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Development of AMI Service Software for Smart Water Grid

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Abstract- Recently, a high-efficient next generation infrastructure system that uses high-tech information and communication technology is required to surmount the limits of water resource management. As a result, Smart Water Grid (SWG) has lately been developed in an attempt to solve the regional imbalance of water resources through efficient distribution, manage and delivery of them. In this paper, AMI (Advanced Metering Infrastructure) service system is a software program that can support various platforms and multiple communication standards interfaces on the basis of the systematic analysis and design of AMI service was developed in this study. In addition, certifying tests were commissioned (to the third party) the software for AMI operation to know the efficiency of the program.

Keywords- Smart water grid, AMI, Remote meter reading service, Multi-channel cluster, Operation Software

1. Introduction

Smart Water Grid (SWG) is a next generation water management technology that can overcome existing limits by combining existing water resource management system with ICT technology [1]. It uses various water resources, efficiently distributes and manages water sources, by which it can solve the regional imbalance of water resources. The present study is aimed to describe the requirements for developing AMI system and operational software for Smart Water Grid and its performance.The AMI technology is classified into wired method and wireless method depending on communication systems composed. Typically, a wired method of the technology is using telephony network[2] and power line network[3], whereas a wireless method of the technology is composing low power wireless reading meter network and gathering reading meter data and sending them to remote sites by using CDMA network or wireless LAN[4-5].

It consists of server, graphical monitor and remote monitoring program to monitor the measured data from on-spot measuring equipment precisely. As for the remote monitoring program of a server, it should be designed to be easy to use for a general computer system so that it will not require a separate training or education but be directly applied to existing field system operation only after a simple training. In addition, for user's convenience, it should be configured to operate all functions of the system simply with a mouse such as shift between screens, menu option, and system monitoring and so on. Therefore, the system developed in this study aims to be one that can be compatible with various platforms and support multiple communication standard interfaces. To do so, systematic analysis and design are essential and preconditioned to develop the system.

2. AMI System

2.1. Multi-Channel Cluster -Based AMI Network

The system developed in this study can remotely meter water usage charged on customer through AMI network-based digital metering; also remotely meter the guideline values of the meter to the net customer charge of the system network; and perform provides the metered data to water supply manager. In addition, the system provides used water amount on daily, monthly and yearly base by customer charge and other information on water usage. AMI network configuration is shown in Fig. 1.

Developed AMI system consists of end device (ED) that collects used water amount from a meter; out home display (OHD) installed outdoor so user can read readings; OHED added with ED; end device management (EDM) to expand the communication distance between OHD and NC (Network Concentrator) and process reading data; NC that transmits reading data to s server using mobile communication network.[6]

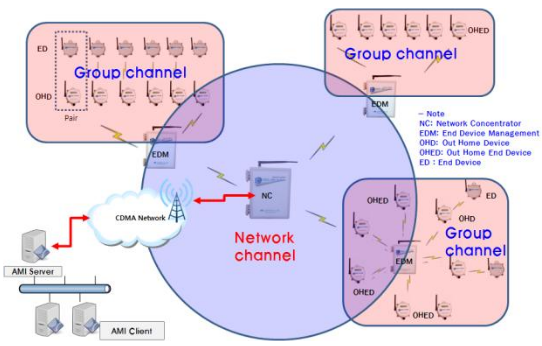

Fig. 1.Configuration Diagram of the AMI network

2.2. AMI Service Program

Fig.2 shows the overall system logic of server/client structure.AMI service program is structured with 2Tier (Server/Client). One server has 1:N structure (linked to multiple user clients). Here, the client consists of .netframework 4.0-based WPF (Window Presentation Foundation), so it provides users an intuitive UI interface.

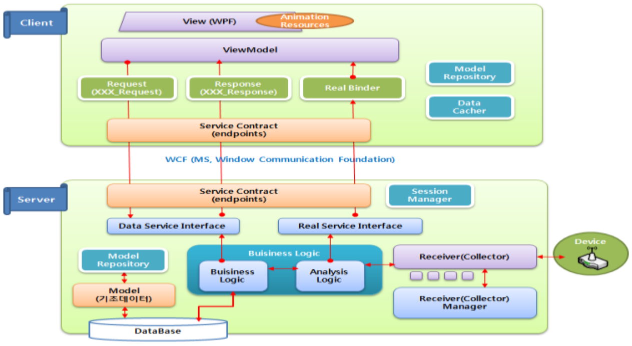

Fig. 2.Logic Diagram of Server and client for AMI Service System

It uses WCF (Window Communication Foundation) for the communication between client servers to build flexible communication environment. Client consists of 'View' that provides user interface; 'View Model' that provides data logic of 'View'; XXX_ Request that is data inquiry entity; and XXX_ Response that is response entity. Sometimes, 'Real Binder' module is used for real-time management of client. The components of server include 'Model Repository' module that manages database; 'Receiver/Receiver Manager' module that receives data from CDMA; and 'Business Logic' that engages in data analysis and processing. Here, client and server have 'Service Contract (End Points)' for interactive communication contact. The basic requirements of AMI service program can be divided into functional requirements and non-functional requirements. First, functional requirements includes customer charge list management; ED/OHD installed by customer charge; assignment and management of EDM/NC that controls network; computation of water amount used on daily, monthly and yearly base; appropriateness analysis of water used based on monthly usage; and connection with tariff system management after confirming water amount. Second, non-functional requirements include flexible system configuration based on the number of customer charge; client UI configuration based on the work performance of system user, N:1 client/server setup; flexible processing for more than 10 client concurrent users.

Fig.3 shows AMI service program developed in this study. As seen in Figure 3(a), integrated inquiry menus provide flexible and multi-angled data inquiry of each customer charge; information of remotely metered customer charge, customer charge; inquiry of reading history by period to set (daily and monthly) and confirmation of daily usage and usage pattern in graph. All the results of inquiry/analysis can be printed out in Excel format with final grid (table), making it easy to report and secure basic data.The daily/monthly inquiry (Figure 3(b)) meters the current usage from a water meter of customer charge installed in an area and communication device (NC/EDM). If necessary, a user can perform additional functions such as history inquiry, inquiry of customer charge details, manual input, call, entering management information by using short-cut menus. Status information inquires remote metering terminal error, status information of customer charge. Cumulative history inquires reading history data of selected customer charge.

(a) Integrated query view (b) Daily/Monthly query view

Fig 3. Client UI View

3. SW Performance Evaluation

This study commissioned an objective test for the developed AMI service software to the Software Test and Certification Institution in order to verify its satisfaction with the requirements and quality, increase software reliability and comparativeness[7]. The developed software was tested for quality evaluation model in Table 1. Test environment is as in Fig.4.

Table 1. SW evaluation model

Main characteristic tests	Sub-characteristic tests
Functionality	Suitability, accuracy, interoperability, security, and compliance
Reliability	Maturity, fault tolerance, recoverability, and compliance
Usability	Intelligibility, interoperability, preference, compliance
Efficiency	Time efficiency, resource efficiency, and compliance
Maintainability	Analysis, change, stability, test property, compliance
Portability	Adaptability, install castle, alternative, co-existence, compliance
In general requirements	Identification and display stability

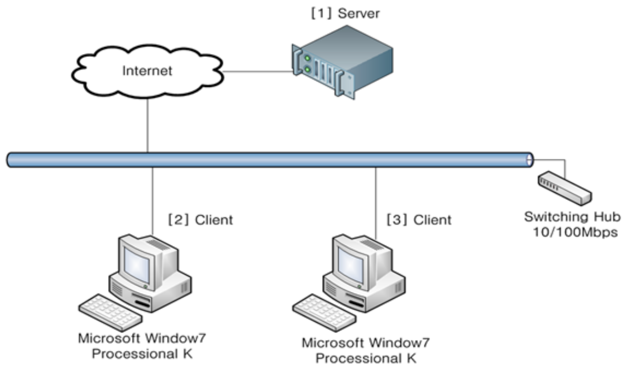

Fig. 4. Test Environment Configuration

In functionality test, the software was found having error in pattern information display and section list inquiry but they were fixed and finally confirmed to be normally working after regression test. In reliability test, the software was found having abnormal shutdown but it was fixed and finally confirmed to be normally working after regression test. In efficiency test, the software was measured for CPU use rate, used memory capacity and response time during operation. CPU use rate reaches up to 14.1% and 26.68% in server 1 and 3, respectively, when one-month remote metering history was inquired but it dropped below 1% and 15%, respectively, when processing had completed. Used memory capacity maintained at constant level to 1,608MB and 5,516MB or less, respectively. In the meantime, response time turned out to be 1.228 seconds. And the software found no particular errors in the test of usability, maintainability, portability and general requirements.

4. Conclusion

Smart Water Grid(SWG), which is suggested in this study, is a next generation water management technology that combines existing water resource management system with ICT technology and solves the imbalance of water resources in regions through efficient distribution, manage and delivery of water resources. The fusion with ICT technology is bringing a dramatic shift in the paradigm of water resource management technology. In this respect, the present study developed AMI service system program (software) that supports various platforms efficiently and stably on the basis of systematic analysis and design, aiming to the connection with integrated platforms for more efficient water management system.

Acknowledgements

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