
**Ain Shams University**
**Faculty of Engineering**
**Electronics and Communications Engineering Department**

# Efficient Multiple Access Technique for Future Generation Wireless Systems

A Thesis
Submitted in partial fulfillment for the requirements for the degree of Doctor of Philosophy in Communications Engineering
(Electronics and Communications Engineering)

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# "Efficient Multiple Access Technique for Future Generation Wireless Systems"

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# Statement

This dissertation is submitted as a partial fulfillment of the degree of Doctor of Philosophy in Electrical Engineering (Electronics and Communications Engineering), Faculty of Engineering, Ain Shams University.

The author carried out the work included in this thesis and no part of it has been submitted for a degree or a qualification at any other scientific entity.

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" يرفع الله الذين امنوا منكم والذين أوتوا العلم درجات والله بما تعملون خبير "

صدق الله العظيم

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# List of Publications

1. **M. A. Abd El-Hamed**, Abdelhalim Zekry, Salah S. Elagooz and Fathi E. Abd El-Samie "Blind Selective Mapping for Single-Carrier Frequency Division Multiple Access System" Digital Signal Processing, 75 (2018) 25–37, 2018, Elsevier. (**IF=2.33**).

2. **M. A. Abd El-Hamed**, Abdelhalim Zekry, Salah S. Elagooz , and Fathi E. Abd El-Samie, "Impact of Power Amplifier non-linearity on Blind Selective Mapping for SC-FDMA System" Japan-Africa Conference on Electronics, Communications and Computers (JAC-ECC 2017), Hilton Alexandria Green Plaza, Alexandria, Egypt 18-20 Dec. 2017.

3. **M. A. Abd El-Hamed**, Abdelhalim Zekry, Salah S. Elagooz and Fathi E. Abd El-Samie "All Pass Filter Approach for Single-Carrier Frequency Division Multiple Access System" International Journal of Communication Systems, Wiley. (**Revision**).

# Abstract

Next generation of wireless mobile communication system will allow the provision of advanced multimedia services with ubiquitous access thanks to the higher data rates offered. However, it is necessary for the transmission technologies to be able to cope with problems deriving from high data rate transmission over wireless channels.

Hitherto, Orthogonal Frequency Division Multiplexing has been the most widely used multiplexing technique due to its robustness against frequency selective fading channels that highly encounter in mobile transmission. However, it suffers from High Peak-to-Average Power Ratio which may be particularly troublesome in uplink transmission because of the costly high power amplifiers that are needed in the user terminals.

Single Carrier-Frequency Division Multiple Access has become an alternative technique to the Orthogonal Frequency Division Multiple Access due to its low Peak-to-Average Power Ratio. It was chosen as the uplink multiple access scheme in the 3rd Generation Partnership Project Long Term Evolution. However, Single Carrier-Frequency Division Multiple Access still suffer from high Peak-to-Average Power Ratio in the uplink transmission which results in reducing power efficiency of the system. As a result there is a need to reduce the Peak-to-Average Power Ratio of the Single Carrier-Frequency Division Multiple Access system.

In this thesis many theoretical foundations of Single Carrier-Frequency Division Multiple Access have been introduced. The performance of the Single

Carrier-Frequency Division Multiple Access system has been studied and enhanced by applying two proposed techniques for reducing the Peak-to-Average Power Ratio namely Blind-Selective Mapping and All Pass Filters schemes. Different factors and parameters are taken into consideration and many comparisons have been made to clarify the obtained results. Results show that the proposed Blind-Selective Mapping Single Carrier-Frequency Division Multiple Access scheme provides better performance compared with the traditional Single Carrier-Frequency Division Multiple access scheme. Also, in comparing the performances of the two proposed Peak-to-Average Power Ratio reduction schemes, results shows that the All Pass Filters Single Carrier-Frequency Division Multiple Access provides better performance in terms of the Peak-to-Average Power Ratio. Many other results are given in the thesis.

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# List of Abbreviations

| | |
|---|---|
| 1G | First Generation |
| 2G | Second Generation |
| 3G | Third Generation |
| 3D | Three Dimensional |
| 3GPP | Third Generation Partnership Project |
| 4G | Fourth Generation |
| 5G | Fifth Generation |
| A/D | Analog-to-Digital |
| ACE | Active Constellation Extension |
| AMPS | Advance Mobile Phone Service |
| AM/AM | Amplitude/Amplitude |
| AM/PM | Amplitude/Phase |
| APFs | ALL Pass Filters |
| APFs-SC-FDMA | SC-FDMA system based on APFs |
| ASE | Active Set Extension |
| AWGN | Additive White Gaussian Noise |
| BER | Bit Error Rate |
| BS | Base Station |
| B-SLM | Blind Selective Mapping |
| B-SLM-SC-FDMA | Blind Selective Mapping scheme for SC-FDMA |
| B-SLM-SC-IFDMA | SC-IFDMA based on B-SLM |
| B-SLM-SC-LFDMA | SC-LFDMA based on B-SLM |
| CCDF | Complementary Cumulative Distribution Function |
| CCRR | Computational Complexity Reduction Ratio |

| | |
|---|---|
| CDMA | Code Division Multiple Access |
| CFOs | Carrier Frequency Offsets |
| CL | Clipping Level |
| CP | Cyclic Prefix |
| CR | Clipping Ratio |
| C-SLM | Conventional Selected Mapping |
| C-SLM-SC-LFDMA | SC-LFDMA based on C-SLM |
| D/A | Digital-to-Analog |
| DFDMA | Distributed Frequency Division Multiple Access |
| DVB | Digital Video Broadcasting |
| dB | Decibel |
| FDE | Frequency Domain Equalization |
| EDGE | Enhanced Data Rates for GSM Evolution |
| FFT | Fast Fourier Transform |
| FBMC | Filter Bank Multicarrier |
| FDMA | Frequency Division Multiple Access |
| GA | Genetic Algorithm |
| GFDM | Generalized Frequency Division Multiplexing |
| GPRS | General Packet Radio Service |
| GSM | Global System for Mobile |
| HD | High Definition |
| HPA | High Power Amplifier |
| HSPA | High Speed Packet Access |
| IP | Internet Protocol |
| I/Q | In-phase/Quadrature-phase |
| IAI | Inter-Antenna Interference |
| IBI | Inter-Block Interference |
| IBO | Input Back-Off |