

TABLE OF CONTENTS

CHAPTER	TITLE	PAGE
	DECLARATION	
	DEDICATION	
	ACKNOWLEDGEMENT	i
	ABSTRACT	ii
	ABSTRAK	iii
	TABLE OF CONTENTS	iv
	LIST OF TABLES	viii
	LIST OF FIGURES	ix
	LIST OF ABBREVIATIONS	xi
	LIST OF APPENDICES	xiii
1	INTRODUCTION	
	1.1 Project Background	1
	1.2 Objective	3
	1.3 Scope of Project	3
	1.4 Project Methodology	4
	1.5 Thesis outlines	5
2	LITERATURE REVIEW	

2.1	History Of Mobile Communication	7
2.2	Types Of Switching	10
2.2.1	Circuit Switching	10
2.2.2	Packet Switching	11
2.3	Multiple Access Techniques	12
2.3.1	Frequency Division Multiple Access	12
2.3.2	Time Division Multiple Access	12
2.3.3	Code Division Multiple Access	12
2.4	WCDMA Radio Access Network Architecture	14
2.4.1	CS Switching	15
2.4.2	PS Switching	15
2.5	CDMA Technologies	15
2.5.1	Handover	16
2.5.2	Soft Handover	16
2.5.3	Softer Handover	17

3

QUALITY OF SERVICE

3.1	Quality Of Service Measurements	21
3.1.1	Quality Of Service Definition	22
3.1.2	Network Performance Definition	22
3.1.3	Key Performance Indicators	22
3.1.4	Quality Of Service Indicator List	23
3.1.4.1	Network Access	23
3.1.4.2	Service Access	23
3.1.4.3	Service Integrity	24
3.2	Packet Switch Indicator	24
3.3	Quality Of Service Architecture	25
3.3.1	UMTS Bearer	26

3.3.2	Radio Access Bearer Service	26
3.3.3	Core Network Bearer Service	26
3.4	UMTS QoS Classes	26
3.4.1	Conversational Class	27
3.4.2	Streaming Class	27
3.4.3	Interactive Class	27
3.4.4	Background Class	27
3.5	QoS Attributes	28
3.6	General Requirements For QoS	28
3.7	Interactive Traffic	29
3.8	UMTS Measurement Modes	30
3.8.1	Statistics In The Idle State	31
3.8.2	Statistics In The Connection Establishment	31
3.8.3	Statistics In The Connected Mode	31
3.9	QoS Measurement Methods	32
3.9.1	Offline Vs. Online	32
3.9.2	Throughput Measurements	33
3.9.3	Delay Measurements	33
3.9.4	Statistical Measurements	33

4

Test Bed Description and Field Measurements

4.1	Introduction	34
4.2	Test Bed Topology	35
4.3	Test Bed Procedures	37
4.3.1	Test Routes	37
4.3.2	Drive Test Time	37
4.3.3	Connection Types	38

4.3.4	Measurement Configuration	38
4.3.5	Key Performance Indicators	39
4.3.5.1	CPICH Ec/No	40
4.3.6	Data Transfer To QVP	40
4.4	HTTP Measurements	41
4.4.1	Sequence of HTTP Access	41

5

3G Radio Network Performance measurements and Analysis

5.1	Data Collection Technique	44
5.2	Field Measurements	44
5.2.1	Scanner Measurements	44
5.2.2	Throughput Rates Achieved	46
5.2.3	Measurement Statistics	47
5.3	Problem Areas	59
5.3.1	Air Interface	50
5.3.1.1	Coverage	50
5.3.1.2	Handover	53
5.3.2	Core Network Problem	55
5.3.2.1	Long Time Processing	60

6

CONCLUSION

6.1	Conclusion	59
6.2	Future Work	60

REFERENCES	62
-------------------	----

APPENDIX A-G	64
---------------------	----

LIST OF TABLES

TABLE NO.	TITLE	PAGE
2.1	Features Of WCDMA	9
2.2	Difference Between WCDMA And GSM	10
3.1	QoS Attributes	28
3.2	UMTS Classes Requirements	29
5.1	HTTP Throughout Summary	46
5.2	Call Statistics	46
5.3	QoS Statistics	48
5.4	Test Survey	57
A.1	Operator A Statistics(www.google.com)	64
A.2	Operator B Statistics(www.google.com)	65
A.3	Operator A Statistics(www.yahoo.com)	66
A.4	Operator B Statistics(www.yahoo.com)	67
A.5	Operator A Statistics(www.yahoo.com.sg)	68
A.6	Operator B Statistics(www.yahoo.com.sg)	69
A.7	Operator A Error Distribution	70

LIST OF FIGURES

FIGURE NO.	TITLE	PAGE
1.1	3G Evolution Path	1
1.2	Frequency Allocation For IMT2000	2
1.3	QVOICE	4
1.4	Project Methodology	5
2.1	Mobile Telephone Systems Using Cellular Architecture	8
2.2	UMTS Network Architecture	10
2.3	Multiple Access Technique	13
2.4	UMTS Call Initiation Procedure	18
2.5	UMTS Mobile Originated Call Transfer Procedures	19
2.6	UMTS Mobile Terminated Call Transfer Procedures	20
3.1	Quality Of Service Aspects	23
3.2	End-To-End Quality Of Service Architecture	25
3.3	UMTS QoS Classes	27
3.4	Measurements Modes	30
4.1	Test Bed Topology	35
4.2	Test Procedures	36
4.3	Drive Test Route	37
4.4	Type Of Tests	39
4.5	HTTP Measurements	43
4.6	Sequence Of HTTP Access To Public Server	42
5.1	Scanner Measurements	45
5.2	Cumulated HTTP Throughput Distribution	46
5.3	Network Interfaces	49

5.4	Ec/Io	50
5.5	Coverage	51
5.6	Block Error Rate	52
5.7	Database Observer	53
5.8	Soft Handover Statistics	54
5.9	Soft Handover	55
5.10	Download Time	56
5.11	Download Time Survey	56
5.12	Remote Access Service Survey	57
A.1	Operator A Statistics(www.google.com)	64
A.2	Operator B Statistics(www.google.com)	65
A.3	Operator A Statistics(www.yahoo.com)	66
A.4	Operator B Statistics(www.yahoo.com)	67
A.5	Operator A Statistics(www.yahoo.com.sg)	68
A.6	Operator B Statistics(www.yahoo.com.sg)	69
A.7	Operator A error distribution	70

LIST OF ABBREVIATIONS

ASCII	
1G	First Generation
2G	Second Generation
3GPP	Third Generation Partnership Project
AMPS	Advanced Mobile Phone service
APN	Access Point Name
CDMA	Code Division Multiple Access
CN	Core Network
CS	Circuit Switching
ETSI	European Telecommunications Standards Institute
FDMA	Frequency Division Multiple Access
FTP	File Transfer Protocol
GMM	GPRS Mobility Management
GMSC	Gateway MSC
GPRS	General Packet Radio Service
GPS	General Position System
GSM	Global Service Mobile
HLR	Home Location Register
HO	Handover
HTTP	Hypertext Transfer Protocol
IMT2000	International Mobile Telecommunication 2000
IP	Internet Protocol
ITU	International Telecommunication Union
KPI	Key Performance Indicator

MO	Mobile Originated
MT	Mobile Terminated
NMT	Nordic Mobile Telephone
Oper.	Operator
PDP	Packet Data Protocol
PDU	Packet Data Unit
PLMN	Public Land Mobile Network
PS	Packet Switching
QoS	Quality of Service
QVM	QVOIC Mobile
QVP	QVOIC Presentation
RAB	Radio Access Network
RAN	Radio Access Network
SGSN	Serving GPRS Support Node
SQL	Structured Query Language
TACS	Total Access Telecommunication System
TDMA	Time Division Multiple Access
TE	Terminal Equipment
UE	User Equipment
UMTS	Universal Mobile Telecommunications Services
UTRAN	UMTS Terrestrial Radio Access Network
VLR	Visit Location Register
WCDMA	Wide Code Division Multiple Access

LIST OF APPENDICES

APPENDIX NO.	APPENDICES	PAGE
A	Statistics for Oper. A. and B.	68
B	HTTP Mean Throughput	75
C	HTTP Download Time	81
D	Handover	87
E	Active Set	88
F	WCDMA Coverage	89
G	HTTP Download Time	90