Ain Shams University
Faculty of Engineering
Electronics and Communications Engineering Department

Design and Implementation of The Multiplexer and Channel Coder for WCDMA

A Thesis
Submitted in partial fulfillment for the requirements
Of the degree of Master of Science in Electrical Engineering
(Electronics and Communications Engineering)

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Cairo 2008

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<u>Statement</u>

This dissertation is submitted to Ain Shams University in partial fulfillment of the degree of Master of Science in Electrical Engineering (Electronics and communications Engineering)

The work included in this thesis was carried out by the author at the department of Electronics and Communications Engineering, Faculty of Engineering, Ain Shams University, Cairo, Egypt.

No part of this thesis was submitted for a degree or a qualifications at any other university or institution.

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Thesis Abstract

Tamer Kamal Elewa,"Design and Implementation Of Multiplexer and channel encoder system for WCDMA " , Master of Science dissertation, Ain Shams University, 2008

Third generation Mobile communication systems has acquired a great attention in the last few years. Boosted by a notable increase in the number of mobile users, and an increasing demand of Mobile based applications not limited to voice and other circuit switched based applications, but extended rapidly to include high speed internet access, Mobile Banking, video and audio streaming, location based services. Third generation Mobile Communications systems makes all the above applications available by providing a reliable network architecture, good utilization of radio resources, and a well managed quality of service profiles according to each service requirements.

WCDMA FDD is the most wide spread third generation system, commercially deployed in many countries, and seamlessly evolving from the existing GSM (second generation) Mobile systems.

In this thesis we focus on an important part of the WCDMA transceiver system which is multiplexing and channel coding, a process that handles the data between the MAC layer and the physical layer, and results in the preparation of data to handle the distortion and errors resulting from the transmission over radio channels

A complete implementation to the transmitter system was done fully compliant with the 3GPP standards, followed by a design and an implementation of the receiver part that perform the inverse operation of the transmitter part. System performance evaluation was carried out to evaluate the system BER performance with different radio conditions, different channel encoding types, different rate matching schemes.
The results can be a useful guideline to system designers to determine the proper operation point for each service type according to the service BER requirements and the available radio conditions.

Acknowledgement

I would like to offer my great thanks and gratitude to Dr.Abdel Halim Zakry for his support, supervision and guidance during all the phases of this work.

I would like to thank my family for their encouragement and support.

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Glossary of Terms

ARQ	Automatic Repeat Request
BCH	Broadcast Channel
BER	Bit Error Rate
BLER	Block Error Rate
BS	Base Station
CCPCH	Common Control Physical Channel
CCTrCH	Coded Composite Transport Channel
CFN	Connection Frame Number
CRC	Cyclic Redundancy Check
DCH	Dedicated Channel
DL	Downlink (Forward link)
DPCCH	Dedicated Physical Control Channel
DPCH	Dedicated Physical Channel
DPDCH	Dedicated Physical Data Channel
DS-CDMA	Direct-Sequence Code Division Multiple Access
DSCH	Downlink Shared Channel
DTX	Discontinuous Transmission
FACH	Forward Access Channel
FDD	Frequency Division Duplex
FER	Frame Error Rate
GF	Galois Field
HARQ	Hybrid Automatic Repeat reQuest
HS-DPCCH	Dedicated Physical Control Channel (uplink) for HS-DSCH
HS-DSCH	High Speed Downlink Shared Channel
HS-PDSCH	High Speed Physical Downlink Shared Channel
HS-SCCH	Shared Control Channel for HS-DSCH
MAC	Medium Access Control
Mcps	Mega Chip Per Second
MS	Mobile Station
OVSF	Orthogonal Variable Spreading Factor (codes)
PCCC	Parallel Concatenated Convolutional Code
PCH	Paging Channel
PhCH	Physical Channel
PRACH	Physical Random Access Channel
RACH	Random Access Channel
RSC	Recursive Systematic Convolutional Coder
RV	Redundancy Version
RX	Receive
SCH	Synchronisation Channel
SF	Spreading Factor
SFN	System Frame Number
SIR	Signal-to-Interference Ratio
SNR	Signal to Noise Ratio
TF	Transport Format

TFC	Transport Format Combination
TFCI	Transport Format Combination Indicator
TPC	Transmit Power Control
TrCH	Transport Channel
TTI	Transmission Time Interval
TX	Transmit
UL	Uplink (Reverse link)

CHAPTER 1

1 INTRODUCTION

1.1 History of Mobile Cellular Systems

1.1.1 First Generation

The first generation of mobile cellular telecommunications systems appeared in the 1980s [1]. The first generation was not the beginning of mobile communications, as there were several mobile radio networks in existence before then, but they were not cellular systems either. The capacity of these early networks was much lower than that of cellular networks, and the support for mobility was weaker.

In mobile cellular networks the coverage area is divided into small cells, and thus the same frequencies can be used several times in the network without disruptive interference. This increases the system capacity. The first generation used analog transmission techniques for traffic, which was almost entirely voice. There was no dominant standard but several competing ones.
The most successful standards were *Nordic Mobile Telephone* (NMT), *Total Access Communications System* (TACS), and *Advanced Mobile Phone Service* (AMPS). Other standards were often developed and used only in one country, such as C-Netz in West Germany and Radiocomm 2000 in France.

All first generation cellular systems employ Frequency Division Multiple Access (FDMA) with each channel assigned to a unique frequency band within the a cluster of cells.