ABSTRACT

LTE-A downlink transmits the data/control signals from the base station enhanced Node B to the mobile user equipment. LTE-A downlink physical layer processing is essential for information retrieval in user equipment (mobile) with reduced error rate and high throughput. Since the wireless channel is time-variant and the channel matrix is always varying by the channel characteristics, there is a necessity to analyse the channel parameters and design an efficient channel estimation algorithm to reduce the mean square error compared to the existing optimized intelligent channel estimation methods.

The channel analysis procedure in the thesis is divided into two parts: channel selection and channel estimation. For channel selection, the different LTE-A MIMO channel scenarios are analysed in terms of Block Error Rate (BLER), Throughput Fraction (TPF) and Spectral Efficiency (SE). The experimental simulations prove that at SNR of 15 dB, indoor hot is the best channel scenario with lowest block error rate of $10^{-0.16}$, high throughput fraction of 31.1% and high spectral efficiency of 9.33 bps/Hz. The next best channel is urban micro environment with low BLER of $10^{-0.105}$, high TPF of 21.4% and more SE of 6.42 bps/Hz. Since the macro environments like Urban Macro, Suburban Macro and Rural Macro are worst in performance with more error rate, they are not used mostly for channel estimation in LTE – A system. Also, it has been concluded that micro cells are better than macro cells and further micro cells can be replaced by nano cells, femto cells etc.

For implementation and analysis of different interpolation and decoding schemes over LTE-A MIMO channel scenarios, soft decoding is better than hard decision decoding and MMSE channel estimation/interpolation is better than LSE and Zero Forcing algorithm is used as the equalization method. At SNR of 15 dB, InH has minimum BLER of $10^{-0.304}$, TPF of 50.3% and SE of 15.09 bps/Hz when using MMSE-Soft decoding with 64-QAM. UMi has BLER

of $10^{-0.242}$, TPF of 42.85% and SE of 12.855 bps/Hz with MMSE-soft decoding at 15 dB SNR and has BLER of $10^{-1.3}$, TPF of 95.05% and SE of 28.515 bps/Hz with Linear-Soft at high SNR of 25 dB. Hence InH and UMi are selected as best channel for LTE-A downlink system and automatically selects the coding and modulation based on the channel statistics. Also, InH achieves 50.3% of theoretical spectral efficiency and UMi results in 42.85% of theoretical SE at 15 dB of SNR, which proves InH is better than UMi with the achievement of 7.45% of the theoretical spectral efficiency 30 bps/Hz for LTE-A downlink.

By considering the indoor hot environment, with an omni-directional antenna at mobile receiver, different antennas such as omni-directional, 3-sector and 6-sector are used in base station transmitter to analyse the performance of LTE-A downlink. The performance metrics used are BLER, throughput, TPF and SE. At SNR of 18 dB, omni-directional transmitter gives BLER of $10^{-0.49}$, throughput of 20.78 Mbps, TPF of 67.95% and SE of 20.385 bps/Hz that achieves 67.95% of theoretical SE; 3-sector transmitter gives BLER of $10^{-0.36}$, throughput of 17.24 Mbps, TPF of 56.4% and SE of 16.92 bps/Hz that achieves 56.4% of theoretical SE; 6-sector transmitter gives BLER of $10^{-0.123}$, throughput of 7.552 Mbps, TPF of 24.7% and SE of 7.41 bps/Hz that achieves only 24.7% of theoretical SE. Hence, among the different transmitting antennas, omni-directional is better than sector antennas by 11.55% and 3-sector is better than 6-sector by 31.7% increased throughput and spectral efficiency. To maintain a trade off between the selection of transmitting antenna and the spectral efficiency, 3-sector antenna is suitable for providing high throughput and spectral efficiency with minimum block error rate.

Channel estimation is used to estimate the channel frequency response compared to the reference channel matrix containing the channel coefficients. The training based CE includes LSE and LMMSE. LSE is easy to implement but has high MSE. LMMSE has low MSE than LSE but complex to implement since needed to estimate the inverse matrix every time the channel characteristics is changing. To overcome the disadvantages of existing training based optimized schemes, GOBCE algorithm is designed using genetic operators like mutation and crossover to reduce the error rate up to 9.9% compared to existing optimized channel estimation and performs superlative reconstruction in receiver. GOBCE is able to select the modulation with reduced MSE but alters the modulation type every time the channel matrix is varying which in turn affects the data rate sometimes. Hence GOBCE algorithm is best suited for fixed wireless networks that uses fibre optic cable, coaxial cables etc.

To suit the high speed wireless communication systems and to estimate the channel coefficients effectively, a lot of optimization schemes were developed. The existing optimization methods have disadvantages like low convergence speed, unsuitable for global wireless environment, more convergence time and sometime results in premature convergence. Hence, an efficient FOCE algorithm is proposed with minimum MSE and 64-QAM provides high data rate and spectral efficiency. When the order of modulation increases, the number of bits transmitted per symbol also increases and results in reduced NMSE. The proposed FOCE results in 100 times reduced NMSE than the existing optimized methods with only 150-200 generations/iterations. The existing PSO has NMSE range of $10^{-2.8}$ to 100, 1.9% lesser for GA than PSO, zero MSE for ANN; but ANN is having large training period to achieve high performance and reduced computational cost. The proposed FOCE has NMSE range of 10^{-5} to 10^{-4} which is 23.74% less than LSE, 7.89% lesser than LMMSE and 1.5% less than the existing optimized channel estimations. It has high speed of convergence, low convergence time and reduced complexity. Also, FOCE suits LTE-A applications and its upcoming generations.

In future, the channel analysis can be interlinked to any high speed networks. To satisfy the demand of users, to utilize the channel effectively and to provide broadband services like video/audio broadcasting, internet etc to all the users in wireless environments, many improvements in LTE-A downlink PDSCH processing is essential to improve data rate and spectral efficiency.