RESEARCH ON SMART METER MANAGEMENT SYSTEM FOR LOW-VOLTAGE CUSTOMERS

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ABSTRACT

Based on the current telecommunication technologies, this paper focuses on the establishment of a low-voltage smart meter management system to build a two-way communication between the utility and low-voltage customers at the minimum cost to achieve smart Demand Side Management. The operating principal, technological specification and function of these four components are described in detail in this paper. The smart meter management system can make smart DSM possible at the minimum cost to create a win-win situation for both the utility and the customers.

FOREWORD

With rapid growth of power consumption in Shanghai, the energy consumed by low-voltage (0.4KV) customers accounts for about 30% of the total energy. The local utility is expecting that the low-voltage customers will keep the increasing momentum. For Southern Power Supply Company, it has all together 1.09 million customers. The number of customers with low-voltage (220V or 380V) connection is about 1.08 million which account for 99.1% of the total customer. Among these low-voltage customers, only 30 thousand customers are equipped with the remotely read meters. So every month, the utility company has to send field workers to visit the customer door to read the meters manually.

For customers with connection voltage at high-voltage (10kV or above), bidirectional load control devices are installed at the customers side to ensure two-way communication between the utility and the customer. This enables the customers to share the load information of the local grid at real-time to help them to adjust their production schedules for Demand Side Management. For 10kV or 35kV exclusive feeder customers, additional line-loss monitoring devices are deployed at both the utility side and the customer side to detect any abnormal consumption by comparing the data from the meters and these devices. But neither the load control nor the line-loss monitoring are applied to the low-voltage customers. Based on the current telecommunication technologies, this paper focuses on the establishment of a low-voltage smart meter management system to build a two-way communication between the utility and low-voltage customers at the minimum cost to achieve smart Demand Side Management.

LINE-LOSS ANALYSIS METHOD

The current line-loss analysis for low-voltage (0.4kV) Distribution Transformer (DT) supply zone is following: Line loss analysis is carried out within a DT supply zone. Every low-voltage customer is clearly connected to a certain DT to have power supply (a match). At the 0.4kV side of a DT, a master meter which can be read remotely is installed. For low-voltage customers in this DT supply zone, traditional meters are installed at customers premise for energy metering. The energy consumption sum of all the customers in this zone should be more or less equal to the data of master meter with a difference allowance of ±7%. But due to metering date lag or mismatch of a customer meter with a master meter or customer fraud, the accuracy of this line-loss analysis method is only 70%. So this method needs to be improved.

FOUNDATION OF THE SYSTEM

Pre-conditions to build a smart meter management system:

1.Distribution gird topology
2.Customer connection data(to ensure a correct match)
3.Energy supplied by Distribution Transformers
4.Energy consumption (metering) of every customer

Thanks to the development of IT system in SMEPC, all these above pre-conditions are met. All the IT applications such as PMS, EMS&SCADA, D-SCADA, Load Control System, Remote metering for MV&HV Customers, CMS and ERP can share data with the IDP (Integrated Data Platform). With the support of these applications, the smart meter management system is possible to deploy.

SYSTEM COMPONENTS AND PRINCIPLES

1. Components of smart meter management system

The smart meter management system comprises of operation centre, data collector for DT(Distribution Transformer), smart meter and telecommunication channel. (Figure1)

Figure1: components of the system

On each of the Distribution Transformers, a data collector is installed to collect consumption data in the DT's supply zone. The collector can remote read the consumption data from the smart meters at customer side by wireless networks or PLC and store the consumption data in its memory. The smart meter management system can call the

collector to read the customer's consumption data or to upload the data to the center servers or to broadcast update configurations by GPRS networks or other means of telecommunications. The system can also instruct the collector to remotely read an individual customer meter on real-time or to disconnect or reconnect the customer online. With this system, the DT supply zone line-loss analysis and DSM on low-voltage can be improved with better consumption data available.

2. Smart meter management system principles

Smart meter management system can issue commands (such as meter-reading instruction) to the collectors on DT with GPRS networks. When the collector receives the commands successfully, it will confirm with the system and relay the commands to the smart meters at customers side to be executed. Then consumption data is transmitted to the collector and later uploaded to the center servers. The system can issue commands on pre-set schedule or system operators can issue commands manually to read the consumption data.

3. Inter-connection with other IT application systems

The smart meter management system can communicate and exchange data with other IT systems such as CMS and IDP.(Figure2)

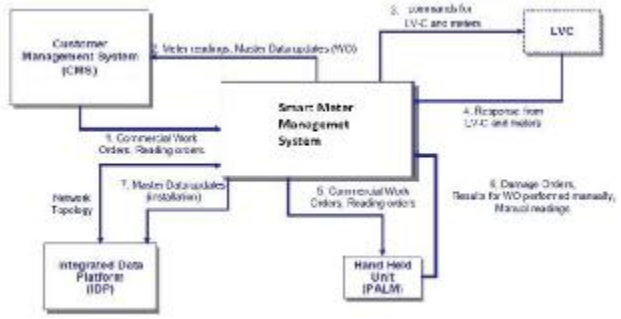

Figure2: Inter-connection with other IT systems

SMART METER MANAGEMENT SYSTEM

1. DT supply zone data collector

Data collector is installed at the 0.4kV side of the DT and is connected to the phase A,B,C line. The collector can talk to the smart meter to acquire the consumption data by PLC or other means of telecommunication. Date collector is the telecommunication hub for the smart meter management system, its performance is the key to the system's reliability and stability.

1.1 Data exchange with operating center.

1). To receive instruction from the system (or operators), for parameter setting, remote-metering on schedule and etc.

2). Transfer the consumption data to the data servers with protocols.

3). Alarm the operating center when detecting any faults of telecommunication or meter malfunction.

4). Smart meter and collector software updates.

1.2 Data exchange with smart meters at customer side.

1). Collect consumption data on schedule

2). Remote connect meter at customer on command from operating center. Remote modification the contract power capacity. Remote setting the multi-tariff and holiday tariff.

3). Remotely disconnect or reconnect a low-voltage customer on command from operating center(normally for bad-payer customers).

1.3 Other functions of data collector

All networks parameters concerning the communication with the operating center are stored in the data collector. The parameters include the IP address, service port of the operating center servers. Whenever the collector is powered on, it automatically searches the GPRS network and connects to the center after successful registration. The collector enters into power-save(sleep) mode when there is no date to transfer. Once called by the operating center or by pre-set meter-reading instructions, the collector wakes up and executes the instructions. When there is an interruption of the GPRS, GSM text message takes over the communication with the operating center.

2. Function of the operating center

The operating center can be integrated with the exiting CMS and PMS systems to deploy the smart meter management system for low-voltage grid.

3. Function of the smart meters

1).On the one hand, with the help of smart meters, information such as the planned outage date and time of the local grid can reach the customers easily. So customers can get change its shifts to be prepared. On the other hand, customers can also inform the local utility its production plan to help the utility company to make better load forecasts to reduce the reserved generating capacity of the grid. Smart meter can also enable customers to choose the energy generated either from coal-fired power plants or from renewable generation.

2). Smart meters can record the incident of loss of power, loss of single phase, illegal opening of the meter cover and alarm the operating center.

3). Smart meter can store consumption data for different time period. When the customers switch to new tariff, the smart meter automatically records the consumption data with previous tariff.

4). Smart meters can automatically change the tariff when the customer consumption reaches the threshold. The tariff varies depending on the energy consumed.

5). Smart meters also support the pre-paid customers. When the balance of the pre-paid customers is below the limit, alarm should be sent to remind the customer.

6). Smart meters should support multi-tariff, at least 4 tariffs during a single day. Special tariff offer such as holiday tariff should also be supported.

CONCLUSION

The research on smart meter management system is necessary for it can monitor the meters of low-voltage customers remotely and at real-time, make rapid respond to multiple tariff and DSM, enables the customers to improve energy efficiency. The smart meter management system can make all these possible at the minimum cost to create a win-win situation for both the utility and the customers.