Smart Meters in Smart Grids

1. Introduction

Smart grids (SG) is generated by the conventional power grids through new technologies. There are many technologies that engineers should use to achieve the evolution. Smart meters (SM) are one of the basic parts in smart grids [1], which are discussed in this passage.

2. Background

In conventional electricity meters, information flows in one direction. It just measures and displays the consumption and sends information from meters to suppliers, so the users cannot adjust their energy usage in real time. Meanwhile, because of the lack of flexibility, the suppliers cannot react immediately when some failures happen. Therefore, conventional electricity meters need to be replaced by smart meters to solve these problems [2].

3. Types of Smart Meters

According to British standards, smart meters have two main types, SMETS 1 and SMETS 2 [3]. SMETS 1 uses 3G mobile network to communicate with suppliers. However, the network of different suppliers is different. This may cause a problem that if you change another supplier, the meter will stop working for a while. SMETS 2 were first launched in 2018. All

the suppliers use the same dedicated network to solve the problem of SMETS 1. Figure 1 shows the appearance of SMETS 2. In China, smart meters also have two different types [4]. The first type is electromechanical integrated watt-hour meters. This type of meters is the most common. Because of the large population of China, replacing all the old meters is not realistic. Therefore, they modified the mechanical watt-hour meters and installed a sensing device to turn it into smart meters with electrical pulse output at the same time as the mechanical meters. The second type is full electronic smart meters. They have the same function as SMETS 2. The next section will discuss the capabilities of smart meters.

Fig 1. SMETS 2 [5]

4. Capabilities of Smart Meters

Smart meters mainly include measurement, storage, data processing, and communication functions [1]. To achieve these functions, engineers developed advanced metering infrastructure (AMI) based on smart meters. AMI includes smart meters, data concentrators, communication media/networks, central system [6]. Therefore, smart meters have a much more complex structure than conventional meters.

4.1 Measurement

The measurement and data processing of smart meters are based on integrated circuits. The most important measurement data of smart meters is the user's supply voltage and current. After this, the A / D conversion part of the circuit then samples the analog signal into the digital signal. Phase and frequency also need to be measured. Meanwhile, for precise and regular measurement, this data needs to be collected frequently. In this way, smart meters can pass the real-time energy consumption to suppliers and users [7].

4.2 Storage and Data Processing

In AMI system, meter data central (MDC) system and meter data management (MDM) system are responsible for data storage and processing [8].

MDC can send the data collected by the smart meters to a central database and operate the smart meters infrastructure to keep it running. MDM uses integrated circuits to process the sampled voltage and current signals and converts them into pulse output that is proportional to the electrical energy; Then, it processes and controls the microcontroller to display the pulses as power consumption. After that, it will analyse the obtained data and use the corresponding algorithm to convert power consumption into expenses. Finally, MDM will analyse this data and make better energy usage decisions for users based on their electricity usage, and it will also analyse energy consumption of different appliances and provide energy discount plans. In addition, it will also analyse for suppliers so that suppliers can better allocate power to different users [9].

It is worth mentioning that its data processing capability is not just calculation and analysis, it can also perform data monitoring. If there is abnormal data, such as abnormal calibration or abnormal power consumption, it will pass the data to suppliers and may issue an alarm, which guarantees the safety of users and protects the interests of suppliers.

4.3 Communication

Communication capability is the biggest difference between conventional and smart meters. As mentioned before, information on electricity meters, suppliers and users flows in both directions. Figure 2 shows the information flows in both directions from smart meters system. The communication module is independent, and it will not affect the data collection and storage analysis of smart meters. The main information transmission methods in smart meters is using wide-area communication network (WAN) and home area network (HAN) [3].

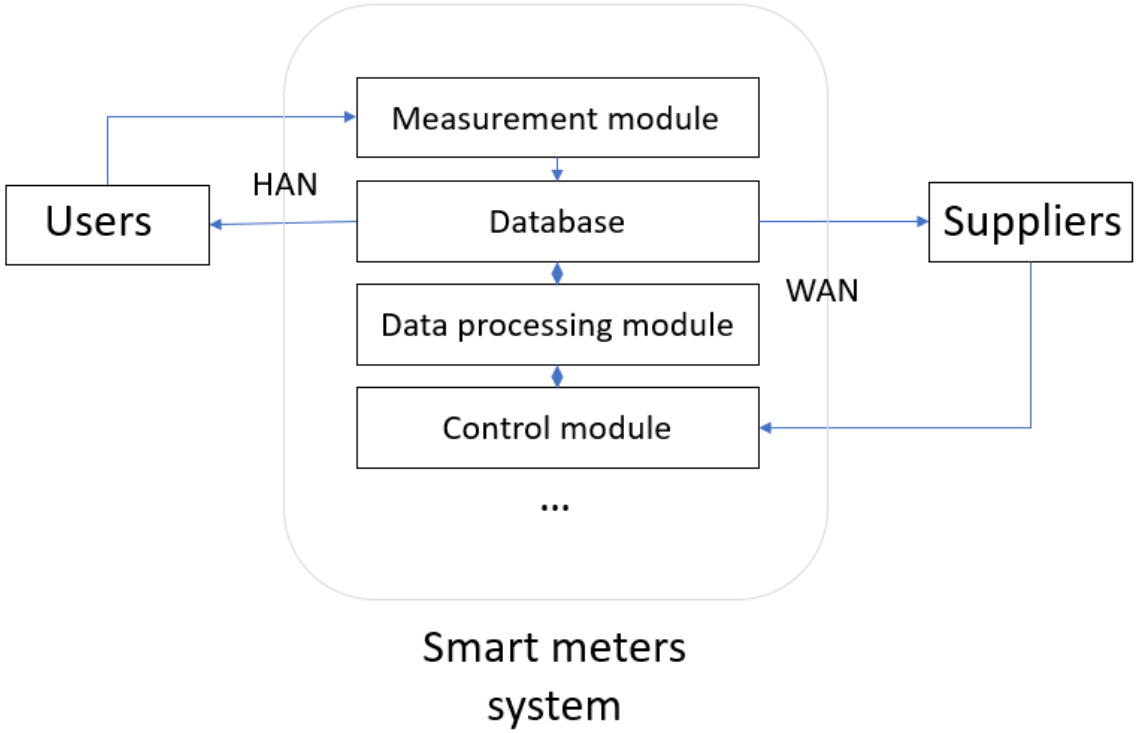

Fig 2. Information flows in both directions from smart meter systems

WAN uses 3G wireless network or optical fiber and power line to transfer information. The most important thing is that it allows smart meters, users and suppliers to transfer information in both directions. What's more, its coverage area is very large, and the transmission of data can be very far [10].

HAN is mainly used to connect devices inside the home. Through it, smart meters can communicate with home appliances and even electric cars for information transfer. In this way, smart meters can not only display the total power consumption, but also the power consumption of different devices for users to adjust. Bluetooth, WiFi, etc. belong to HAN [3][8].

5. Advantages and Challenges

Smart meters have a lot of advantages. Compared with conventional electricity meters, it has greatly improved in terms of accuracy and safety. Figure 3 compares the performance of conventional meters and smart meters.

	Conventional meters	Smart meters
Measurement	Yes	Yes
Real-time meter reading	No	Yes
Cost information	No	Yes
Data processing	No	Yes
Automatic control	No	Yes
Information flow	One way	Two way
Accuracy	Low	High
Safety	Low	High
Meter energy consumption	Low	High
Total energy consumption	High	Low
Privacy	High	Low
radiation	Low	High

Fig 3. Performance of conventional meters and smart meters

However, there are challenges when using smart meters [11]. The problem that everyone thinks of first is also the most contradictory problem, which is privacy. The user's power privacy is presented in the suppliers' database without any reservation. Perhaps the suppliers signed the agreement will not leak the data, but people may also worry about

hackers stealing the data and other issues. Being aware of the privacy of your electricity use is likely to cause more serious security issues.

6. Conclusion

In recent years, the development of smart meters has been very rapid. Its data collection, analysis, and information transfer functions have facilitated people's lives. In the future, smart meters may be more accurate and safer.

7. Reference

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