

Automated Meter Reading System for CEB

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**A dissertation submitted for the Degree of Master of
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ABSTRACT

The Ceylon Electricity Board (CEB) is the largest and only integrated electricity producer and supplier since 1969 to Sri Lankan consumers. CEB is catering for both retail & bulk customers. Where bulk consumers are responsible for 50% of the revenue. Due to the competitive bidding procedure digital smart meters provided for these consumers were purchased from various vendors which makes billing complicated due to cross-platform incompatibility. Need specific network accessories in addition to currently available remote meter reading systems in the market make this process more expensive. Thus, the need for a separate automated solution to connect all devices into the main Heavy Supply Billing System (HSBS) was aroused. This could minimize the labor cost and potential human errors.

Developing an automated solution in-house for in-expensive vendor independent remote smart meter reading and writing directly into database from any type of network is the main objective of this project. Using this system CEB could make the billing process faster and bills readily downloadable on the next day after the reading from the CEB datacenter.

By implementing this solution, CEB is mainly focusing on streamlining the reading collection process while reducing work force and also enhancing this process and the automation application to get real time reading processing and automatic bill calculation. This will be a benefit for a corporate customer to get real time reading and billing information for their industries.

Further this solution will be improving for the mobile version software hence the users get more benefits from that.

DECLARATION

The thesis is my original work and has not been submitted previously for a degree at this or any other university/institute.

To the best of my knowledge it does not contain any material published or written by another person, except as acknowledged in the text.

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TABLE OF CONTENT

Abstract.....	i
Declaration.....	ii
Acknowledgements.....	iii
Table of Content	iv
List of Figures	vi
List of Tables	vii
List of Abbreviations	viii
Chapter 1.....	1
Introduction	1
1.1 Background	1
1.2 Motivation.....	1
1.3 Aim and Objectives	2
1.4 Scope of the Project.....	2
1.5 Structure of the Dissertation.....	2
Chapter 2.....	4
Background	4
2.1 Literature Review.....	4
2.1.1 Current situation.....	4
2.1.2 Shortcomings of the current system.....	5
2.1.3 Systems used in the industry	5
2.1.4 Proposed solution	6
2.2 System Requirement.....	6
2.2.1 Functional Requirement.....	6
2.2.2 Functional Description Overview.....	7
2.2.3 Non-Functional Requirement	8
2.3 Association with current systems in CEB	9
2.4 Study and Critical Analysis of Existing System	9
Chapter 3.....	10
Methodology.....	10
3.1 Modeling	10
3.1.1 Process Modeling.....	10
3.1.2 Selection of Modeling Language.....	10
3.2 Data Modeling.....	11
3.2.1 ER Diagram.....	11

3.2.2 Use case diagrams.....	12
3.3 Database Table Structure.....	12
3.4 Design of Audit Trails	21
3.5 Security scheme Design	22
Chapter 4.....	23
Implementation	23
4.1 Selection of Technology	23
4.1.1 Software Tools	23
4.1.2 Hardware	23
4.2 Implementation Methodology.....	23
Chapter 5.....	24
Testing and Evaluation.....	24
5.1 Software Testing	24
5.1.1 Software Testing Model.....	24
5.1.2 Testing Stages	24
5.1.3 Levels of Granularities of Testing.....	25
5.1.4 Software Tools used for Testing	26
5.1.5 Test Cases.....	26
5.2 Software Evaluation	26
5.3 Usability Evaluation.....	27
5.4 Problems and Lessons Learnt	27
5.5 Problems beyond Control	27
Chapter 6.....	28
Conclusion.....	28
6.1 Improvements through Future Work.....	28
References	29
Appendix	30
A. Test Case	36

LIST OF FIGURES

1.1	Functional explanation and its flow from consumer's meter to CEB Billing System.....	7
2.1	Network Architecture....	8
3.1	ER Diagram	11
3.2	Use Case Diagram	12
3.3	Class Diagram	14
3.4	Sequence Diagram	17
3.5	Activity Diagram for user login	18
3.6	Activity Diagram for schedule meters for download	19
3.7	Activity Diagram for Read Meter	20
3.8	Activity Diagram for update Head Office database	21
5.1	Comparison Model of program Testing	25

LIST OF TABLES

3.1	Structure of area Table.....	30
3.2	Structure of customer Table.....	30
3.3	Structure of meter table.....	30
3.4	Structure of metermodel.....	31
3.5	Structure of Rdn_Status.....	31
3.6	Structure of Reading Table.....	32
3.7	Structure of Reading_tmp Table.....	33
3.8	Structure of sch_status	34
3.9	Structure of schedule Table.....	34
3.10	Structure of schedule_list Table.....	35

LIST OF ABBREVIATIONS

CEB	Ceylon Electricity Board
DLMS	Device Language Message Specification
GPRS	General Packet Radio Service
GSM	Global System for Mobile communication
OBIS	Ocean Biogeographic Information System
ER	Entity-Relationship
VPN	Virtual Private Network
ASP	Active Server Page
UML	Unified Modelling Language
CLR	Common Language Runtime
CIL	Common Intermediate Language
IDE	Integrated Development Environment

CHAPTER 1

Introduction

1.1 Background

The Ceylon Electricity Board is the largest and only integrated electricity utility in Sri Lanka. It controls all major functions of electricity generation, transmission, distribution and retailing in Sri Lanka. It was established in 1969 under the Electricity Act. The CEB now has a total installed capacity of 4,046 MW and a gross generation of 15,985 GWh as at 2018. CEB interacts with a large number of consumers in Sri Lanka including domestic, general purpose, religious and industry customers who are categorized based on the purpose of using electricity. [1]

1.2 Motivation

CEB is catering two types of customers, retail & bulk supply customers. Out of those two types 50% of CEB revenue is being collected from bulk supply consumers, around 12,000 customers connected to national grid island wide. Almost all the bulk supply consumers are connected to the grid via digital smart meters, CEB is able to read those meters remotely by the Energy Management Unit, and sometimes by the relevant Area Office directly. The collecting meter reading for those bulk supply consumers has become more complicated as the CEB is installing different types of meters from different manufacturers, as CEB has to adhere government tender procedure. Therefore CEB is supposed to purchase third party remote meter reading downloading software licenses from those different manufacturers.

As the reading downloading formats are different from one model of meter to another model, It has been identified the need of separate automated solution to streamline those different formats and compiling into one format where the main HSBS (Heavy Supply Billing System) can use as the meter reading input file. This eliminates the human intervention in preparing the downloaded reading file into the specific format that Heavy Supply Billing System requires as the input file.

1.3 Aim and Objectives

The aim of the Project is to implement and automated meter reading solution in CEB to make efficient way in providing timely billing information for the corporate electricity consumers as well as corporate management in Ceylon Electricity Board.

In achieving the above aim, objectives are listed below.

- Develop a common meter reading software which will be used to access consumption data from different types of digital electricity meters with manufacture specific configurations and transfer those reading data to a centralized location for bill processing with reducing the cost of data collection and manual updates.
- With the system implementation, real time and accurate consumption data will be available for analysis and decision makings to the management.
- Provide a low cost hardware solution with a standard modem suitable of all meter types to avoid purchasing of dedicated modems recommended by the meter vendor.

1.4 Scope of the Project

Develop a CEB own AMR software solution, with the scope of download remote meter readings of bulk customers, consumption measurement, transmission of measured data, and data processing and billing. This system designed with a scheduler process to schedule all meters to get remote readings and reading will be downloaded to the billing system located at CEB data centers. System exceptions, relevant to reading failures will be captured and log for further analysis. At any reading failure, system will be facilitated to retry the reading process. System is designed to support both GSM and telecommunications networks in reading meters.

1.5 Structure of the Dissertation

Chapter 2 is included a detailed description of functional and non-functional requirements of the system and a literature review. Chapter 3 is described the structure of the overall system, design methodologies which were used, development tool used, use case diagrams, sequence diagrams, class diagrams , entity relationship diagram and brief introduction of database tables.

Chapter 4 is described design methodologies, implementation environment and development tools used. Chapter 5 elaborates the approaches of testing and evaluation of the software. The last chapter 6 is described the summary of achievements of the project and suggestions for future enhancements.

CHAPTER 2

BACKGROUND

With AMR solution, billing can be based on actual consumption rather than on an estimate based on previous consumption, giving customers better control of their use of electric energy. Therefore CEB will get the opportunity to increase operational efficiency, improve customer service, reduce data- collection costs and quickly gather critical information that provides insight to decision-makers. Therefore prior to develop the system, it is required to be aware on the existing RMR solutions that are available and how those methods could be used in developing the system. CEB uses telecommunication system to link up the meters to CEB data centers. Hence, a unique system is required for RMR for CEB for more efficient data collection across the electricity meters.

2.1 Literature Review

2.1.1 Current situation

Currently, the CEB uses five different systems of meter brands to read for Remote Meter Reading (RMR). Each of these systems is provided by separate vendors. A brief description of the five systems are provided below.

M-cube:

This software can read Premier, Secure and sprint meters that manufactured in India. This software required a license from the manufacture. Reading can be output in CSV, Text and XML format. This software support schedule reading and on demand reading.

Ezview:

This software comes with EDM family of meters that manufactured in German. Support schedule reading and on demand reading, output can get as excel or csv format.

HexView:

This software comes with Hexing meters. CEB use two versions of this software. Schedule reading and on demand reading supported by this software.

Sep2view:

This software used to read Iskra meters. On demand and schedule reading supported only run on windows XP.

Mdm2.0:

This software use to read Holley meters that manufactured in India. On demand reading supported, schedule reading function available but has some errors.

2.1.2 Shortcomings of the current system

It is operationally complex to maintain 5 different RMR Systems concurrently due to the following challenges.

1. Cost – for licensing
2. Different skills required for maintenance
3. Lack of standardization of operations
4. Lack of integrity of metering data
5. Have to process different data formats

2.1.3 Systems used in the industry

Discussed below are few other RMR solutions available in the industry. There are many advantages of RMR compared to traditional methods, for instance that the RMR systems that use the telecommunication network is stable, reliable, and requires less maintenance.

Kamstrup OMNIA [2]:

This is a smart metering system that supports all important tasks involved in remote reading of smart meters and management of meter data and communication network over RF Mesh and 2G/4G cellular technologies.

Huawei PLC-IoT AMI Meter Reading Solution [3]:

This solution provides online self-help services by providing customers with household or industry smart prepaid electricity meters.

A prior study [4] has described a design of a remote wireless meter reading system based on GPRS. However, for CEB uses telecommunication system to link up the meters to CEB data centres. Hence, a unique system is required for RMR for CEB for more efficient data collection across the electricity meters.

There are two types of electricity meters in the industry – Cumulative and Advanced Meters. The Cumulative meters are read once every one month whereas Advanced meters allow electricity consumption to be measured at half-hourly intervals. In the context of CEB, Advanced meters are used.

2.1.4 Proposed solution

By considering above findings with comparison between existing meter models used in CEB, the proposed unified system aims to address the disadvantages and technical limitations of the current CEB RMR system and presents a more efficient and practical system to replace the five systems currently being used. The proposed system can support both GSM and telecommunication networks in reading meters. System is able to read the billing data of meters and sends the billing data directly into the billing system, thus eliminating the interim step of “downloading” meter reading data to the host computer.

2.2 System Requirement

The system requirement of Automated Meter Reading System for CEB is depicted below.

2.2.1 Functional Requirement

1. Schedule meters for read:

List of meters to be read need to be scheduled. Status of the individual schedule and also status of the meter need to be updated. Scheduler need to be started automatically at the given time.

2. Identify meter details:

Before established connection with the meter, meter detail such as meter brand, media type and phone number need to be identified. Mechanism has to be implemented to retrieve above details from the database.

3. Establishment connection to the meter:

2.2.3 Non-Functional Requirement

1. Protocol Utilized for Meter Reading:

DLMS protocol is used to read the data from the meter. GSM/GPRS is used to communicate with the meter. [7]

2. Application Development Technology:

VB.NET (community edition) is utilized to develop complete application which is free to development. [8]

3. Database Software:

Microsoft access is used to build client-side database and Informix database is used to build Head Office database.

4. Security

Client side database is fully encrypted and secured VPN connection used to access Head Office database. The network architecture is shown in Figure 2.1. [9]

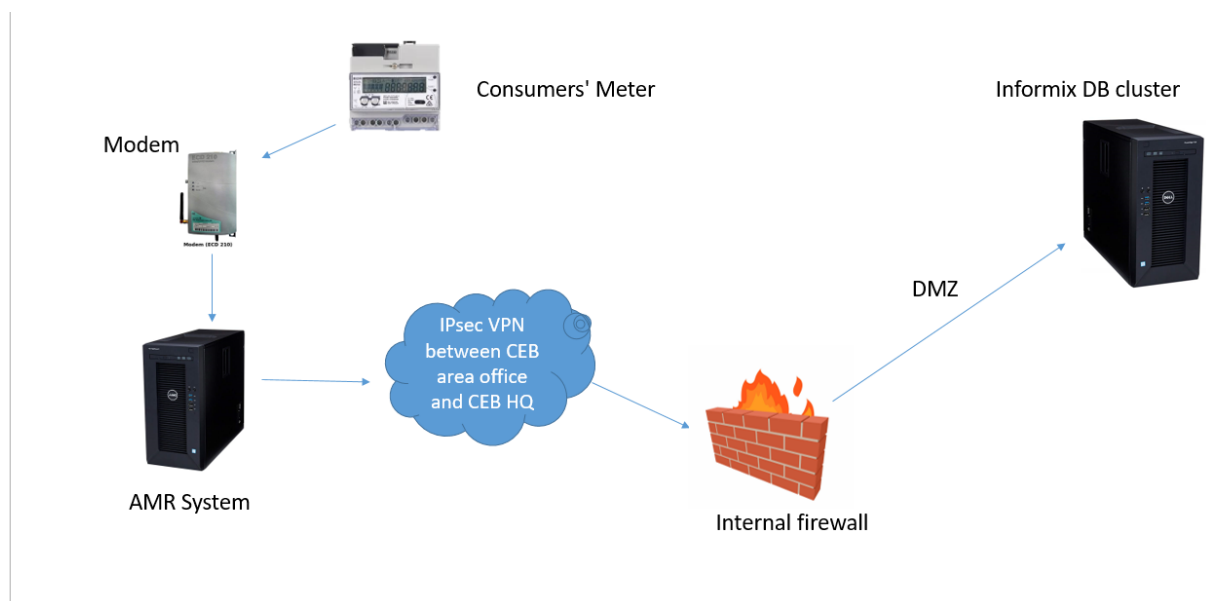


Figure 2.1: Network Architecture

2.3 Association with current systems in CEB

This system associated with the heavy supply billing system that already exist in CEB which is used for prepare heavy supply bill and management information. This system can be considered as a input generator for the heavy supply billing system.

2.4 Study and Critical Analysis of Existing System

For AMR functions .many vendor specific systems are available and currently those systems are using in CEB as well. Commonly use systems are listed below.

M-cube : this system is fully integrated software for meter reading but can only support premier , secure and sprint brand of meters. This software can download reading and store in encrypted file.

Ezview : this is also a similar system that support only for edmi meters.

Hexview : this is also a similar system that support only for Hexing meters.

Sep2view :this is also a similar system that support only foriskra meters.

Mdm2.0 : this is also a similar system that support only for holley meters.

All these systems are vendor specific and reading will be downloaded in different formats, where internal systems cannot use those data formats as it is. Therefore middle layer is required to convert those data formats to the format required by the CEB billing system. And also different units have been involved in to run these software to download reading data.

With the meter purchase, specific software license and key to be purchased separately.

If any installations to be done in different machine, again activation key should be get from the vendor and without the new key, software cannot be run. Have to communicate the vendor frequently for any changes or a problem in the software. If any failures in software, IT branch cannot be involved to solve those software matters since those are maintained by the vendor.

If any CEB area installed multiple types of meters (i.e. without a single type of meters to all customer belongs to same area) to the customers in same area, specific type of software relevant to each meter types should be maintained and supplier specific modems should be maintained.

CHAPTER 3

METHODOLOGY

The design methodology will be described in this chapter. The methodology consists with process modelling, modelling language, database table structures, design of audit trails, security scheme design, class diagrams and sequence diagrams.

3.1 Modeling

3.1.1 Process Modeling

While the CEB Heavy Supply Billing System is at present up and running in CEB and a third-party meter reading software is used by CEB to collect meter reading remotely. The requirement is familiar and the expansion of same process up to the automated meter reading system is needed. Hence, it has been decided to use the waterfall model as it is very appropriate for this type of project.

The Waterfall Model was the initially introduced process model which is also known as a linear sequential life cycle model, It is fairly straightforward to understand and practice, where individual phase need to be accomplished prior to the next phase starts and the phases do not overlap.

3.1.2 Selection of Modeling Language

The Unified Modeling Language (UML) is selected and used for modeling the proposed system as it is a visual modeling language used by vast number of designers and developers in the software industry. It can be easily utilized to state, visualize, create and document the artifacts of a software system in a user friendly manner.

It is well equipped with visualization tools, hence provides a comprehensive approach to model the system using such techniques. Out of the UML diagrams available, Use case Diagram, Class Diagram, Sequence Diagram and Activity Diagram are used in this project as appropriate.

3.2 Data Modeling

3.2.1 ER Diagram

Figure 3.1 displays – the ER diagram of the database used in this project.

The database is recording all information related to each and every transaction of the system. It consist of information of the transaction and the meter. This system is linked to the Heavy Supply billing system of CEB, therefore data associated to customer details and billing are taken from the existing database.

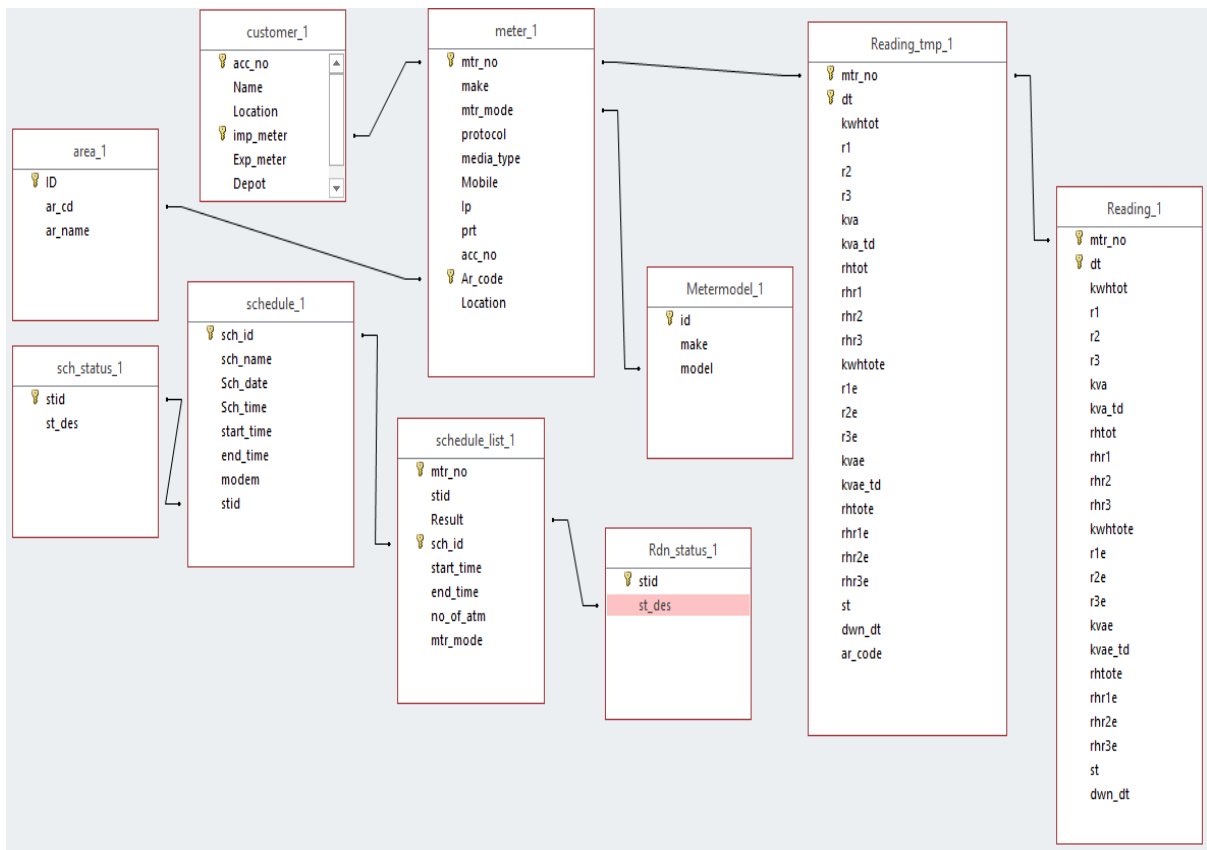


Figure 3.1: ER Diagram

3.2.2 Use case diagrams

The system is basically used by the area offices. System is accessed over the VPN. The one and only actor of the system is meter reader. The use case diagram is shown in figure 3.2.

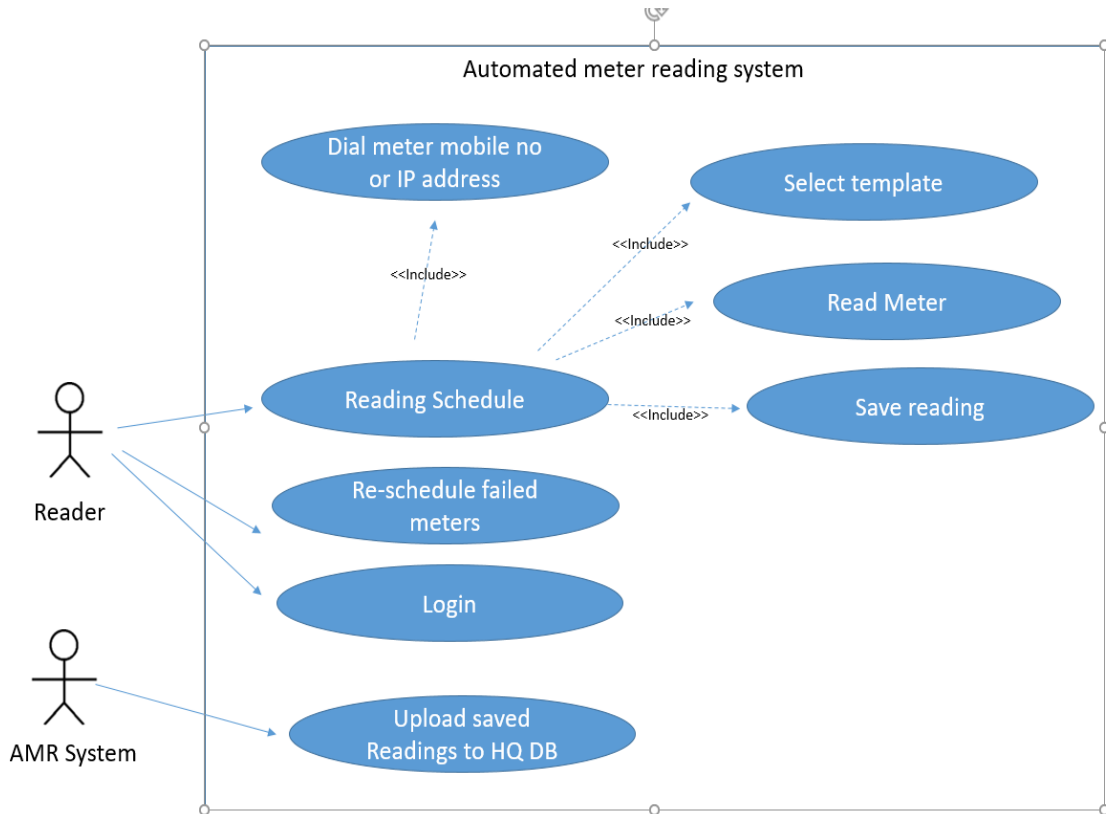


Figure 3.2: Use Case Diagram

3.3 Database Table Structure

This project utilizes the rational database system. The database system of the project is depicted using the Entity Relationship diagram (ER Diagram) displayed in the Fig. 3.1. The system consists of ten tables as described below.

1. Area related information are stored in area table. Table structure is presented in table 3.1 in Appendix.

2. Customer details are stored in the customer table. Customer table structure is displayed in table 3.2 in Appendix.
3. All meter details are stored in the meter table. Meter table structure is shown in table 3.3 in Appendix.
4. All meter model details are stored in the meter model table. Meter model table structure is shown in table 3.4 in Appendix.
5. Rdn_status table structure is shown in table 3.5 in Appendix.
6. All readings details are stored in the reading table. Reading table structure is shown in table 3.6 in Appendix.
7. All download readings details are stored in the reading_tmp table. Reading_tmp table structure is shown in table 3.7 in Appendix.
8. sch_status table is shown in table 3.8 in Appendix.
9. Reading schedule is saved in the table called schedule. Schedule table structure is presented in table 3.9 in Appendix.
10. Schedule list is saved in the table called schedule_list, Schedule_list table structure is presented in table 3.10 in Appendix.

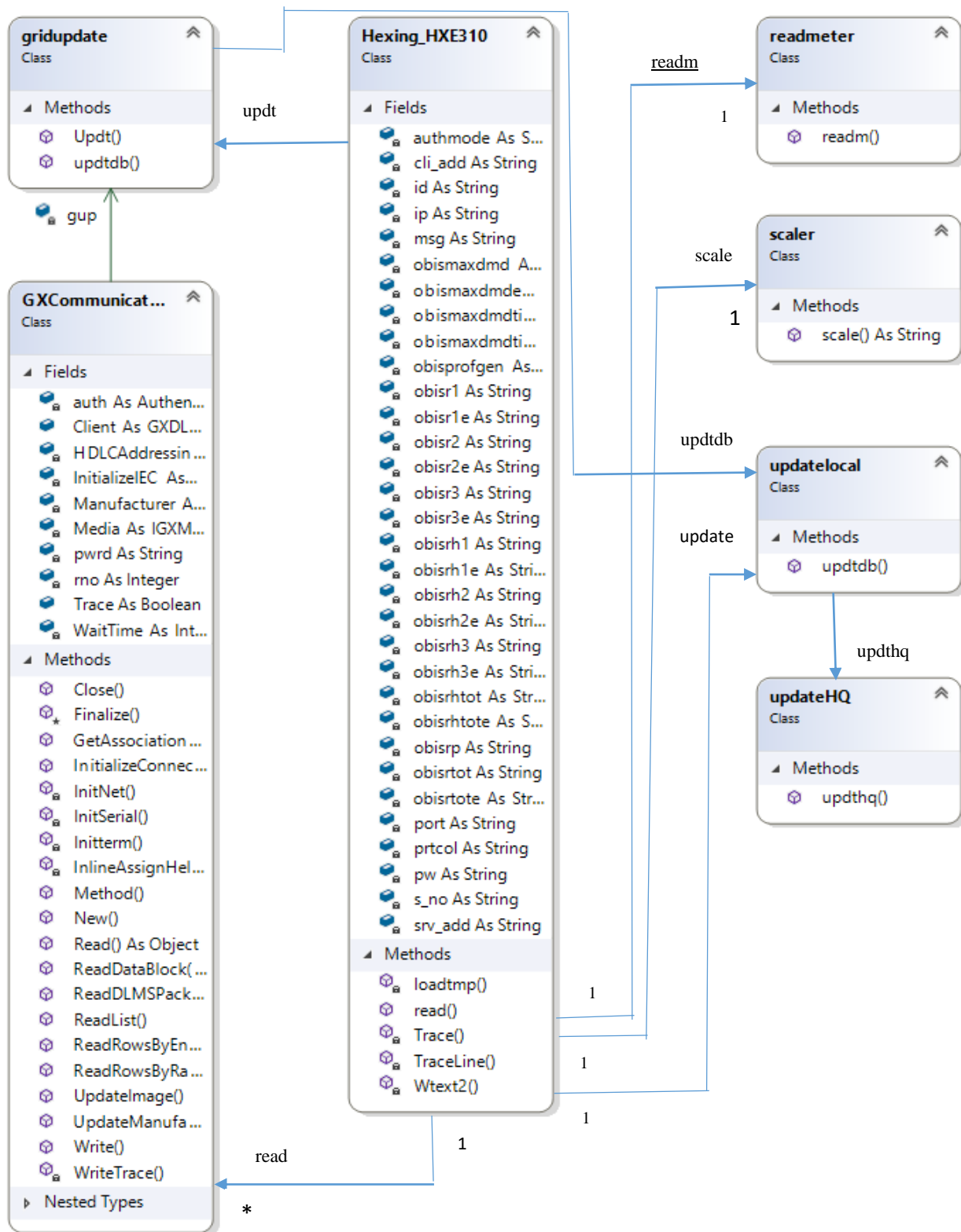


Figure 3.3: Class Diagram

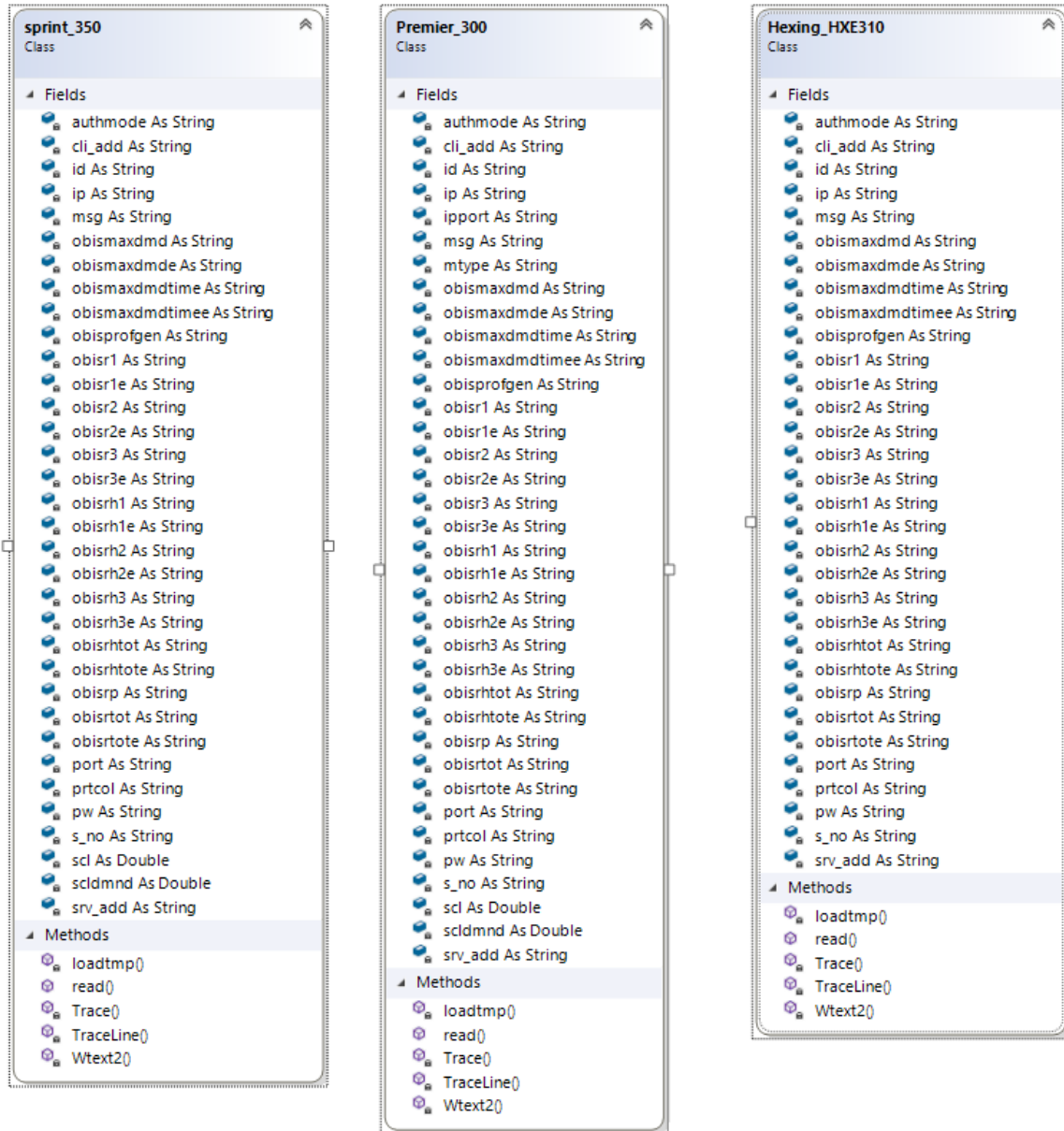


Figure 3.3: Class Diagram (Cont.)

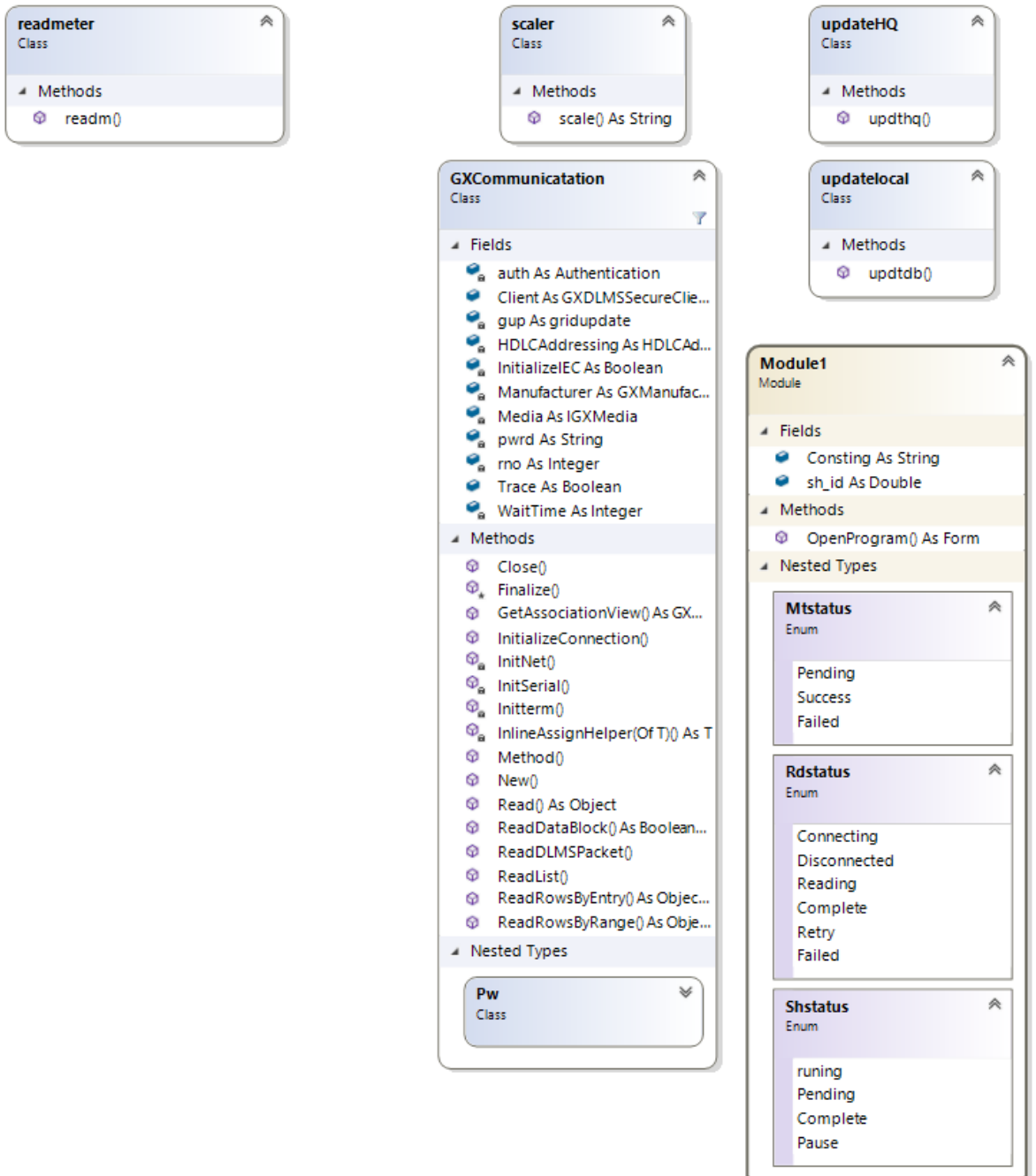


Figure 3.3: Class Diagram (Cont.)

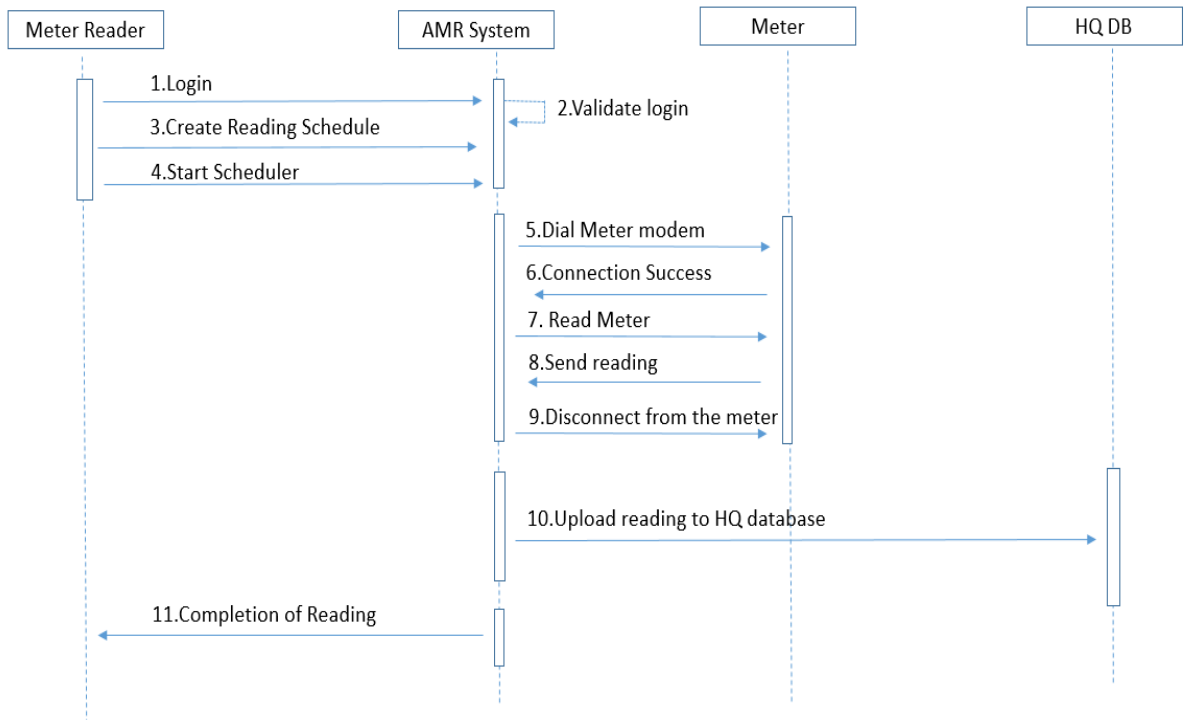


Figure 3.4: Sequence Diagram

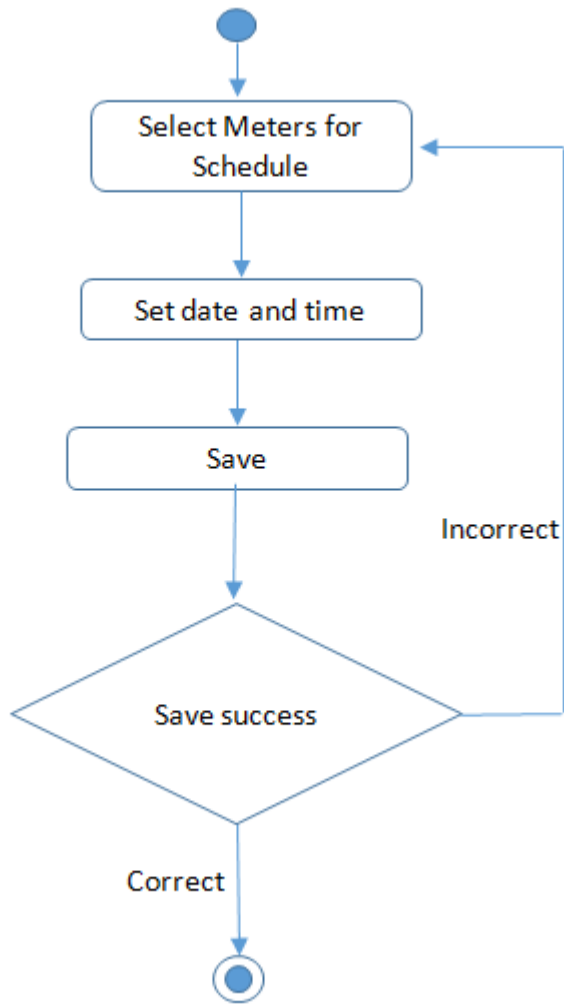


Figure 3.6: Activity Diagram for Schedule meters for download

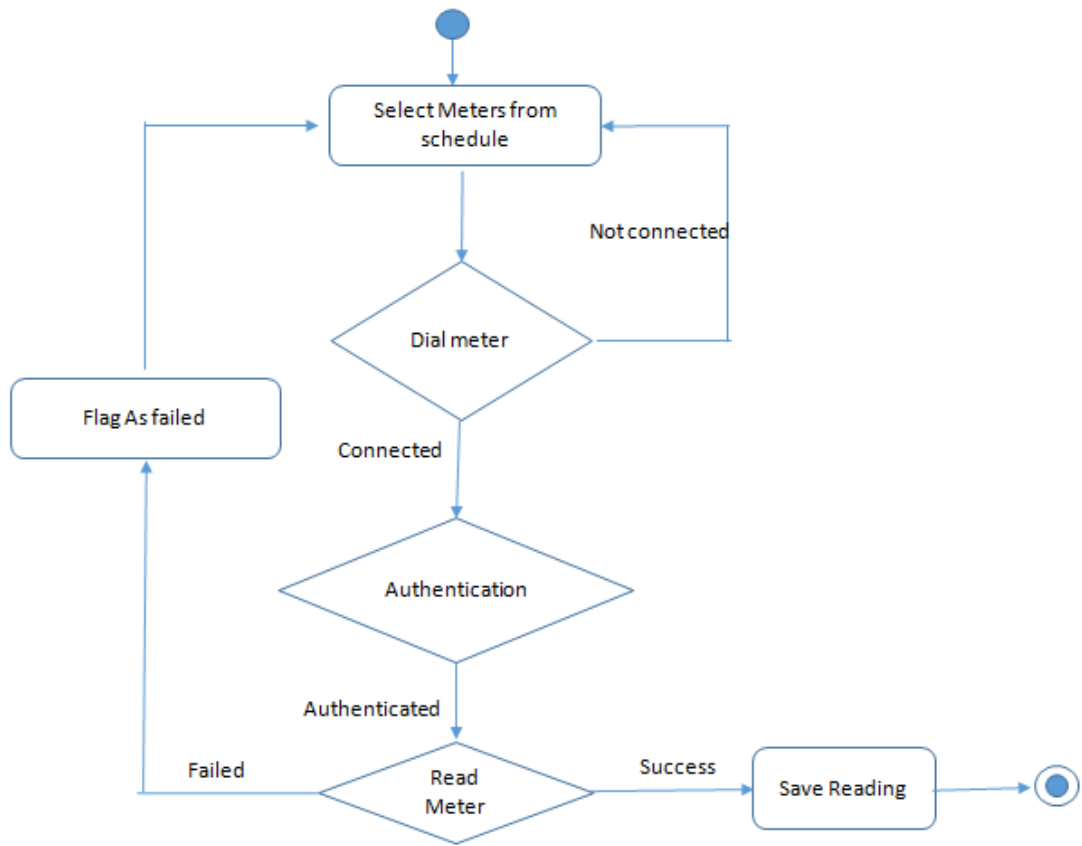


Figure 3.7: Activity Diagram for Read Meter

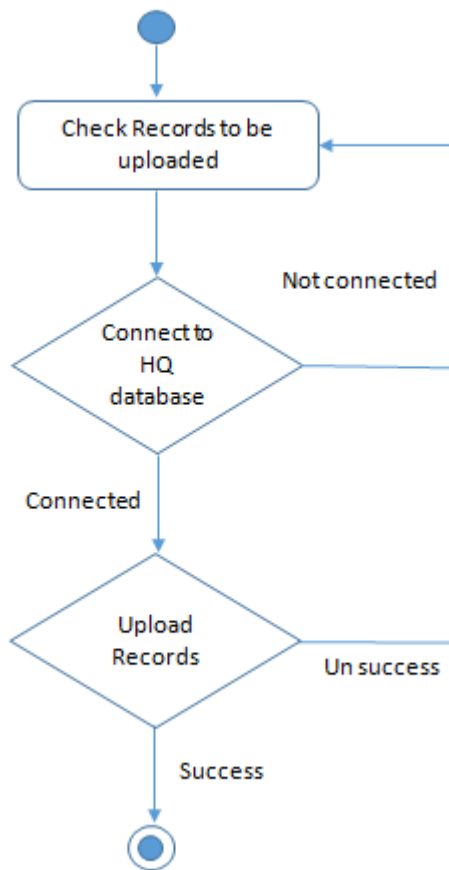


Figure 3.8: Activity Diagram for Update HQ database

3.4 Design of Audit Trails

Inbuilt logging mechanism is used in this system. That can be used for tract activities and errors. Therefore system is designed to maintain logs in below given functionalities.

- i. Log indicating start, end and result status for each scheduler cycle.
- ii. Audit trail regarding overrides applied to the scheduler.
- iii. Audit trail regarding transfer of customer account number from one priority to another.
- iv. The start and stop time of connection established and success status.
- v. Unsuccessful attempts with reasons(communication line busy, meter not responding, etc.)

System level audit trail will capture

- i. Attempt to log on to the system (successful or unsuccessful).
- ii. Log on ID.

- iii. Date and time of log on.
- iv. Date and time of log off.

Database level auditing consist with,

All updates on DB tables. Audit data like adding columns such as created by/ created on, and updated by / updated on to every targeted table. At commit time, these fields are set to the current user and system date. It also included the time of the last update.

System Archives will include following data.

- i. Meter reading configuration files
- ii. Daily meter reading schedule
- iii. System should store one year old data files received from meters. Data files older than this should be archived by the System Administrator.

3.5 Security scheme Design

The system will used GSM, VPN network that own by CEB which is already secured for communication. Therefore additional security for data communication is not implemented in the system. However storing data in local database will be encrypted by using Microsoft access integrated security method.

CHAPTER 4

IMPLEMENTATION

This chapter elaborates the implementation methodology of the system with how the software functionalities developed and implemented.

4.1 Selection of Technology

4.1.1 Software Tools

Software tools are selected based on the availability. Since this system has to be installed in the current CEB infrastructure, following software tools selected for system developments.

- i. Microsoft .Net Framework
- ii. Programming Language – VB.net
- iii. Informix Database

Since CEB has the infrastructure support and the corporate license for Informix database in its data center. Informix is used as the database system to this project.

- iv. Microsoft Access Database

4.1.2 Hardware

Existing Digital meters with inbuilt modems implemented for CEB bulk supply customers will be used. Communication servers with multiple communication ports can be used for simultaneous communication with meters.

4.2 Implementation Methodology

Parallel implementation methodology was selected where users of the system will be given the trust with comparison between data captured through existing systems and with the reading data captured through the AMR system. If the accuracy level is high, users can shift to Live run of the system.

CHAPTER 5

TESTING AND EVALUATION

This chapter elaborates the approaches of testing and evaluation of the software. Additionally, explains on how the functionality of the required specification are achieved.

5.1 Software Testing

The purpose of Testing is to confirm that a software does what it is aimed to do and to identify defects before it is deployed for use. The program is carried out using real meter reading data when the software is tested. The outcomes are checked for errors, abnormalities and compared with the actual meter readings that already exist in the CEB billing database.

5.1.1 Software Testing Model

Comparison model of program testing is implemented to test the software for meter reading data.

5.1.2 Testing Stages

The system was tested in three stages listed below.

1. Development testing: Using the Visual Studio IDE the testing was carried out during the development stage.
2. Release testing: Prior to the release, the system was tested by a separate team upon the completion of development testing.
3. User testing: Once the system released, the system will be tested using the live meters that are fixed at the customer premises by the users of the system.

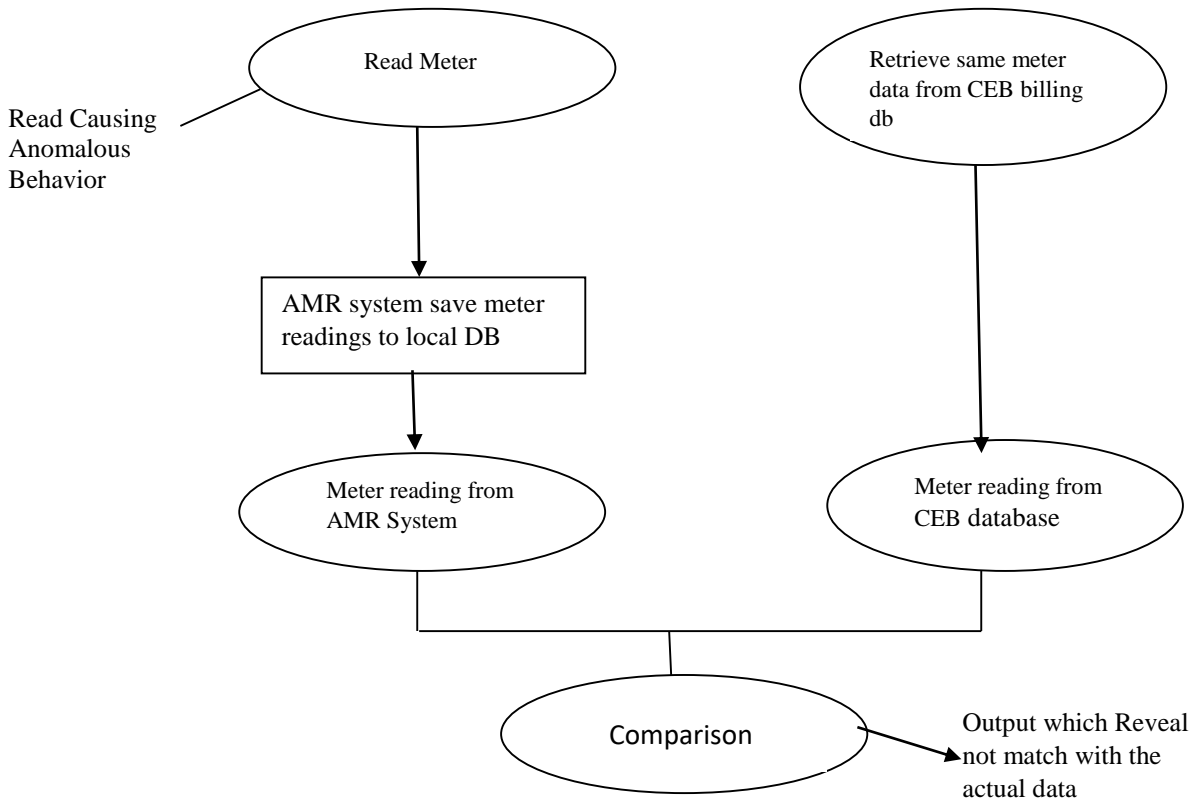


Figure 5.1 : Comparison Model of program Testing

5.1.3 Levels of Granularities of Testing

During the development testing, Following three granule levels were taken into consideration:

1. Unit testing, each module were tested by comparing the expected value and the real results by passing the test data.
2. Component testing, sequentially all methods and modules of the system were tested. Tested order is dial modem, connected to meter, read data, save data, disconnect from meter and hang up modem.
3. System testing, software install on a separate computer and setup modem and antennas. Then performed the sequence mentioned in above component testing.

5.1.4 Software Tools used for Testing

Microsoft Excel sheet used to carry out comparison with data.

5.1.5 Test Cases

System is tested through several test cases by using different meter models and different meter locations around the country.

5.2 Software Evaluation

The software is critically evaluated in order to understand whether the project objectives were achieved or not. Outcome of this project is to build a software working between customer meter and CEB system. As per the Chapter 1, below mentioned are the objectives of the project and the way these objectives are accomplished.

1. Providing an automated solution for downloading meter reading for the specific Digital Smart Meter.
2. Directly writing downloaded data to CEB billing database.
3. Develop a software that can read any type of meters.
4. Eliminate the cost of purchasing the dedicated modems and related software.

The developed system can be connected to the meter and read data. And also reading of meters can be schedule according to the user requirement of CEB. Therefore above first objective is satisfied.

The software is integrated with background processing function that can upload downloaded readings to CEB billing database immediately and that process was fully automated due to that human intervention on data is eliminated. Therefore the second objective is satisfied.

The software can be read any kind of meter that compatible with DLMS standard. Therefore the third objective is satisfied.

Software can use any standard dial up modem or active internet connection to communicate with the meter. So specific modem or software is not required anymore. Therefore the fourth objective will be satisfied with implementing the system.

5.3 Usability Evaluation

This system is deployed in all areas in CEB. Electrical Superintendent (Bulk) is the main user who going to work with this system. AMR system designed to identically in function to system they are using now. On the test run Electrical Superintendent (Bulk) schedule meter reading by using this system and confirmed that the required functionalities are satisfying. After that the system was evaluated by using billing reports and other validation reports that already used in CEB.

5.4 Problems and Lessons Learnt

Following are the problems faced during the development of the system.

1. As this system has to communicate with meter, but it is been difficult to find documentation about the meter parameters. Therefore meter vendors and meter lab engineers had to consult time to time to get correct parameters.
2. Some meter vendors are not 100% compatible with DLMS protocol but they have mentioned their compatibility with DLMS protocol on their product specification. Therefore that issue creates some difficulties in reading meters remotely, and had to find out different way to read those meters.

5.5 Problems beyond Control

Some meters that already purchased by CEB are not compatible with DLMS protocol so this software cannot be used to read such a meters.

CHAPTER 6

CONCLUSION

Goal of this project is to implement an automated system to take online smart meters readings of corporate consumers remotely and provide timely information for the customers. Through this system CEB take the benefits of automating manual process of reading collection and streamline the process of bulk billing. On the other hand time and cost of this process also reduced by eliminating lot of manual works.

The system is using latest technologies for the development and implementation of the system. Hence the security, stability and also maintainability of this system is quite easy and also system improvements can be done easily. As the system is implemented in Ceylon Electricity Board, it is clearly see that the time taken for the whole process is reduced comparing to manual process. On the other hand human errors are eliminated up to the satisfied level. The cost is reduced as it's not necessary to visit the place where the remote meter is placed, so the staff for this work can be allocated for another tasks.

The challenge faced was converting employees from manual system to the automated system. Some employees may find difficult to understand and work with the automated computer system. Presentation and hands on trainings are arranged for this purpose. The other challenge was that the system should have better network and database connections for the remote reading collections. So there were meetings with Network and Database teams frequently for acknowledge of the system functionalities and also network and database.

6.1 Improvements through Future Work

This software can be designed and implemented as a mobile application and allow to download from Play Store or iCloud that enable all CEB bulk supply consumers to know their bill at real-time by using their mobile phones.

Extended this software to read ordinary supply smart meters will be great achievement of CEB billing system that can service more than 6.5 million consumers.

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APPENDIX

Table 3.1: Structure of area Table

Field	Type	Null	Field Length
id	Long Integer	Yes	
ar_cd	Short Text	Yes	2
ar_name	Short Text	Yes	20

Table 3.2: Structure of customer Table

Field	Type	Null	Field Length
Acc_no	Short Text	Yes	10
Name	Short Text	Yes	25
location	Long Text	Yes	50
imp_meter	Short Text	Yes	20
exp_meter	Short Text	Yes	20
Depot	Short Text	Yes	1
Ar_code	Short Text	No	2

Table 3.3: Structure of meter Table

Field	Type	Null	Field Length
Mtr_no	Short Text	No	20
make	Short Text	Yes	25

Mtr_mode	Short Text	Yes	10
protocol	Short Text	Yes	15
Media_type	Short Text	Yes	10
Mobile	Short Text	Yes	20
ip	Short Text	Yes	25
prt	Short Text	Yes	10
Acc_no	Short Text	Yes	10
Ar_code	Short Text	No	2
location	Short Text	Yes	50

Table 3.4: Structure of Meter model Table

Field	Type	Null	Field Length
id	Long Integer	Yes	
make	Short Text	No	10
model	Short Text	Yes	20

Table 3.5: Structure of Rdn_status Table

Field	Type	Null	Field Length
stid	Long Integer	Yes	
St_des	Short Text	Yes	10

Table 3.6: structure of Reading table

Field	Type	Null	Field Length
Mtr_no	Short Text	No	20
dt	Short Text	Yes	20
Kwh_tot	Short Text	Yes	20
r1	Short Text	Yes	20
r2	Short Text	Yes	20
r3	Short Text	Yes	(20,2)
kva	Short Text	Yes	(20,2)
Kva-td	Short Text	Yes	20
rhtot	Short Text	Yes	20
Rhr1	Short Text	Yes	20
Rhr2	Short Text	Yes	20
Rhr3	Short Text	Yes	20
Kwh_tote	Short Text	Yes	20
R1e	Short Text	Yes	20
R2e	Short Text	Yes	20
R3e	Short Text	Yes	20
kvae	Short Text	Yes	20
Kvae_td	Short Text	Yes	20
rhtote	Short Text	Yes	20
Rhr1e	Short Text	Yes	20
Rhr2e	Short Text	Yes	20
Rhr3e	Short Text	Yes	20

st	Short Text	Yes	5
Dwn_dt	Short Text	Yes	20

Table 3.7: structure of Reading_tmp

Field	Type	Null	Field Length
Mtr_no	Short Text	No	20
dt	Short Text	Yes	20
Kwh_tot	Short Text	Yes	20
r1	Short Text	Yes	20
r2	Short Text	Yes	20
r3	Short Text	Yes	(20,2)
kva	Short Text	Yes	(20,2)
Kva-td	Short Text	Yes	20
rhtot	Short Text	Yes	20
Rhr1	Short Text	Yes	20
Rhr2	Short Text	Yes	20
Rhr3	Short Text	Yes	20
Kwhnote	Short Text	Yes	20
R1e	Short Text	Yes	20
R2e	Short Text	Yes	20
R3e	Short Text	Yes	20
kvae	Short Text	Yes	20

Kvae_td	Short Text	Yes	20
rhtote	Short Text	Yes	20
Rhr1e	Short Text	Yes	20
Rhr2e	Short Text	Yes	20
Rhr3e	Short Text	Yes	20
st	Short Text	Yes	5
Dwn_dt	Short Text	Yes	20
Ar_code	Short Text	No	2

Table 3.8: Structure of sch_status Table

Field	Type	Null	Field Length
stid	Long Integer	No	
St_des	Short Text	Yes	10

Table 3.9: Structure of schedule Table

Field	Type	Null	Field Length
Sch_id	Long Integer	No	15
Sch_name	Short Text	Yes	25
Sch_date	Long Text	Yes	20
Sch_time	Short Text	Yes	20
Start_time	Short Text	Yes	20
modem	Short Text	Yes	15
stid	Long Integer	No	

Table 3.10: Structure of schedule_list Table

Field	Type	Null	Field Length
Mtr_no	Short Text	No	20
stid	Short Text	Yes	
Result	Long Text	Yes	20
Sch_id	Long Integer	No	20
Start_time	Short Text	Yes	20
End_time	Short Text	Yes	20
No_of_atm	Long Integer	Yes	10
Mtr_mode	Long Text	Yes	30

A. Test Case

	A	B	C	D	E	F	G	H	I	J
		mtr_no	dt	kwhtot	r1	r2	r3	kva	kva_td	r
1										
2	Meter Reading From AMR system	19103193	01/02/2020 12:00:00 AM	158446	115611	7165	35670	44.24	11/01/2020 2:45:00 PM	498
3										
4										
5										
6										
7		170002748		378	01/02/2020 0:00	01/03/2020 0:00	1	19103193	KVA	0
8		170002748		378	01/02/2020 0:00	01/03/2020 0:00	1	19103193	KVAH	0
9	Reading from CEB Billing Database	170002748		378	01/02/2020 0:00	01/03/2020 0:00	1	19103193	KWD	115611
10		170002748		378	01/02/2020 0:00	01/03/2020 0:00	1	19103193	KWO	35670
11		170002748		378	01/02/2020 0:00	01/03/2020 0:00	1	19103193	KWP	7165
12										
13										
14										
15										
16										

All CEB Heavy Supply Billing customer’s meters are configured as follows:

r1 reading – KWD(Daytime Reading in the meter)

r2 reading– KWP (Peakttime Reading in the meter)

r3 reading- KWO(OffPeak Reading in the meter)

This system been tested by using different meters, above excel sheet shows test result for one meter. Row no 7,8,9,10 & 11 shows the reading for the 01/02/2020 that get from CEB billing database, same meter read by using AMR system and result captured to local database and copied to row two in same excel. Then had compare the figures with the data from the CEB database (that already paste in row 7 to 11). And it shows AMR system successfully get same reading as in the CEB database and it prove AMR System test result are succeeded.

