RF chains. The circuit power increase is particularly problematic for short-range communication scenarios such as 802.11-based WLAN where circuit power often dominates the total power consumption of the network interface. Existing work on MIMO mainly focus on improving the channel quality such as data rate under the transmit power budget; little published work has considered the dual problem of reducing power consumption, especially the circuit power under a data rate constraint. An antenna management can achieve 21% one-end energy per bit reduction to the front end of the MIMO network interface in WLAN 802.11, compared to a static MIMO configuration that keeps all antennas active (Yu *et al*., 2012). Antennas are employed in different systems in different forms. Antennas also play important role connecting link between the transmitter and the receiver. Antennas are employed in different systems in different form (Soomro and Baharom, 2014).

MATERIALS AND METHODS

Background: The main requirements for the new access network of the evolved packet system in 3GPP in LTE are high spectral efficiency, high peak data rates, short round trip time as well as flexibility in frequency and bandwidth.

3GPP long term evolution: The LTE architecture consists of eNBs that provide the air interface user plane and control plane protocol terminations towards the UE. On one side, the user plane protocols consist of Packet Data Control Plane (PDCP), Radio Link Control (RLC) and Medium Access Control (MAC) and Physical Layer (PHY) protocols. On the other side, the control plane protocol refers to the Radio Resource Control (RRC) protocol. New access solution, LTE is based on OFDMA (Orthogonal Frequency Division Multiple Access) and in combination with higher order modulation (up to 64 QAM), large bandwidths. The eNB schedules the UEs both on the downlink and on the uplink by given intelligence. For the user plane there is only one shared transport channel in each direction. The TB sent on the channel can therefore, contain bits from a number of services, multiplexed together. LTE uses OFDMA scheme for downlink and MIMO with SC-FDMA for uplink purpose. MIMO is used for throughput improvement at the cell edge. OFDMA is used for higher spectral efficiency. In OFDMA, all subcarriers can be shared between multiple users. This solution leads to high Peak-to-Average Power Ratio (PAPR) requiring expensive power amplifiers with high requirements on linearity, increasing the power consumption for the sender. This is no problem in the eNB but would lead to very expensive handsets. Hence, a different solution was selected for the UL (Miao and Zhang, 2011).

LTE advanced: LTE advanced is a term used for the release 10 version of LTE that addresses IMT advanced requirements. LTE advanced is both backwards- and forwards-compatible with LTE. The following lists at a high level, the most important features of LTE advanced as well as other features planned for subsequent releases including release 13:

- Improved performance at cell edges, e.g., for DL 2x2 MIMO at least 2.40 bps/Hz/cell
- Wider bandwidth support for up to 100 MHz via aggregation of 20 MHz blocks (Carrier aggregation)
- Uplink MIMO (two transmit antennas in the deice)
- Higher order downlink MIMO of up to 8 by 8 in release 10
- Coordinated Multipoint Transmission (CoMP) with two proposed approaches: coordinated scheduling and/or beamforming and joint processing/ transmission in release 10
- Heterogeneous network (Het-net) support including enhanced Inter-Cell Interference Coordination (eICIC)
- Relay

Table 1 shows the IMT advanced requirements and anticipated LTE advanced capability.

Table 1: IMT advanced requirements and anticipated LTE advanced capability

Items	ITM required (Advance)	LTE advance project
Peak date rate downlink (Gbps)		1
Peak data rate uplink (Mbps)		500
Spectrum allocation (MHz)	Up to 40	Up to 100
Latency user plan (msec)	10	10
Latency control plan (msec)	10	50
Peak spectrum for DL (bps hz^{-1})	15	30
Peak spectrum for UL (bps hz^{-1})	6	15
Average spectrum frequency for DL (bps hz^{-1})	0.05	2.6
Average spectrum f requency for UL (bps hz^{-1})	0.09	2.7
Cell edge spectrum for DL (bps hz^{-1})	0.02	0.09
Cell edge spectrum for UL (bps hz^{-1})	0.03	0.07

The downlink reference signal structure is important for channel estimation. It defines the principle signal structure for 1-, 2- and 4-antenna transmission. It can be either cell specific or UE specific. LTE TDD UEs must support UE-specific reference signals, while it is optional for LTE FDD UEs. Here, we use UE specific reference signal.

MIMO: In the downlink, LTE uses technologies such as MIMO to achieve high data rates; however, it also offers fallback technologies such as transmit diversity or SISO. Release 10 uses MIMO support for eight transmit and receive antennas in downlink and introduces uplink MIMO by supporting up to four transmit and eight receiver antennas (LTE advanced whitepaper, Nokia-Siemens Network). The various scenarios for the downlink are reflected in the different Transmission Modes (TMs). Release 10 describes eight different TMs (LTE Advanced Whitepaper, Nokia-Siemens Network). In this study, we use 4×4 MIMO antennas along with QPSK and 16 QAM. In downlink, control channels such as PBCH and PDCCH are transmitted using transmit diversity. For four antennas, a combination of SFBC and Frequency Switched Transmit Diversity (FSTD) is used. In uplink, PUSCH data is transmitted around middle resource blocks to reduce out of carrier band emissions. PUCCH symbols are defined by a code and two resource blocks adjacent in time. Also, inter-slot hopping is enabled for PUCCH to support frequency diversity Physical Uplink Control Channel (PUCCH) carries ACK/NACK for downlink transmission, Scheduling Request Indicator (SRI) and feedback of downlink Channel Quality (CQI) and pre-coding vector to eNB. The smallest unit is 'Resource Element (RE)' and the smallest resource allocation unit is RB (Resource Block) which spans 7 REs along time domain and 12 REs along frequency domain (LTE advanced whitepaper, Nokia-Siemens Network). PUCCH reference signal is used for channel estimation on the base station in order to detect and demodulate the receive data correctly. Closed-loop transmit diversity is applied to both PUSCH and PUCCH. For sending retransmission request Acknowledgment (ACK) and Negative ACK (NAK) signals as well as scheduling request signals, application of an orthogonal zing code sequence (cyclic shift, block spread sequence) has been used. UE get the required quality at cell-edges, so applying transmit diversity to the control channels can not contribute to increasing the coverage area but only to reducing the transmission power required.

Mathmatical model and assumption in mimo power model: Many of the recent research are interested to design energy efficient MIMO. Earlier researches on energy efficient MIMO system design have been verified on 802.11 n complaint prototype (Yu *et al*., 2012). Here, we consider both one and two ended communication management system as in Yu *et al*. (2012).

System model: The MIMO system model considerations are as follows: with M transmit and N receive antennas the assumptions are frequency non-selective fading and square-rootNyquist filters at transmitter and receiver (pulse energy $E_g = 1$) and no Inter Symbol Interference (ISI). Again, Rician fading (including LOS component), i.e., channel gains are zero-mean complex Gaussian random variables is considered. Block fading, i.e., channel gains are invariant over complete data block and change randomly from one block to the next are also assumed. For discrete-time channel model, discrete time index is 1 = k = NB where NB is block length (Cho *et al*., 2010).

Mimo power model: The objective function, the MIMO energy per bit E_b can be calculated as the power consumption P divided by the data rate R, $E_b = P/R$.

In the research, we consider a MIMO transceiver which can allow more passive antennas than RF chains and employ antenna selection techniques to determine the optimal subset of antennas. Here, the power consumption of a MIMO link, PMIMO, includes that of the transmitter P_T and that of the receiver PR and also includes the power consumed by all the power amplifiers P_{PA} and that by all the other transmitter circuitries (Miao *et al*., 2011). Since, the power amplifiers are usually identical, PPA only depends on the total transmit power P_{TX}. Researchers approximate $P_{TRANSMIT}$:

$$P_{TRANSMIT} = P_{TX}/\eta\ (P_{TX})+N_T P_{T\text{-}RF\_CHAIN\_T}+P_{T\text{-}SHARED\text{-}T} \quad (1)$$

And:

$$P_{RECEIVER} = N_R\ P_{T\text{-}RF\_CHAIN\_R}+P_{T\text{-}SHARED\text{-}R} \quad (2)$$

For complete our program, we take few equation. When both ends are nodes, so we have $P = P_{MIMO}$. So, we also have $P = P_{TX}$ and $P = P_{RC}$ then we can write:

$$P_{MIMO} = P_{TRANSMIT}+P_{RECIEVER} \quad (3)$$

We have $E_b = E_b\ (P_{TX}, N_T, N_R)$ for both end and $E_b = E_b\ (P_{TX}, N_T)$ for single end antenna management for transmit. And for receive we have $E_b = E_b\ (N_R)$. Here, we also consider two types of scenarios.

A MIMO link is composed of two ends; they can be either a pair of mobile nodes like smart phones or laptops

Table 2: MIMO energy per bit minimized

		Optimization one end	
Parameters	Optimization both end	a	b
Energy per bit end	Case 1 $E_b = P_{MIMO}/R = E_b\ (P_{TX}, N_T, N_R)$	Case 2 $E_b = P_{MIMO}/R = E_b\ (P_{TX}, N_T)$	Case 3 $E_b = P_{MIMO}/R = E_b\ (N_R)$
Transmitter energy per bit	Case 4 $E_b = P_{T/R} = E_b\ (P_{TX}, N_T, N_R)$	Case 5 $E_b = P_{T/R} = E_b\ (P_{TX}, N_T)$	Case 6 $E_b = P_{T/R} = E_b\ (N_R)$
Receive energy per bit	Case 7 $E_b = P_{T/R} = E_b(P_{TX}, N_T, N_R)$	Case 8 $E_b = P_{T/R} = E_b(P_{TX}, N_T)$	Case 9 $E_b = P_{T/R} = E_b\ (N_R)$

Table 3: System model

Parameters	Description
Traffic models	
User distribution	Indoors with uniform distribution
User speed	3 km h^{-1}
Traffic model	File transfer
Radio network and deployment models	
Deployment	Hexagonal grid with wrap-around, 3 sectors/site, 21 sectors in total
Inter-site distance	500 m
Distance attenuation (L)	$L\ (d) = \beta + 10\times\alpha\ \log_{10}\ (d)$ $\beta = 3.76$, $\alpha = 15.3$
Indoor penetration loss	20 dB
Shadow fading	Log-normal, 8 dB standard deviation
Small-scale fading	3 GPP SCM urban macro 15 (Yu *et al*., 2012)
LTE system model	
Spectrum allocation	FDD, 10 MHz downlink at 2 GHz carrier frequency
Base station output power	46 dBm (40 W)
No. of base station transmit antennas	1, 2 or 4
No. of UE receive antennas	4
UE receiver	MMSE
Scheduling	Proportional fair in time and frequency domains
Transmission scheme	Code-book based precoding with rank adaptation using the LTE Rel 10 codebook

or a centralized node such as an access point or a base station and a mobile node. Usually, a mobile node is power-constrained due to limited battery life or thermal concerns while a centralized node is regarded as having unlimited power. Therefore, P can be either the power consumption of both ends or that of a single end (Yu *et al*., 2012).

There can be nine different cases due to three different expressions of the power consumption as well as three different optimization variable combinations shown in Table 2.

Among nine, here we consider three selective cases 1, 2, 3. We consider operating frequency of 2.6 GHz for LTE advanced-MIMO coverage area of 500 m urban indoor, data rates for uplink is 50 Mbps and for downlink is 100 Mbps. The no. of antennas is 4, UE speed 3 km h^{-1} both 512 and 2048 OFDM subcarriers are being considered, base station output power is about 40 W, indoor penetration loss around 20 dB. Maximum transmit power for uplink is 23 dBm or 200 mW and for downlink, it will be 46 dBm or 50 W. Hata model for pathloss is also considered. The detailed system model is shown in Table 3.

By using the above mentioned three cases we calculate the optimal transmit power and an efficient antenna configuration with an algorithm.

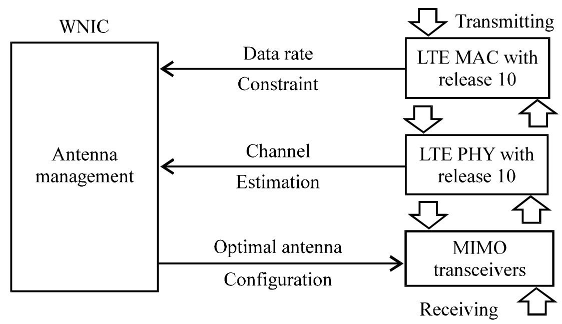

Fig. 1: Antenna configurations for LTE MAC and LTE PHY (release 10)

ALGORITHM

Algorithm; antenna management:
Input; MIMO channel matrix H, minimum data rate constraint R_{min}. Output; Optimal transmit power P_{tx_opt}, Optimal antenna configuration ω_{opt}

$E_{b,min} = +\infty$
For $1<= n_t <= N_T$, $1<= n_r <= N_R$
identify R (n_t, n_r), Using antenna selection algorithm
$P_{TX} = P_{TX}\ (n_t, n_r, R_{min})$, Using water filling algorithm
$E_b = E_b\ (P_{TX}, n_t, n_r)$
if $E_b<E_{b,min}$
$E_{b,min} = E_b$, $P_{TX\_opt} = P_{TX}$, $\omega_{opt} = \omega$
end
end
returnP_{TX_opt}, ω_{opt}

Antenna configuration

Mimo-based LTE with release 10: Release 10 supports MIMO with up to four RF chains integrated in the MIMO network interface (Fig. 1 and 2). More than one passive antenna can be attached to each RF chain to enable antenna selection. Each RF chain together with its selected passive antenna is responsible for sending a spatial stream. A single frame from LTE MAC (release 10) can be broken up and multiplexed across multiple spatial streams and then reassembled at the receiver.

Design overview: The first design is one-ended targeting the mobile node in a legacy LTE release 10 networks. The mobile node only considers its own energy efficiency. The second design is two-ended with antenna management at both ends to minimize energy per bit for the MIMO link. It is desirable when two mobile nodes on both ends are in energy constrained in a LTE release 10 ad-hoc networks.

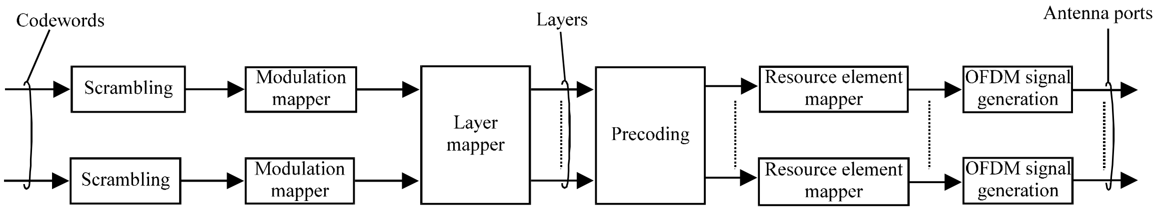

Fig. 2: Downlink PHY layer of LTE (release 10)

One end energy, continuous traffic: This is open-loop channel estimation. This estimation effective because of the acknowledgement mechanism intrinsic to LTE release 10, a receiver sends back ACK frame immediate after receiving data frame from transmitter. This ACK frame carries channel estimation information. All antennas are active by default and MIMO is working in receive mode. The transceiver can then calculate the optimal transmit power with minimum energy per bit for each antenna configuration based on CSI. For one-end antenna energy, we use R_{min} = 50, 100 Mbps. The peak data rate of LTE is given by:

$$\text{Peak bit rate}\left(\text{Mb sec}^{-1}\right) = \frac{\text{No. of symbols per subframe}}{1\,\text{m sec}} \times \left(\frac{\text{bits}}{\text{Hz}}\right) \times \text{No. of sub carriers}$$

Two-ended energy, continuous traffic: This is close-loop channel estimation but no ACK frame. Two reasons are there, one is that each data frame gets CSI from training symbols in PLCP preamble, the training symbols are much shorter compared to the resultant energy, so the total transmitted and receive energy overheads are negligible. Another point is that the receiver only needs to send back the optimal antenna configuration ω_{opt}. So for by 8 bits representations there are 256 combinations of possible configurations in the case of 4×4 MIMO link. To let the receiver identify ω_{opt}, the power profile of the transmitter, including P_{T_RF}, P_{T_SHARED} and mapping for P_{TX_opt}, needs to be known by the receiver. However, these parameters can be exchanged by the two ends in advance of data transmission and such exchange is needed only once.

Simulation-based evaluation: MATLAB is used as simulation tool for this optimal transmit power calculation and antenna management under MIMO channels in LTE advanced (release 10) system.

Simulation We choose UE category 3 (DL/UL, 100/50 Mbps) for UE-specific reference signal. UE-specific reference signals are supported for transmission of PDSCH and are transmitted on antenna port (s) p 5, 7 and 8 or p 7, 8, ..., 6 where is the number of layers used for transmission of the PDSCH. UE-specific reference signals are present and are a valid reference for PDSCH demodulation only if the PDSCH transmission is associated with the corresponding antenna port. UE-specific reference signals are denser in frequency but only transmitted when data is transmitted on the corresponding layer.

CSI reference signals are transmitted on 1, 2, 4 or 8 antenna ports using p 15, 16, p 15-18 and 15-22, respectively. Here, we use ports p 15-18 for 4×4 MIMO antenna. CSI reference signals are defined for 15 kHz only.

Feedback of Channel-State Information (CSI) is based on a separate set of reference signals CSI reference signals. CSI reference signals are relatively sparse in frequency but regularly transmitted from all antennas at the base station.

The CSI reference signal is transmitted in each physical antenna port or virtualized antenna port and is used for measurement purposes only. From the calculated PT_RF = Reference Signal Transmit Power (RSTP)+OFDM Symbol Transmit Power (OSTP) = 44.77 dBm. And PR_RF (PUSCH) = 18 dBm, η = 0.4 as in (Yu *et al*., 2012), PT_Shared = 50 mW same as model described in (Cui *et al*., 2004). We use MATLAB environment to simulate 4×4 MIMO-LTE advanced link for identical two nodes. Each transceiver has four RF chains and optimal power calculation comes from Eq. 1 and 2.

We use continuous traffic pattern that means MIMO transceiver are always busy for transmitting and receiving data, no idle period at all, frames from upper layers arrive with high rate. For example, FTP data rates will be more than the capacity of MIMO link. So, user is needed to be specifying the minimum data rate that should be satisfied by antenna management. We vary Rician factor K from 0 up to 100 for both uplink and downlink for both one ended and two ended antenna managements for UE category 3 data rates. Rician fading is a stochastic model for radio propagation normally caused by partial cancellation of a radio signal by itself the signal arrives at the receiver by several different paths. Also, we consider channel coherence time will be large enough for adapting every frame in antenna management.

As in Yu *et al.* (2012), we also consider 1000 data frames for two ended MIMO antenna link to measure the average energy per bit where the first 500 frames transmitted by node 1 and second 500 frames transmitted by node 2. For one ended energy calculation per bit consideration is that 1000 frames are transmitted by node 1. The LTE operating frequency is 2.6 GHz, QPSK and 16 QAM with convolution code of 1/2 rate and viterbi soft decision for bit are considered. Besides on Rician fading, shadowing fading and block fading are also considered. Number of subcarriers in OFDM varies from 512-2048.

RESULTS AND DISCUSSION

From algorithm, we got the optimal transmit power PTX for 16 channels of 4×4 MIMO link which is calculated by using water filling algorithm for both downlink and uplink data transmission which is shown in Table 4 and 5.

For full coverage of 500 m, eNB use three sector antennas with 1200 coverage by each. Shadowing fading is caused by obstacles in the propagation path between the UE and the eNB and can be interpreted as the irregularities of the geographical characteristics of the terrain introduced with respect to the average pathloss obtained from the macroscopic pathloss model (Ikuno *et al*., 2010). By using same low complex two-dimensional space correlated Gaussian process, we obtain highly correlated (range from 10-30 dB) shadowing effect that means during an UE travel through the ROI, slowly varying pathloss map is found which is shown in Fig. 3.

With Rician fading by using QPSK and convolution code with rate 1/2, 2048 subcarriers and 500 frames, we achieve BER up to 10-4 for LTE with very less Eb/N0 of 11 dB shown in Fig. 4.

With soft decision Viterbi decoding with Turbo coding and QAM16 modulation scheme with LTE operating frequency 2.5 Ghz, BER of 10-5 is easily achievable only the expanse of 8 dB SNR. Again from Fig. 5a, we verify that with only 4 dB power QPSK performs better (BER<10-4) than QAM16. If we expense more dB power around 10 dB, we can achieve BER near about 10-6 shown in Fig. 5b.

Table 4: Number of antenna to optimal transmit power (downlink)

No. of receiver antenna	No. of transmit antenna (W)			
	1	2	3	4
1	2.846	0.846	6.846	5.846
2	0.000	1.846	2.846	6.846
3	4.846	0.000	0.846	4.846
4	0.000	1.846	1.846	0.846

Table 5: Number of antenna to optimal transmit power (uplink)

No. of receiver antenna	No. of transmit antenna (mW)			
	1	2	3	4
1	13.125	11.125	17.125	13.125
2	7.125	12.125	11.125	15.125
3	15.125	12.125	12.125	11.125
4	9.125	16.125	16.125	14.125

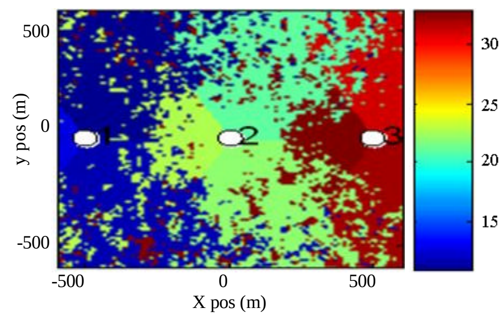

Fig. 3: Space correlated shadowing fading

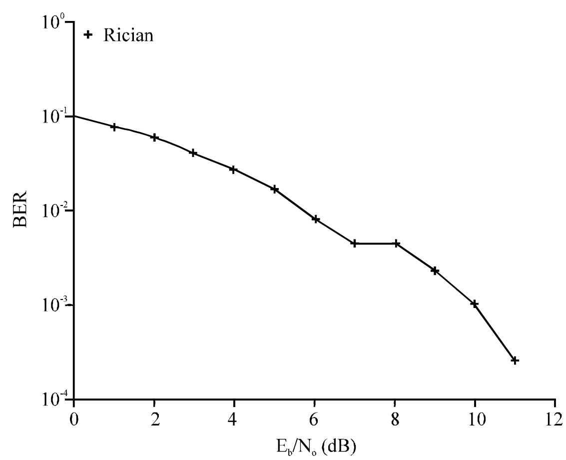

Fig. 4: QPSK in LTE with Rician fading

In the research, we examine the both one ended and two ended antenna management system with continuous traffic pattern both for downlink with R_{min} = 100 Mbps and for uplink with R_{min} = 50Mbps. Here, the running parameter is Rician factor K. We vary K from 0-100 and verify the performance. For downlink with two ended system energy per bit can be saved up to 17% and for uplink it is 18% by adaptively selecting number of antennas shown in Fig. 6a, b.

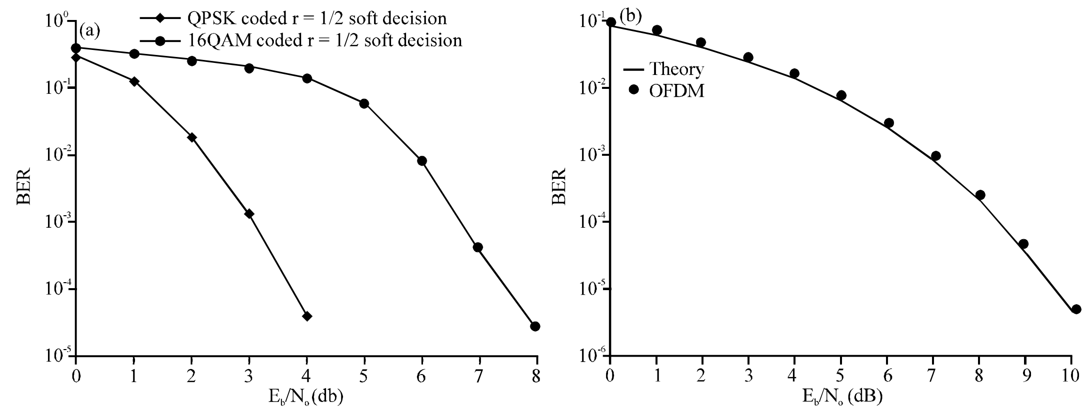

Fig. 5: a) QPSK vs. QAM16 in LTE performance (AWGN), OFDM No. of subcamer = 512 viterbi decoding; b) OFDM performance vs. shannon capacity theory vs. OFDM (QPSK/AWGN/No. channel coding)

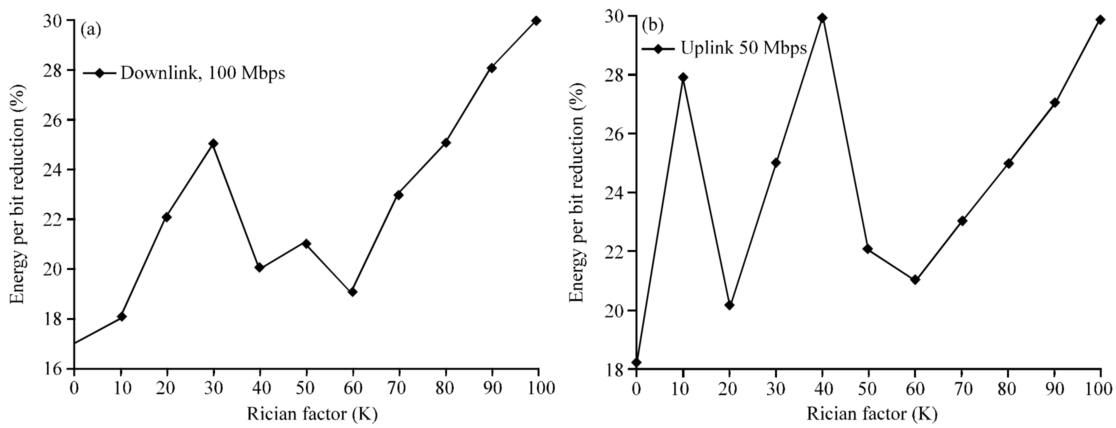

Fig. 6: a) Energy per bit reduction in downlink for two-ended system; b) Energy per bit reduction in uplink for two-ended

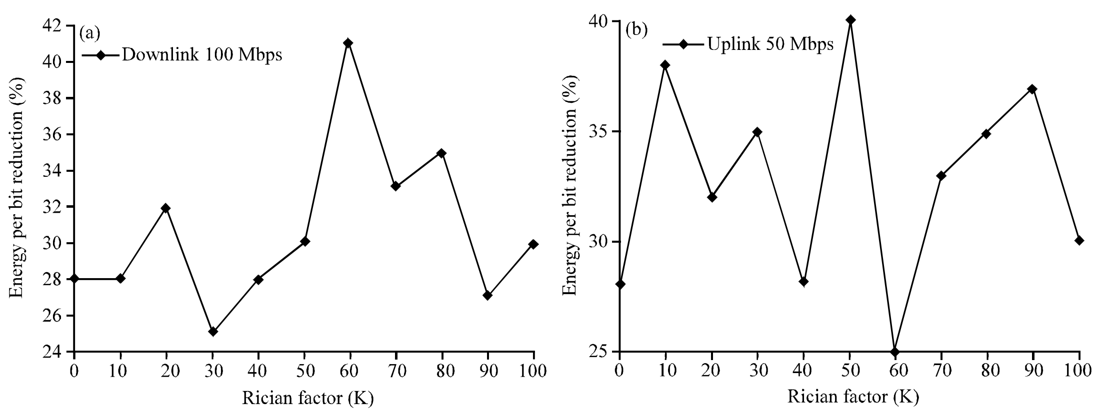

Fig. 7: a) Energy per bit reduction in downlink for one-ended system continuous traffic; b) Energy per bit reduction in uplink for one-ended system continuous traffic

With one ended system, energy per bit can be saved up to 25% by adaptively selecting number of antennas for both downlink and uplink with same data rates as before shown in Fig. 7a, b.

CONCLUSION

For 4×4 MIMO in LTE advanced (release 10) due to higher capacity and better coverage, it needs large amount of energy bit in Watt range for downlink. But for uplink we need mW range of energy. For certain amount of minimum data rate (category 3) by using adaptive selection algorithm for antenna and water filling algorithm for adaptive optimal power allocation for all channels, the system can save up to 25% of energy per bit in case of one-end system. For two-ended system it is up to 18% of saving energy per bit. Using convolution-viterbi-soft decision Turbo coding system and by increasing number of OFDM subcarriers to 2048, BER of upto 10-6 has been achieved for the expense of only 10 dB Eb/No. At the transmitting end, eNB, three sector antennas has been used for 500 m area coverage and at the receiving end. By using 2D Gaussian process we achieved highly space correlated Shadowing fading in the range of 10-30 dB.

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