RF Mesh System for Smart Metering

Authorship Statement

I do, hereby, declare that the internship report is done by me in partial fulfillment of the requirements for the Degree of Bachelor of Science in Electronics and Communications Engineer. (ECE) from East West University. It is not plagiarized, and the interpretations put forth are based on my reading and understanding of the original texts. The other books, articles, and websites, which I have made use of are duly acknowledged at the respective places in the text.

Date: **30 October 2022**

Signature

Name: **Ahanaf Muttaque**

Acknowledgments

It is my pleasure to acknowledge the extra-ordinary supervision, invaluable suggestion, and proper guidance of my supervisor Zahidur Rahaman Lecturer Department of Electronic and Communication Engineer and respectable trainer Engr. Mohammad Emdadul Haque, Manager, ICT Development Circle, Dhaka Power Distribution Company Limited (DPDC), from whom I have been very much benefitted throughout the course of my training. I express my humble gratitude to him. Without his kind cooperation and help the internship report would never have been possible. I am also thankful to my honorable teachers of the Department of Electronic and Communication Engineer (ECE) at East West University (EWU) and well-wishers for their valuable suggestion during the period of my internship work.

Finally, I would like to express my indebtedness to my parents for their constant support and inspiration to accomplish the job.

Date: **30 October 2022** Name: **Ahanaf Muttaque**

Abstract

This paper describes the RF mesh system design and ongoing project in DPDC for advance metering infrastructure and its performance. This system is based on Neighborhood Area Lan (LAN). Its operating band is 920-925 MHz and is based on the frequency hopping spread spectrum. The deployment scenario's geographic model serves as the foundation for the performance evaluation, which uses geographical routing and the appropriate models for radio transmission. It ensures accurate and error free billing. Further, we conclude that the RF mesh system supports us for smart metering and create transparency to customers and DPDC.

Keywords: Automatic meter reading, geographical routing algorithm, RF mesh systems. Advance metering infrastructure (AMI).

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CHAPTER 1

Introduction and Concept of the Project

1.1. Introduction

RF Mesh System for Smart Metering in Bangladesh is an innovative technology that enables the efficient and accurate collection of energy consumption data. The system utilizes a network of radio frequency (RF) devices, also known as "nodes," that communicate with each other in a "mesh" configuration. This allows for a decentralized system that eliminates the need for a centralized hub and provides a resilient and cost-effective solution for data collection. Additionally, the system is designed to be compatible with smart meters, which allows for real-time monitoring of energy consumption and facilitates the implementation of advanced metering infrastructure (AMI) in Bangladesh. In initial point DPDC place 10,000 smart meters in one NOCS (Paribag-Division, Dhaka). On basis of pilot success 90,000 smart meter placed in whole DPDC aria.

1.2. Literature Review

A literature review of RF Mesh systems for smart metering would cover a variety of topics related to the design, implementation, and performance of these systems.

One key area of focus would be the design and deployment of RF Mesh networks. Research in this area would examine the various configurations and protocols that can be used to set up and maintain a mesh network, as well as the factors that can affect the performance of the network (e.g., radio frequency interference, distance between nodes, etc.). Additionally, some studies may look at the role of network topology in determining the reliability and scalability of RF Mesh systems.

Another important area of research would be the use of RF Mesh systems for smart metering. This could include evaluations of the accuracy and reliability of the data collected by RF Mesh-enabled smart meters, as well as the potential benefits and challenges of using these systems for advanced metering infrastructure (AMI) applications.

Smart metering systems based on RF mesh typically operate in unlicensed ISM bands, such as the 920-925 MHz range, which is governed by the FCC's Part 15 regulations. Compared to higher frequency ISM bands like 2.4GHz, using this band gives the advantage of increased range and enhanced penetration through walls and objects.

Most systems in use today use FHSS for collision avoidance and proprietary frequency shift keying (FSK) modulation techniques. Because FHSS has a smaller channel bandwidth than direct sequence spread spectrum (DSSS), it also has a better link budget and a more sensitive receiver. Improved range is the result of increased link budget. Additionally, FHSS mitigates the interference risk that is present in shared ISM bands. Systems using frequency hopping are permitted to transmit at 30dbm power levels under FCC Part 15. A total EIRP of 36dbm can be attained when 6dbi antenna gains are combined. Systems that don't hop are subject to stricter rules. The IEEE's 802.15.4g SUN work group is leading efforts to standardize RF mesh-based smart systems, although these efforts will take some time to accomplish.

Some studies may also investigate the security of RF Mesh systems, particularly with regard to the protection of sensitive energy consumption data. This could include research into the various encryption and authentication methods that can be used to secure RF Mesh networks, as well as the potential vulnerabilities and risks associated with these systems.

Additionally, there would be a study on the cost-benefit analysis of RF Mesh system for smart metering in Bangladesh, which would examine the potential cost savings and other benefits that can be achieved through the use of these systems, as well as any potential drawbacks or limitations.

Finally, research may also evaluate the impact of RF Mesh systems on the environment and human health, as these systems typically use radio waves, which have been linked to certain health risks and environmental concerns.

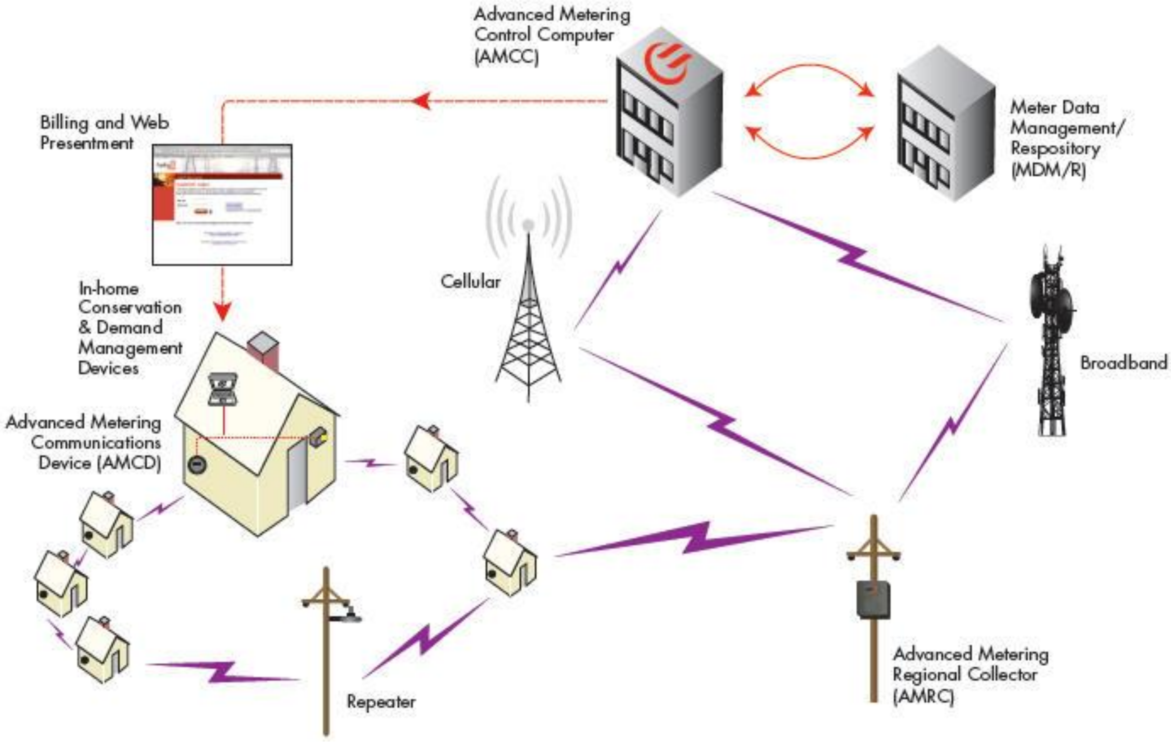

Figure 01 : RF Mesh System

1.3. Object of study

RF Mesh is a wireless technology that allows for the rapid deployment of network links in hard-to-reach or dangerous areas. It is a powerful tool for development in Bangladesh, where the country's geography and infrastructure present some challenges. Bangladesh's population is primarily rural, and the rural population is spread over a wide area. This makes it difficult to provide access to reliable, high-speed internet connections. RF Mesh has the potential to provide access to the internet in the most remote areas of Bangladesh, helping to bridge the digital divide and improve access to educational and economic opportunities. The paper will look at how RF Mesh can be used in Bangladesh, the advantages, and disadvantages of using this technology, and the potential for its use in the country. Finally, the paper will discuss the potential for Smart Metering applications with RF Mesh technology in Bangladesh.

1.4 Significance of the study

Systems for measuring and monitoring are crucial to effective facility management. These systems provide vital insight into facility and equipment performance, allowing for better management of energy use and expenses, as well as increased system feedback and optimization. Smart meters gather thorough data on consumption, and by using this information, users may better understand their energy use and make changes to it in order to save money and reduce carbon emissions. While there are numerous ways to define a smart meter, most incorporate some form of two-way communication between the household meter and the utility provider in order to effectively gather comprehensive data on energy usage. Some solutions go beyond the energy bill to gather online web data and include consumer comments. SMS text messages or a customer information display. One of the more difficult parts of implementing a smart meter is providing a dependable, affordable communications system. AMI data is imported, verified, edited, and processed by a system or application called a "meter data management system" before it is made available for invoicing and analysis.

Chapter 2

Background OF RF Mesh System

2.1. Smart meter

2.1.1. Smart meter and its necessity

A smart meter is an advanced type of meter that can measure and communicate a customer's electricity, gas, or water usage in real-time or near real-time. It is needed for several reasons:

1. Improved Billing accuracy: Smart meters can provide more accurate and detailed information about a customer's energy usage, which can lead to more accurate billing.
2. Better energy management: Smart meters can provide customers with real-time information about their energy usage, which can help them to manage and reduce their consumption.
3. Increased efficiency: Smart meters can help utility companies to improve the efficiency of their operations by providing them with real-time information about energy usage, which can help them to better manage the supply and demand of energy.
4. Smart grid integration: Smart meters can also be integrated into a smart grid system, which can help to improve the overall efficiency and reliability of the energy distribution system.
5. Remote reading and disconnection: Smart meters can also be remotely read and disconnected if customers are not paying the bill on time.
6. Time of use pricing: Smart meters can also enable utilities to offer time-of-use pricing, which can encourage customers to use energy at times when it is less expensive.

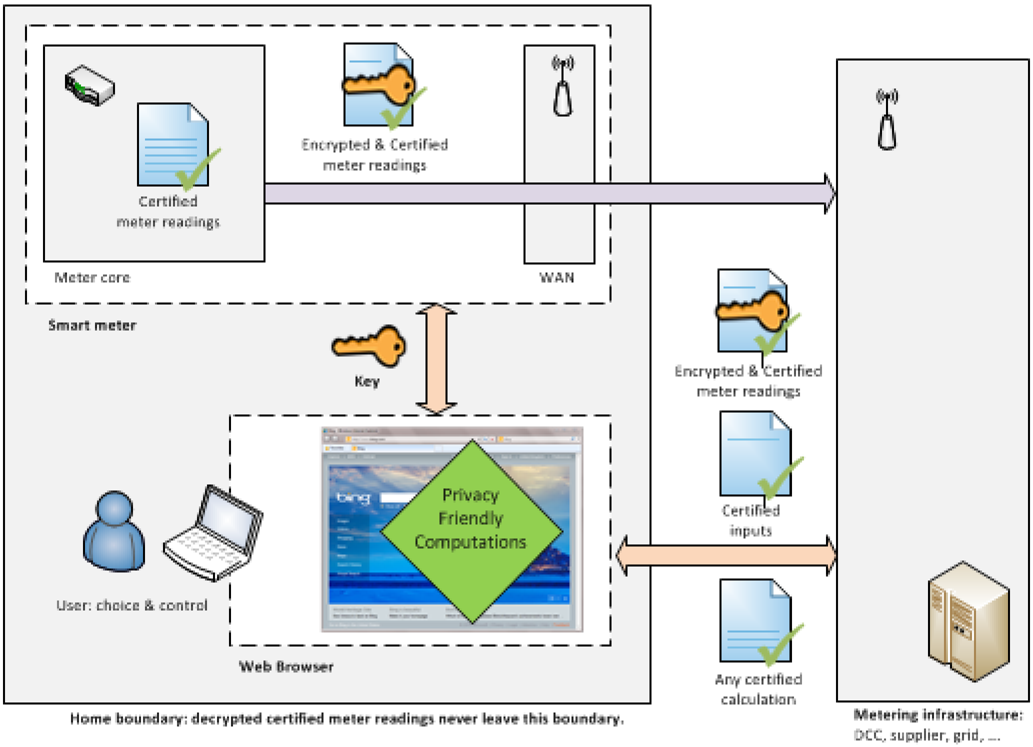

Figure 02: Smart Meter Architecture

2.1.2. Smart meter For Bangladesh

Smart meters can help Bangladesh to improve its energy distribution system by providing accurate and real-time data about energy consumption, which can help utility companies to manage the supply and demand of energy more efficiently.

In Bangladesh, the implementation of smart meters can also help to reduce energy losses and improve revenue collection for the utilities by providing remote meter reading and disconnection options for customers who are not paying their bills on time.

Additionally, the integration of smart meters into a smart grid system can help to improve the overall efficiency and reliability of the energy distribution system in Bangladesh. It can also help the utilities to offer time-of-use pricing, which can encourage customers to use energy at times when it is less expensive, thus helping to reduce peak loads and overall energy consumption.

However, there are also challenges, such as the high cost of deployment, lack of infrastructure, lack of technical know-how among the utilities, lack of consumer awareness and privacy concerns.

2.1.3. Types of pre-paid meter

There are two types of smart meter.

1. Token based smart meter.
2. Smart card meter.

2.1.4. Communication network in Smart meter

A smart meter communication network is a system of communication infrastructure that connects smart meters to a central data collection and management system. This network typically includes a combination of wired and wireless communication technologies, such as power line communication (PLC), radio frequency (RF), cellular, or satellite.

The communication network must be able to transfer the data from the meter to the central system in real-time or near real-time and must be able to support a large number of devices. The network must also be able to handle the large volume of data generated by smart meters and must be secure and reliable.

Some common communication protocols used in smart meter communication networks include:

- **Zigbee:** Zigbee is a low-power, low-data rate wireless communication protocol that is often used in smart meter networks.
- **Wi-Fi:** Wi-Fi is a wireless communication protocol that is commonly used to connect devices to the internet and can also be used in smart meter networks.
- **GPRS:** GPRS is a wireless communication protocol that is commonly used for cellular communication and can also be used in smart meter networks.
- **PLC:** PLC is a communication protocol that uses existing power lines to transmit data and can be used in smart meter networks.

The choice of communication network for smart meters depends on several factors, including the availability of infrastructure, the cost, the coverage area, the power consumption, and the security requirements.

2.1.5. Different Layer Communication Technology

Technology / protocol	Home Area Network (HAN)	Last mile/ NAN/FAN	Wide Area Network (WAN) / Backhaul
Wireless	• RF mesh • ZigBee • Wi-Fi • Bluetooth • NFC	• **RF mesh** • ZigBee • Wi-Fi	• **Cellular/GPRS** • Satellite • Private Microwave Radio
Wired	• PLC • Ethernet • Serial interfaces (RS-232, RS-485)	• **PLC** • Ethernet • Serial interfaces (RS-232, **RS-485**) • DSL	• **Optical Fiber** • **Ethernet** • PLC • DSL

Figure 03: Different Layer Communication Technology

2.1.5. Smart Meter Data Flow

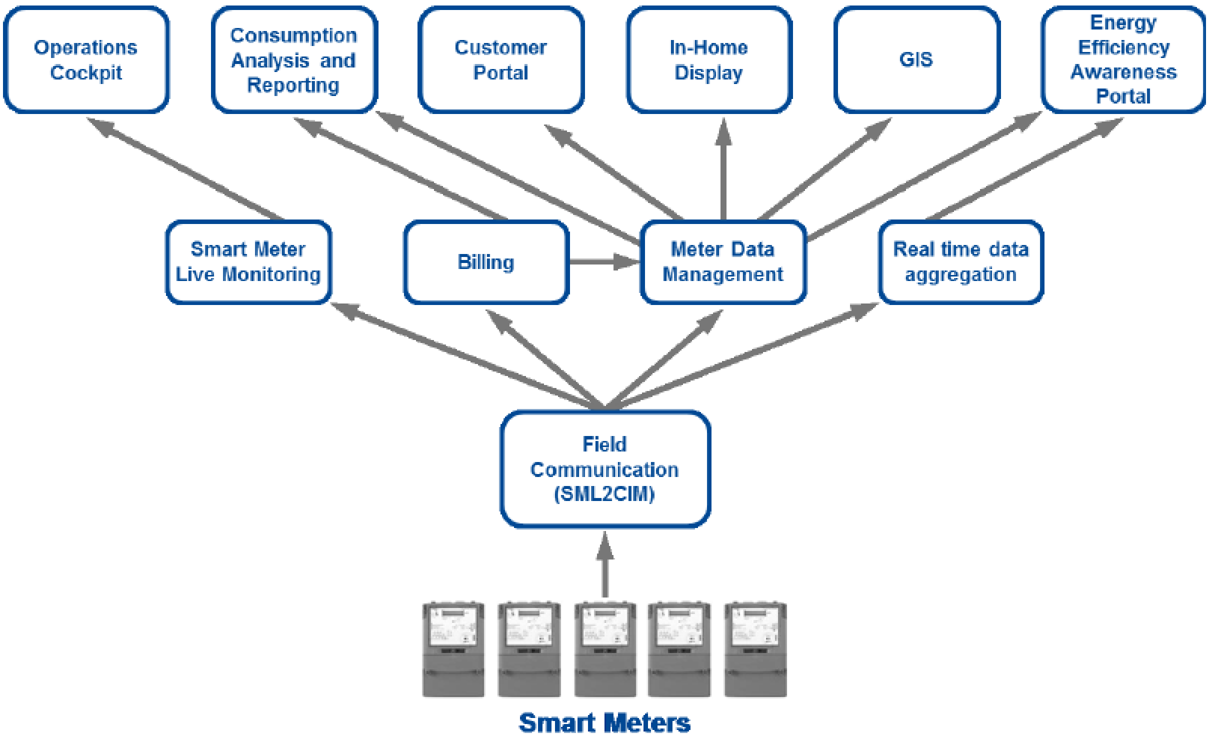

Figure 04: Data flow of Smart Meter.

Chapter 3

RF Mesh System

3.1. Architecture of RF mesh system

RF mesh technology is suitable for use in smart metering applications because of its dynamically form ad-hoc communication links between neighboring nodes. RF mesh technology basically a layered system architecture in which electricity meter are mashed together in the last layer. In middle layer router are interconnects with the meter mesh below and routes to a collector gateway which link to the upper Wide Area Network (WAN) layer where the traffic is backhauled to the Utility's HES. WAN is control by utility companies. The company uses different IP addresses using GPRS, 3G,4G, WiMAX or fiber network and collect real time data from the user.

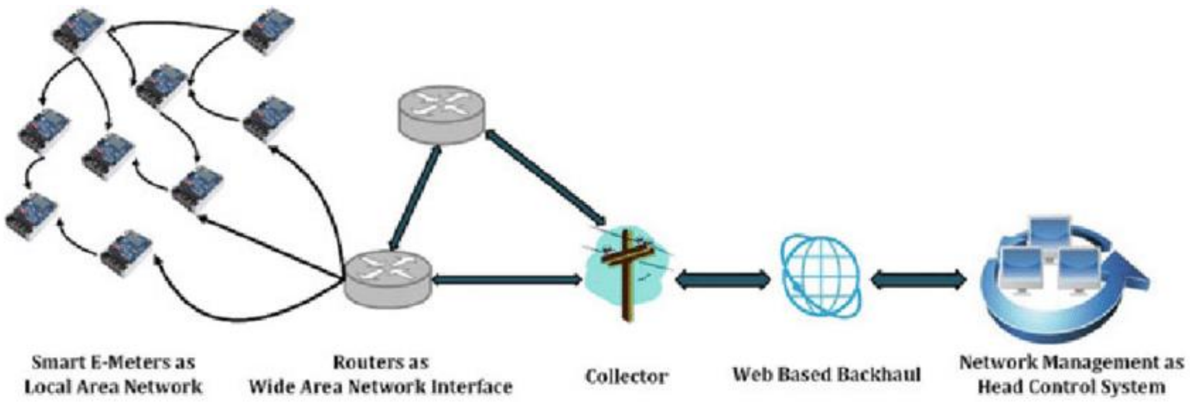

Figure 05: RF Mesh Architecture

3.2 Retransmission

Retransmission in an RF mesh system refers to the process of forwarding data packets from one node to another in the network. This is done to ensure that data can reach its destination even if the direct path between the source and destination is blocked or unavailable.

In an RF mesh network, each node acts as a relay for other nodes, forwarding data packets to the next hop in the network. This allows for multiple paths for data to reach its destination, increasing the reliability and robustness of the network.

Retransmission can occur in different ways depending on the specific RF mesh protocol being used. Some protocols use a flooding method, where a node simply forwards a data packet to all of its neighbors, while others use a more sophisticated routing algorithm to determine the best path for the packet to take.

Retransmission can also be used to improve the performance of the network by reducing congestion and reducing the number of collisions between packets. Additionally, retransmission can also be used to increase the range of the network by allowing data packets to be relayed over longer distances.

In summary, Retransmission in RF mesh system is a key feature that enables the data to reach its destination even when the direct path is not available. It improves the reliability, robustness, performance, and range of the network.

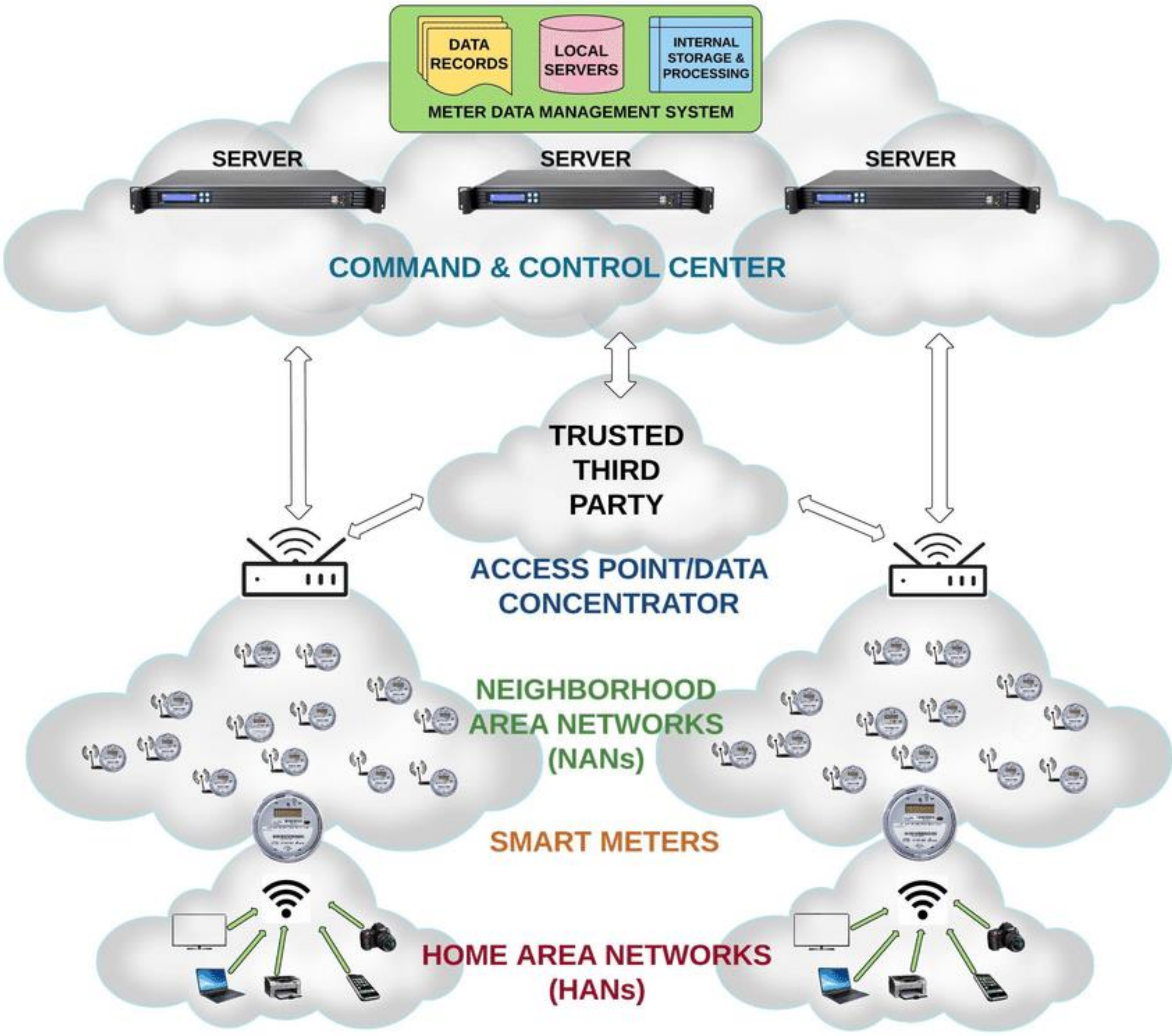

Figure 06 : Flow Chart of Transmission.

3.3 Meter Reading and Demand Response

Meter reading and demand response (DR) are related concepts in the field of energy management. Meter reading refers to the process of measuring and collecting data on the amount of energy consumed by a particular customer or group of customers. This data is typically collected by automated meter reading (AMR) systems or advanced metering infrastructure (AMI) systems, which use a variety of technologies such as wireless communication, power line communication, or cellular networks to transmit the data to the utility.

Demand response, on the other hand, refers to the practice of managing the demand for electricity by incentivizing customers to reduce their consumption during periods of high demand. This can be achieved through a variety of mechanisms, such as time-of-use pricing, demand bidding, or direct load control programs. The goal of demand response is to help utilities balance the supply and demand for electricity, and to avoid the need for expensive peaking power plants.

Meter reading and demand response are closely related because the data collected through automated meter reading systems is used to monitor and manage the demand for electricity. For example, a utility can use the data collected by AMI systems to identify customers who are consuming large amounts of energy during peak periods, and then use demand response programs to incentivize those customers to reduce their consumption. Additionally, real-time meter reading data can also be used to inform dynamic pricing, which can help to balance supply and demand in near real-time.

Figure 07 : PLC Meter

3.4 Outage Detection

Meters are able to detect and report power loss as well as any changes to the conditions of the line. To ensure that these outage detection notifications are effectively relayed to the HES, the power meters, router nodes, and collectors all have super capacitors.

3.5 Security

RF mesh system used public key infrastructure (PKI) based security architecture to protect the network nodes from cyber-attack. Keys are installed between metering point and HES point. Which blocks the critical massage and firmware downloads. Command is securely transmitted to the DPDC so they can take necessary action.

3.6 Firmware Upgrade

The process of standardizing the smart grid is still in progress, and it is likely that standards will change during the course of the deployment of the deployed meters and networking nodes. The firmware protocol stacks must consequently be able to be upgraded remotely via the air interface. Such firmware changes are supported by the RF Mesh System in a safe and controlled manner. The nodes will only take authenticated firmware images, and these must be sent using the Utility HES. The network nodes that need the upgrade are inundated with new firmware or propagated over the metering population. The network as a whole switch to the new protocol stack in a time-coordinated fashion.

3.7 Feature of RF Mesh

Meter is communicated with neighbor meter and bult a mesh system which learn to each other in the end communicate with end point. End point router communicate with neighbor router for further communication. The router smartly made a link budget for better connectivity. Though the internet is easy to access now a days the router and meter synchronize easily. If one route is faulty the router finds another route for its connection to datacenter of DPDC.

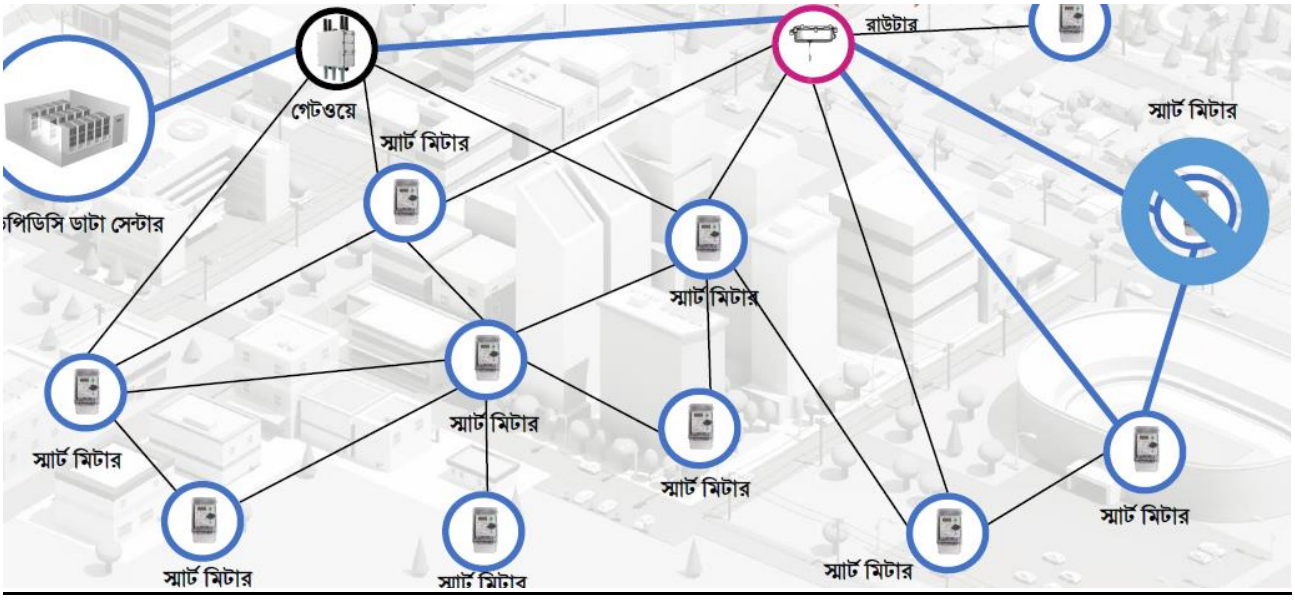

Figure 08: Self-healing of RF Mesh.

3.8 Advantage and Disadvantage of RF Mesh

3.8.1. Advantages of RF Mesh networks include:

- High scalability: RF Mesh networks can easily expand to cover large areas and support a large number of devices.

- Reliability: The use of multiple nodes allows for automatic routing around failures or interference, making the network more resilient.

- Low infrastructure costs: RF Mesh networks do not require a centralized hub or router, reducing costs.

3.8.2. Disadvantages of RF Mesh networks include:

- Limited bandwidth: RF Mesh networks may not be able to support high-bandwidth applications such as streaming video.

- Interference: RF Mesh networks may be subject to interference from other wireless devices, which can affect performance.

- Power consumption: RF Mesh networks rely on battery-powered devices, which may require frequent replacement or recharging.

3.9 Ongoing RF mesh system project in DPDC

3.9.1 Advanced Metering Infrastructure (AMI) tentative Rollout Plan DPDC:

DPDC plans to implement AMI project in phases as per the below table:

<table>
<tr><th colspan="2">Plan</th><th colspan="2">Phase – 1 (1st Tender)</th><th colspan="2">Phase – 2 (2nd Tender)</th></tr>
<tr><th>Timeline</th><th>FY19-20</th><th>FY20-21</th><th>FY21-22</th><th>FY20-21</th><th>FY21-22</th></tr>
<tr><td colspan="2">Install 8,50,000 Smart Meter</td><td colspan="2">□ Setup RF Based Network for smart meter communication in 36 NOCS area of DPDC. Initially 1 NOCS for Pilot.
□ Procure 8.5 Lac RF based NIC/RF module with plug-in facility for Smart Meter.
□ Procure 1 Lac Smart (3 Phase & Single Phase) Meter from 3 different meter manufactures and Interface NIC to the meter.
□ Setup IT Hardware (DC & DR) and Establish Data Connectivity.
□ Procure & Setup HES, MDM & Other Related Software
□ Install 10,000 Smart Meters in 1 NOCS as Pilot bases.
□ On basis of pilot success, set up RF Based Network and install 90,000 smart meters in whole of DPDC area.</td><td colspan="2">□ Call Tender and procure 7.5 Lac Smart meter in 3 Lots (2.5 lac meter each lot).
□ Install 5.5 lac Smart Meters in DPDC 17 NOCS
□ Install 1 lac Smart Meters in DPDC other NOCS as per requirement.</td></tr>
</table>

Table 01: Budget Link Plan.

3.9.2 Project Stakeholders and Recent Progress of the Project

Project stakeholders of the project titles “AMI with 8.5 Lac Smart Pre-Payment Meter in DPDC Area” are given below:

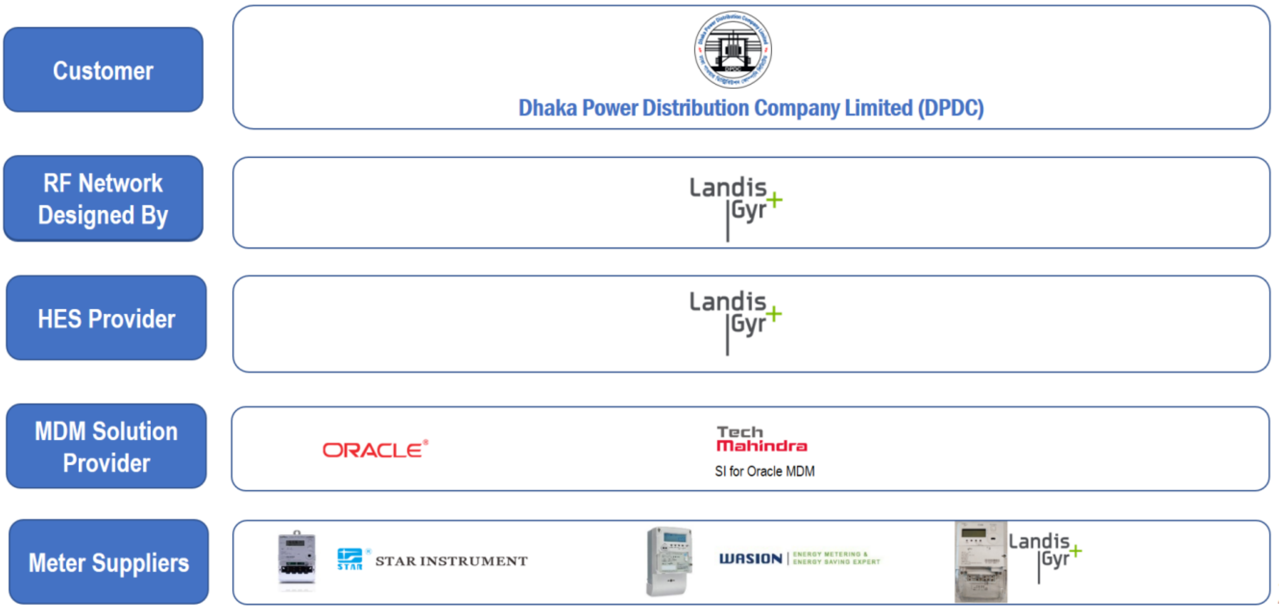

Figure 09: Stakeholders of Project

Recent progress of the project is summarized below:

Total Smart Meters Installed till 30 October 2022		
Paribag Network Operation & Customer Service (NOCS) Office		Total No.
Single Phase (1P) L+G Smart Meter	:	23,131
Three Phase (3P) L+G Smart Meter	:	449
Total L+G Smart Meter	:	23,580
Jigatola Network Operation & Customer Service (NOCS) Office		Total No.
Single Phase (1P) L+G Smart Meter	:	4,543
Three Phase (3P) L+G Smart Meter	:	14
Total L+G Smart Meter	:	4,557
Grand Total	:	28,137

Table 02: Budget Plan.

3.9.3 Areas of GPRS Technology Used in This Project:

1. Primary and redundant data connectivity from Data collector/ DCU/ Router/ Repeater/ Gateway etc. to system/data center during project implementation stage, defect liability period and 3 years AMC period: minimum 2 MBPS for each (the connectivity shall be fiber optic based on 2 different NTTN i.e ISP provider) along with GPRS/3G/4G data connectivity.
2. Use of the GSM/GPRS & Fiber Optics connectivity to connect the DCU/Access Points to the data center where optical fiber connectivity is unavailable.
3. The HES must be able to communicate with the access point /router/DCU via optical fiber and GSM/GPRS connectivity.
4. HES will be able to communicate with GPRS, PLC & RF based Meter.

Chapter 4

Methodology

METHODOLOGY Starting with the topic selection and ending with the writing of the final report, the study is carried out in a systematic manner. Identification and data collection played a crucial role. To identify the key points, they were then categorized, examined, explained, and presented in a systematic way. The overall technique used in the study is described in more detail.

Selection of the topic: The study's topic was given to me by my supervisor. Before the topic was assigned, it was thoroughly explored to enable the creation of a well-structured internship report.

Sources of Data

Primary Sources: From the practical deskwork, primary data was derived. In addition, my boss at DPDC assisted me in getting information directly from the business.

Secondary Sources:

Internal sources: The organization's many circulars, manuals, and files, as well as various documents supplied by concerned officers.

External source: Different websites related to RF mesh system and online resources.

Classification, analysis, interpretations, and presentation of data: Some diagrams and tables were used in this report for analyzing the collected data and to explain certain concepts and findings more clearly. Moreover, collected data were analyzed more precisely.

Findings of the study: The collected data were analyzed well and were pointed out and shown as findings at the end.

Final report preparation: The final report is prepared after valuable suggestions and advice of my honorable advisor.

Chapter 5

Discussion

5.1. RF Mesh System

RF mesh system is generally a system where every meter is always in online. Consumer can access their consume data every moment and built a fair communication and faithful connection to consumer and DPDC. RF mesh system connected every meter with a radio frequency and all meters are connected in a router and router are connected to DPDC data center.

5.2. Cost effect from this project.

1. Commercial Benefits:

- Automated Meter Reading – Improvement in Billing Efficiency
- Remote Disconnection – Improvement in Collection Efficiency
- Improvement in Data Analytics – Improvement in hit rate in Tamper Detection
- Capturing Maximum Demand - Improvement in revenue through SAC & Fixed charges 36
- Reduction in Ad-hoc readings - leads to save time & resource.
- Faster Detection of Dead Meters - Real Time Energy Audit Reduction in Revenue
- Billing Cycle time

2. Operational Benefits:

- DT Meters on same Canopy leads to identify the Asset Utilization / Overloading etc.
- Removal of Manual Disconnection / Reconnection
- Faster Outage Detection
- Real time Power Quality Monitoring

3.**Consumer Benefits:**

- Less Outages
- Error Free Bills due to no Manual Intervention
- Option to choose – Prepayment.
- Better usage visibility through Mobile app
- Enablement for Renewable Integration
- Incentive for maintaining PF>0.85.

5.3. Challenge of Smart Metering in Bangladesh:

Bangladesh is a highly dense country and people are not too much familiar to new technology. In the beginning people are not ready to accept this technology and they have trust issue. On the other hand, electricity provider company also have leakage of skillful worker in that sector. For dense people proper link budget also a challenge.

The design challenges in realizing the smart meter are multi-faceted. One of the first challenges is clear definition of features, as Smart meters for Home and Utility occupy different spectrum of feature sets with minimal overlap. Clarity in the definition of requirements by user community can optimize the cost of the Smart meter by use of optimal hardware and software components. Some of the features which can impact the cost and modularity of the design are listed below:

i. **Communication Protocol:** It is important that specific communication protocols to be implemented are specified/mandated by central body for Smart Meters to ensure that proprietary protocols do not find way into the Smart Meter.

ii. **Communication Security:** Communication security in an AMI/ Smart Grid environment will be a prime requirement as remote-control features are enabled, and sensitive revenue data is transmitted. It is important that the specific sections of the standards (IEC 62351) to be incorporated in the Meter Firmware are specified which are compatible to the AMI and MDM systems.

iii. **Interoperability:** The control commands and other data formats used in smart meters should be ensured that they are interoperable with the existing AMI infrastructure.

iv. **Meter Data:** Different Consumers (Utilities, Industry and Home) require different measurement parameters. Standardization parameter requirements across consumer segments is a must.

v. **Communication ports:** Since the Smart meters will be provisioned with Ethernet, optical Ethernet other than the Serial connector and USB. Specification of the ports will help optimize the case design and upgradeability.

vi. **Communication:** There is a varied choice of communication modes available for the smart meters like wireless (Zigbee, WiFi, LowPowerRF) or power line. It will be desirable to define the choice of these modes as focused study, analysis and implementation can be carried out.

vii. Standardization of Smart meter size and footprint would also be an important consideration.

viii. **Power Quality Requirements:** The specification on the type of power quality measurements required across different consumer segments will need to be defined for higher order harmonic distortions, Sag, Swell, Outages, dips, transients recording, duration of records. Clear specification on these requirements will optimize the cost of the smart meter as it will impact use of Digital Signal processors and high-speed memories for implementing the Power quality measurement feature.

5.4. Challenge of RF mesh System for Smart Metering in Bangladesh:

RF mesh need high frequency radio signal. There is building everywhere for this the signal will reflect and scattering too much and the signal will destroy. The link budget more challenging for high dense structure. The cost of router and meter will be high and the sever maintaining also will be costly.

Figure 10: Router of RF Mesh

5.5. Experience as an Intern of DPDC

One of Bangladesh's biggest power distribution firms is Dhaka Power Distribution Company Limited (DPDC). DPDC wants to use the advantages of Advanced Metering Infrastructure (AMI) to raise the bar for power quality and reliability as it travels the path of making power distribution smarter every day. Considering this, DPDC has created a bold plan for the implementation of advanced metering infrastructure. RF mesh is one of them.

As an intern of DPDC we learn a lot of from them. Their organogram, culture and working environment are very good. Our inter teacher and other teacher and employee are success to tech about their working policy. Every site visit is enjoyable and effective to their effort and hospitality. I will recommend other to take participate in their inter program to learn something with a corporate vibe.

At the end of May 2022, some of us students from East West University participated in DPDC's 3-month internship program. The following topics are highlighted in the internship program:

(a) Introduction of electricity supply, gradual formation of PDB, REB, DESA, DESCO and DPDC by the Government under the Power Sector Reforms 1

(b) Power supply system at DPDC.

(c) Network Operations and Customer Service (NOCS) activities at DPDC.

(d) Activities of supporting offices of NOCS (eg: HR, Finance, ICT, Audit, Planning, Development, Metering, System Protection, Grid, Tariff and Energy Audit).

(e) Activities of Training and Development Department of DPDC.

(f) Inspection of 132/33 KD GIS Substation and 33/11 KV Substation.

(g) Inspection of SCADA System, Workshop, Meter Testing Lab, Central Warehouse, Medical Center of DPDC.

5.5.1 Sites Visiting

Figure11: Dhanmondi Sub-Station

Figure 12: -NOCS (Network Operation & Customer Service) Narinda

Figure 13: Grid Sub-Station (Shahjahanpur)

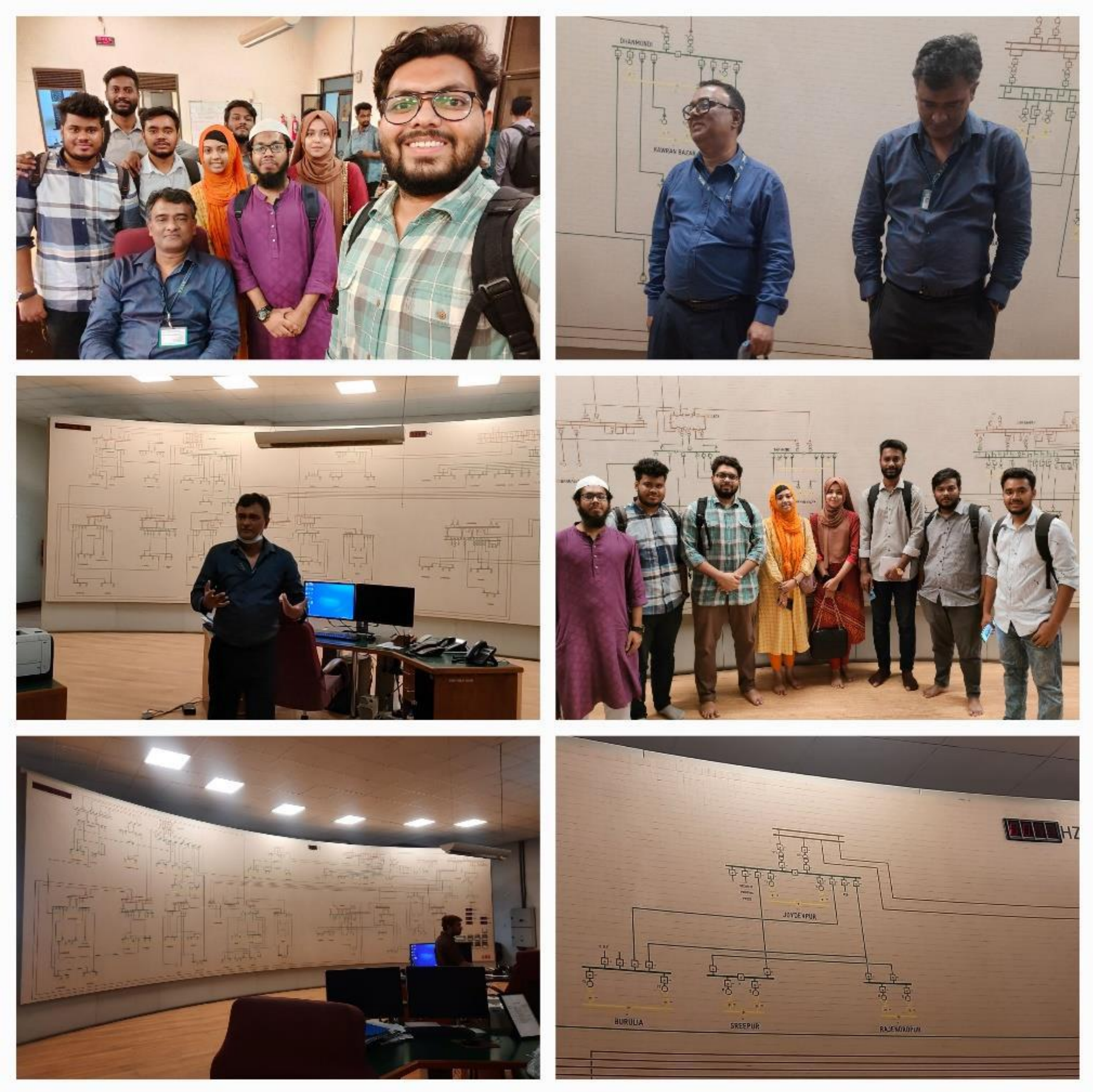

Figure 14: SCADA (Supervisory Control and Data Acquisition)

Figure 15: HR, Finance, ICT Division, 132/33 KV GIS

Figure 16: DPDC Library

5.6. Ongoing project on DPDC

Designing, supplying, establishing, installing, testing, commissioning, operating, and maintaining the Advanced Metering Infrastructure (AMI) for customers with Single Phase and Three Phase Whole Current meters is the scope of the project. The DPDC plans to install the AMI system throughout the DPDC territory (225 Sq.km). In the 36 NOCS zones of DPDC, 100,000 metering nodes from 3 different meter manufacturers are part of the project's initial stage of smart metering. The three distinct meter producers must come from at least two separate nations. 8,50,000 smart meters will eventually be covered by the smart metering, or AMI, project. For these meters, the AMI system will be developed and scaled up for 2 million meters.

I. The goal of this project is to set up the AMI system for all Distribution customers, with the following features included but not limited to: I. The ability to access AMI meter data on a regular basis, provide all the necessary information on a single console in an integrated manner, and provide remote network control capabilities to improve operational efficiency.
II. The contractor must set up a network platform using RF communication technology that can accommodate numerous applications, such as AMI, GlS, and DMS, on a single communications platform.
III. The contractor must set up a network platform using RF communication technology that can support numerous applications, such as AMI, GIS, DMS, Street Light Management, and HAN, among others, on a single communications platform.
IV. To connect with field devices, the network canopy that will be built using RF communication technology will need intermediary network components such routers, repeaters, collectors, gateways, data concentrators, access points, etc.
V. At the areas where the meters will be installed, the contractor must install smart meters and build an RF communication canopy.
VI. The contractor will provide, install, configure, and commission all necessary hardware (Data Center & Disaster Recovery Center) and software (HES, MDM, Database, Application Server, Mobile Apps, etc.) for efficient AMI administration.
VII. The project must be able to accommodate all signals from the DPDC distribution network, which consists of a 5,213 km power line, a 228 km 132 KV transmission line, a 390 km 33 KV line, a 4431 km 11/0.4 KV line, 19000 no. of distribution transformers, and an initial 100,000 no. smart meter. Within the whole DPDC region, future phases

of smart metering must be able to accommodate 8,50,000 metering nodes, which is why the proposed AMI The 8.5% average annual growth rate of customers and related infrastructure should be considered while designing the communication network, control center, data center, and AMI system. This adds up to a total cost of 2 million (approximately) AMI meters after installation and implementation have been completed.

In order to collect data on power consumptions and remotely connect and disconnect the power supply, technology embedded in the communications system for smart meters should enable the configuration-less formation and self-restoration of communication networks that can scale up to the required level for AMI applications. Additionally, the system ought to offer users value-added services such in-depth, visually appealing power usage reporting.

According to the agreement between DPDC and the bidder, the network's design and technology should allow for the connection of a greater number of communication devices by adding more components at each level of the RF network canopy and IT infrastructure.

Achieving device level interoperability is another goal of DPDC, which has chosen RF communication technology and a variety of smart meter manufacturers. That is, the manufacturers of numerous meters must adhere to the RF Network Interface Card (NIC)/RF Communication module/chip with plug-in facility requirements of the RF canopy vendor and utilize the same communications technology, RF mesh.

Major items discussed in the following sections of this text are described in terms of their required functional and technical specifications. The bidder will oversee making sure that all systems, subsystems, and equipment/devices adhere in every way to high standards of engineering, design, and workmanship and are able to perform continuously commercial operations in accordance with the current and foreseeable future requirements of the DPDC.

Chapter 6

Conclusion and Future Work

Conclusion:

For applications involving smart meters, radio frequency (RF) mesh systems have become a potential technology. They give utilities a dependable and affordable way to enhance their operations and customer service by enabling the remote collection of data on electricity, gas, and water consumption from a large number of meters. A network of nodes that connect with one another and transfer data over the air is how RF mesh systems work. They are ideal for smart metering applications since they are self-healing and able to function under challenging conditions.

Systems based on RF mesh are widely utilized in North America and other regions of the world. The first company to use this technique was the Dhaka Power Distribution Company in Bangladesh (DPDC). 36 Network Operation and Customer Service (NOCS) organizations make up DPDC. As part of its AMI, one NOCS is installing an RF mesh metering system. The primary goals of an RF mesh-based metering system are to enable automatic meter reading, gather interval data, and provide a Demand Response (DR) program, all of which call for rapid, regular two-way communication between the meter end point and the head-end system (HES). 10,000 smart meters were initially installed by DPDC in one NOCS (Pari bag-Division, Dhaka). According to estimates, the DPDC region has installed 90,000 smart meters.

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Future Work:

The future work for a RF mesh metering system in the distribution network of the Dhaka Power Distribution Company (DPDC) in Bangladesh could include the following:

- Expanding the deployment of RF mesh metering system to cover more areas of the distribution network to increase the accuracy and coverage of meter readings.
- Integrating the RF mesh system with other advanced metering infrastructure (AMI) technologies, such as smart grid and demand-side management systems, to improve the efficiency and reliability of the distribution network.
- Developing software and analytics tools to process and analyze the data collected by the RF mesh system, in order to identify areas of inefficiency and optimize the distribution network.
- Implementing security measures to protect the data and communications of the RF mesh system from hacking and other cyber threats.
- Expanding the use of the RF mesh system to other applications, such as load forecasting, distribution automation, and outage management, to improve the overall performance of the distribution network.
- Enhancing the system to provide real-time monitoring and control of the distribution network to improve customer service, reduce costs and improve reliability.
- The DPDC can also explore the possibility of integrating renewable energy sources into the RF mesh metering system to increase the penetration of clean energy in the distribution network.

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