

# TABLE OF CONTENTS

الاية	i
DEDICATIONS	ii
ACKNOWLEDGEMENT	iii
ABSTRACT	iv
مستخلص	v
LIST OF ABBREVIATIONS	vi
TABLE OF CONTENTS	viii
LIST OF FIGURES	xii
LIST OF TABLES	xiv
<b>CHAPTER ONE</b>	
<b>INTRODUCTION</b>	
1.1 General	1
1.2 Problem Definition	2
1.3 Objectives	3
1.4 Methodology	3
1.5 Lay out	4
<b>CHAPTER TWO</b>	
<b>SUBSTATION OVERVIEW</b>	
2.1 Introduction	5
2.2 Substation Communication	7
2.3 Supervisory Control and Data Acquisition (SCADA) system	8
2.3.1 Human machine interface (HMI)	8
2.3.2 SCADA master	9
2.3.3 Remote terminal unit (RTU)	9
2.3.4 Intelligent electronic device (IED)	10

2.3.5 Communication infrastructure	10
2.4 Integration and Automation Approaches in Substation	12
2.4.1 Substation automation	12
2.4.2 Substation integration	13
2.5 Substation Automation	13
2.5.1 Architecture of typical substation automation	14
2.5.1.1 Protection	15
2.5.1.2 Control	16
2.5.1.3 Measurement	16
2.5.1.4 Monitoring	16
2.5.2 Communication network	16
2.5.2.1 Station level	17
2.5.2.2 Bay level	18
2.5.2.3 Process level	18
2.5.3 Communication type	18
2.5.3.1 Vertical communication	18
2.5.3.2 Horizontal communication	20
<b>CHAPTER THREE</b>	
<b>SUBSTATION AUTOMATION BASED ON IEC61850</b>	
3.1 Introduction	21
3.1.1 History of IEC61850	22
3.2 Information Structure in IEC61850	23
3.3 Information Model of Substation Automation System	25
3.3.1 Data model	27
3.3.2 Application model by logical node	31
3.4 Substation Configuration Language (SCL)	33
3.4.1 Header	33
3.4.2 Substation	33
3.4.3 Communication	34
3.4.4 Intelligent electronic device (IED)	34
3.4.5 Data type template	35

3.4.5.1 System specification description (SSD)	35
3.4.5.2 IED capability description (ICD)	35
3.4.5.3 Substation configuration description (SCD)	35
3.4.5.4 Configured IED description (CID)	36
3.5 Network	37
3.5.1 Network architecture	37
3.5.1.1 Bus or cascading architecture	37
3.5.1.2 Ring network architecture	38
3.5.1.3 Star network architecture	39
3.5.2 Component features	40
3.5.3 Data transfer medium	40
3.5.4 Information security	41
<b>CHAPTER FOUR</b>	
<b>APPLICATION OF GOOSE</b>	
4.1 Introduction	42
4.2 Conventional Information Exchange in Substation	42
4.3 Generic Object Oriented Substation Event (GOOSE) Information Exchange	44
4.3.1 Benefit of GOOSE	45
4.4 GOOSE of IEC61850 Communication View	46
4.4.1 Abstract communication service interface (ACSI) model	46
4.4.1.1 IED server	47
4.4.1.2 Logical device (LD)	47
4.4.1.3 Logical nodes (LN)	48
4.4.1.4 Data	48
4.4.1.5 Data set	48
4.4.1.6 Associations	48
4.4.1.7 Time synchronization	48
4.4.1.8 Data object instance (DOI)	48
4.5 GOOSE Application	49
4.5.1 Bay interlocking	50
4.5.2 Breaker failure protection	52

<b>CHAPTER FIVE</b>	
<b>APPLICATION TEST</b>	
5.1 Documentation	54
5.2 Relevant Documentation	54
5.2.1 Signal list	55
5.2.2 Logical diagram	56
5.3 Arc Flash Protection Application	57
5.4 Intelligent Electronic Devices (IED) Configuration	59
5.4.1 System specification description (SSD) creation	59
5.4.2 Loading the IED capability description (ICD) file	62
5.4.3 Intelligent electronic device (IED) creation	62
5.4.4 Logical device creation	63
5.4.5 Creating logical nodes	64
5.4.6 Mapping of functions to IED	66
5.4.7 Communication set up	68
5.4.7.1 Data set creation	68
5.5 GOOSE Control Block (GOCB) Creation	70
5.6 Test Equipments	73
5.7 Network Testing	74
4.8 Testing Method	76
<b>CHAPTER SIX</b>	
<b>CONCLUSIONS AND RECOMMENDATIONS</b>	
6.1 Conclusions	77
6.2 Recommendations	77
<b>References</b>	78
<b>Appendices</b>	
Appendix-A	80
Appendix-B	82