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## MIMO block spread OFDMA system for next generation mobile communications

Yiwei Yu  
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# MIMO Block Spread OFDMA System for Next Generation Mobile Communications

A thesis submitted in partial fulfilment of the requirements for the award of the  
degree

Master of Engineering by Research

from

UNIVERSITY OF WOLLONGONG

by

Yiwei Yu

Master of Engineering Studies

School of Electrical, Computer and Telecommunications Engineering

March 2008

# Statement of Originality

I, Yiwei Yu, declare that this thesis, submitted in partial fulfilment of the requirements for the award of Master of Engineering - Research, in the School of Electrical, Computer and Telecommunications Engineering, University of Wollongong, is wholly my own work unless otherwise referenced or acknowledged. The document has not been submitted for qualifications at any other academic institution.

Yiwei Yu

March 26, 2008

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# Acronyms

**1G** First-generation

**2G** Second-generation

**3G** Third-generation

**4G** Fourth-generation

**AWGN** Additive white Gaussian noise

**BER** Bit error rate

**BPSK** Binary phase shift keying

**BS-OFDM** Block spread OFDM

**BS-OFDMA** Block spread orthogonal frequency division multiple access

**CDMA** Code division multiple access

**CP** Cyclic prefix

**DFE** Decision feedback equalizer

**DFT** Discrete Fourier transform

**DMB** Digital multi media broadcasting

**DVB** Digital video broadcasting

**DVB-C** DVB-cable

**DVB-H** DVB-handheld

**DVB-S** DVB-satellite television and satellite Internet

**DVB-T** DVB-terrestrial

**EC** Eurppean Commission

**FFT** Fast Fourier transform

**FWA** Fixed wireless access

**GSM** Global system for mobile communications

**HAP** High altitude platforms

**ICI** Inter-carrier interference

**IFFT** Inverse fast Fourier transform

**ISDB** Integrated services ditial broadcasting

**ISDB-C** ISDB-cable

**ISDB-S** ISDB-satellite television

**ISI** Intersymbol interference

**M2M** Machine-to-machine

**MAC** Media access control

**MAGIC** Mobile multimedia; Anytime, anywhere, anyone; Global mobility support;  
Integrated wireless solution; and Customized personal service

**MC-CDMA** Multicarrier CDMA

**MC-DS-CDMA** multicarrier direct sequence CDMA

**MIMO** Multi-input and multi-out

**MISO** Multiple input and single output

**MLSE** Maximum likelihood sequence estimator

**MMSE** Minimum mean square error

**M-PSK** M phase shift keying

**M-QAM** M quadrature amplitude modulation

**NLOS** non-line-of-sight

**OFDM** Orthogonal frequency division multiplexing

**OOB** Out of band

**PAN** Personal area network

**PAPR** Peak to average power ratio

**PHY** Physical layer

**PN** Pseudo-noise

**P/S** Parallel to serial

**QoS** Quality of service

**QPSK** Quadrature phase shift keying

**SNR** Signal to noise ratio

**S/P** Serial to parallel

**SS** Spread spectrum

**STBC** Space-time block coding

**STC-MIMO** Space-time coded MIMO

**STTC** Space-time trellis coding

**TCM** Trellis-coded modulation

**TD-SCDMA** Time division synchronous CDMA

**UMTS** Universal Mobile Telecommunication system

**WCDMA** Wideband CDMA

**W-CPN** Wireless customer premise network

**WiMAX** Worldwide interoperability for microwave access

**W-LAN** Wireless local area network

**WLL** Wireless local loop

**ZF** Zero-forcing

# Abstract

Wireless communications are developing at a booming speed, with plenty of research emerging on the next generation wireless communications. This thesis presents an advanced system for the next generation wireless communications. The proposed system is called block spread OFDMA combined with STC-MIMO (STC-MIMO BS-OFDMA). The system is based on OFDM, which is able to deliver high data rates in highly dispersive channels and is thereby considered as a good candidate of modulation techniques for 4G. The block spreading technique and STC-MIMO scheme are used to provide the system with frequency and spatial diversity, therefore significantly improving system performance.

In this system, there are two stages to combine block spreading and STC-MIMO with OFDMA. Firstly, a novel block spreading approach is applied to effectively achieve frequency diversity in the OFDMA system without any explicit precoding process. The STC-MIMO using Alamouti code is then incorporated on block basis and performs in space and frequency. Accordingly, the signal model and architectures of the proposed system are presented. Two receiver architectures are designed for different STC-MIMO schemes: the receiver with one antenna and receiver with two antennas.



Simulations are carried out to demonstrate the expected performance improvement. The BER performance comparisons indicate that the proposed system can achieve significant performance improvement. The research project also investigates the system performance when different parameters are used. Our results show that using a larger block spreading size and more receive antennas can further improve system performance because of higher order of diversity advantages. In terms of linear equalizations, the MMSE equalization achieves better performance than the ZF equalization.

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