CHAPTER 1

INTRODUCTION

1.1 Background

The increase in carbon emissions causes global warming and climate change. In order to implement the Kyoto Protocol and the Paris Agreement, it is necessary to reduce greenhouse gases to maintain the earth's temperature. One effort to reduce carbon emissions is using renewable energy in power plants [1].

Using New and Renewable Energy in generators has challenges compared to conventional energy. The intermittent & non-dispatchable nature of renewable generators such as solar and wind cells poses challenges [2]. An advanced control system is needed to manage renewable energy in power plants, especially to balance the demand and supply sides of electricity demand, especially in the increasing demand for electricity due to increasingly massive electrification. The advanced control system in the grid needs reliable communication. There are several challenges and opportunities in designing network communication for the grid.

The electricity distribution network that connects the electricity transmission network with customers on the electricity telecommunications network side is classified as a Field Area Network (FAN). FAN connects the distribution network, while the local network side on the customer side is called Home Area Network (HAN). FAN has smart metering, demand response & distribution automation services that require a communication network that supports many field devices (AMI) to communicate with substations on the Grid Operations side and data concentrators. A data rate of around 100kbps-10Mbps is required with a wide range (up to 10 km) that can accommodate thousands of smart metering devices [3].

Smart electricity networks have many Intelligent Electronic Devices (IEDs) and other electronic devices that require telecommunications networks for metering, monitoring & operational purposes. Each customer has a metering device in the distribution network, so the growth of electricity subscribers affects the number of devices connected to the telecommunication network. Without traffic management, congestion can occur on the network and decrease QoS, so the control system cannot operate optimally, especially on a FAN system.

On the other side, the development of internet penetration causes increased network load and network problems. Huawei stated that the percentage of global internet penetration has reached 52% and estimated that by 2030 it would cover 70% of the world's population. Global data volume is growing 30% per year from 2016 until 2030. Problems like running out IP addresses and decreasing network quality can appear [4].

IP networks that are 'host-centric' currently have several issues regarding security, mobility, scalability, and URI (Uniform Resource Identifier) configuration. A distributed network approach, such as Information Centric Networking (ICN), is considered an option to address this issue. ICN considers supporting URI mechanisms, data security, and better scalability [5].

Named Data Network (NDN) is one of the developments of the ICN concept. NDN considers having more capabilities than the existing network based on throughput, latency & packet loss, which can be achieved because the NDN has forwarding, routing, and caching mechanisms [6].

In name-based NDN communication, traffic source devices can be immediately identified. The naming scheme makes it easier than IP communication mechanisms that translate device domains to device IP addresses using DNS [7]. A 'distributed' smart grid network in the electricity supply paradigm (microgrid, the customer can be a producer or a customer) has a paradigm similarity to an NDN network which is also distributed and supports two-way communication between devices [8].

In the maintenance of distributed power network devices, the cache mechanism on the NDN network can accommodate repeated packet requests, such as configuration packages or software updates requested by many devices. The cache will reduce the time needed to perform maintenance. As shown in research [8], the cache mechanism can reduce the delay of repeatedly requested services, such as price info. In [9], the NDN named-based mechanism can lowering recovery time due to link failture than TCP that must re-establish TCP connection. Related research on the Smart-grid Wide Area Network network states that implementing a traffic priority scheme can increase network QoS, especially on the latency side [10].

This final project proposes that a traffic priority scheme based on the NDN mechanism follows the type of service on the FAN for operation, control, and monitoring needs, with several services such as smart metering, demand response & distribution automation. We package priority treatment because there are various types of traffic on the FAN. This various FAN traffic needs different characteristics and Quality of Service (QoS) requirements. Applying the traffic priority mechanism is expected to meet the QoS needs in handling grid service packages in FAN.

1.2 Problems Definition

Based on the context underlying this research, the following problem statement has been constructed:

1. How to model content-based (prefix) FAN traffic based on NDN approach?

2. How is the classification of traffic types on FAN?

3. How to implement a queuing mechanism on FAN based on the NDN approach using the ndnSIM software?

4. How is the packet priority scheme mechanism based on FAN traffic classification based on NDN?

5. How does packet priority affect the QoS of NDN-based FAN networks?

1.3 Research Objective

The objectives of this study include the following:

1. Modeling traffic on FAN with the NDN approach.

2. Provide communication suggestions for FAN with the NDN approach.

3. Knowing the impact of selecting service priorities on network QoS.

   So that the research on this thesis is planned to be able to contribute as follows:

   (a) Provide a communication mechanism proposal on the FAN network, which can meet QoS needs based on the NDN mechanism with a priority scheme based on traffic type.

   (b) Provides FAN communication modeling on Grid systems and service priority methods on NDN.

   (c) Provides an analysis of the effect of the packet priority mechanism used on the FAN Grid network with the NDN mechanism so that it can be used as a reference for developing communication mechanisms on the FAN Grid, both in planning and implementation.

1.4 Scope of Works

1. The testing is conducted using a simulator and on a laboratory scale.

2. The communication design is focused on Filed Area Network, hedge traffic from Wide Area Network & Home Area Network.

1.5 Research Methodology

The research methodology is carried out with the following steps as described in Fig. 1.1 :

1. Literature Study: Required to gain a basis in doing system modeling.

2. Traffic Modeling: modeling the network topology and the type of traffic that will be passed on the network.

3. Package priority scheme: Creates interest package scheme and performs priority based on prefix-based interest group model.

4. Simulation testing: Testing the FAN with the NDN approach model.

5. Data Analysis: Analysis of simulation results to determine network QoS.

1.6 Hypotheses

By conducting traffic modeling with a packet priority scheme based on the NDN mechanism, it is expected to meet the needs of the FAN system. The packet priority mechanism is expected to meet service needs due to the extensive system scalability with many metering devices in the area.

1.7 Research Aspects

The central aspect examined in this thesis is to accommodate the communication needs of the FAN with an NDN approach based on service type priority. Each node on the FAN can be a consumer or producer (prosumer) based on the type of service needed. The router will filter incoming interest requests at each node based on the packet priority scheme. The router then forwards the interest packet to the producer node with a queue according to the packet's priority.

FAN devices such as metering can function as a producer or consumer (prosumer), both on the telecommunication and grid sides. For example, in a rooftop solar power plant, panels can provide the power needs of the grid (producer) or as consumers when power needs are not met. On the communication side, the rooftop PV metering device becomes a producer when it provides information on electricity meter readings on the grid. In contrast, it becomes a consumer when there is a control action from the grid.

Each service type will be modeled into a separate NDN prefix. Each of these prefixes will then be classified in the traffic priority class. The consumer node will send interest

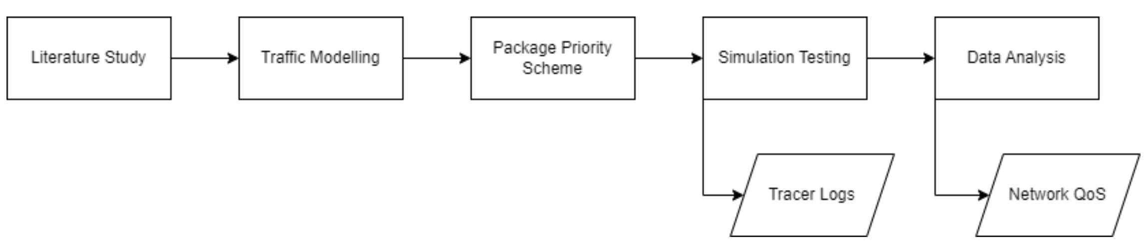

Figure 1.1: Research Methodology

packets if it requires data on the producer node. Furthermore, the interest packet will be forwarded to the producer via the NDN router through a specific interface connected to the next node, according to the packet queue, based on the priority type of packet service. The models of communication design can be observed in Fig. 1.2 .

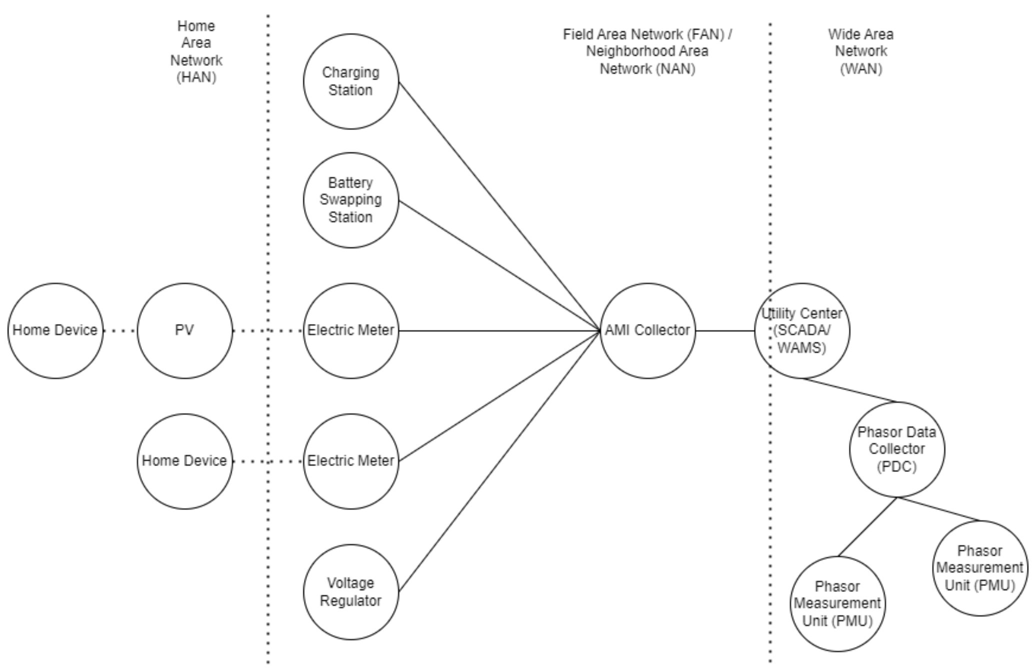

Figure 1.2: Communication Design of Grid