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웹 기술을 이용한 변전소 감시제어 시스템 개발

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Development of SCADA System based on Web Technology

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Abstract - Supervisory control and data acquisition (SCADA) systems are essential parts of power system which employ a wide range of computers and communication technologies. The traditional SCADA system is mainly for information exchange in only one company, and the information is provided only to the operator or administrator. But in the deregulated environment, we need much more information, which can be exchanged among different companies. With the rapid development of internet, we can use it to access information easily.

This paper proposes web technologies to be applied in power system in order to display some important information through accessing data from database, and to realize the real time control of the substation. The functions of SCADA system will be implemented by a set of Web-based components. The monitoring and control of standard 154[kV] substation model is already realized in the laboratory test. The Web-based SCADA system is able to provide sufficient information and control for power system through an efficient and economical way.

1. INTRODUCTION

A supervisory control system is to provide the system operators with sufficient information and control in order to implement the operation in an efficient and economical way. Supervisory control and remote installation have been found a lot of applications in the power system.

Supervisory control and data acquisition (SCADA) system first came into being in the 1960's, and its architecture has been changed a lot nowadays. Particularly, the structure of SCADA system was developed from the mainframe-dominated centralized computing system to network-based distributed computing system in the 1990's [1]. The traditional SCADA system is applied to exchange information for intra-company, so the information sharing is very difficult among different utilities. In the deregulated environment, modern SCADA system can provide an easy way to share information and it should support many new functions, such as monitoring and supervisory control of the entire power system.

The SCADA system should have two advantages: one is real-time monitoring and control, the other is security of operations. internet has played an important role nowadays, and it has been applied to power system more than before. Therefore it is possible to develop a Web-based SCADA system.

Many researchers have developed internet/intranet based SCADA system to realize the certain function. For instance, internet-based SCADA display system applies internet technology to substation automation system. concept design for a Web-based SCADA system consists of intelligent RTUs and distributed master station. A Web-based power quality monitoring system has multi-channel monitoring function for a large network [2-5].

2. WEB-BASED SCADA SYSTEM

2.1 Advantages of Internet

It is possible and easy to develop a Web-based substation system to realize the monitoring and control function due to the advantages of internet, which are shown as follows:

- Internet has become pervasive and it is widely used in the world.
- It can provide consistent human-machine interface (HMI) to users.
- Because there is no special software on client side, users can use web browser that they already have.
- It can support cross-platform architecture. The users can achieve the same web display in different system platforms.
- It has maintenance and expansion capability. There is no need to re-link the whole application to present the updated information.
- The cost is low. New applications can be downloaded through internet, web server and web browser are low cost and it supports open system architecture, such as SQL, HTML, TCP/IP and relational database [6].

2.2 Architecture of Web-based SCADA System

The architecture of Web-based SCADA system is shown as Fig 1. Generally, Web-based SCADA system consists of three parts that are database server, web server and client. The measured data is obtained from the installed potential transformer (PT) and current transformer (CT) of power system, transmitted to remote terminal units (RTUs) passing by relays, then sent to the central substation server through front-end processor (FEP), which reduces the load of communication. According to these characteristics, these data can be transmitted to substation application software

server or database server. Web server connects to relational database management system (RDBMS) by using open database connectivity (ODBC) which supports a standard open application program interface. And the web server can provide dynamic interface to fit the requirement of the clients by using active server page (ASP) and ActiveX control technique.

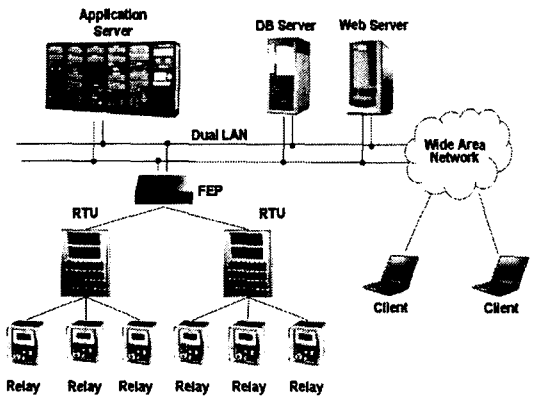

Fig. 1 Architecture of a Web-based SCADA system

2.3 The Development of Real-time Simulator

First of all, one of the most important things of the Web-based SCADA system development is to get a measured data of power system, which ensures the real-time characteristic. Real-time simulator, which consists of one server and three computation nodes, can realize the real-time simulation of power system by using PC cluster technology. The whole computer connects to myrinet and ethernet. myrinet uses real-time communication between server and computation nodes. According to the analysis of the SCADA point lists, which are the whole measured points of substation, the simulated system models the target of the standard 154[kV] substation. But only two banks are simulated by considering the number of real-time simulator input/output points.

2.4 Communication Devices

It is a tendency that the power system equipment will be automatized these days. The automatization function rises not only in existing SCADA system, energy management system (EMS) and distribution management system (DMS), but also in the measuring equipments due to the development of microprocessor technology. Much more data is needed in order to realize other functions, such as exact analysis of power system, management and the additional functions. Therefore, with the enlargement of protection ranges, a large amount of data is needed to be transmitted.

RTU and FEP are used as our communication processing equipments, by which required data can be processed before transmitting to the upper server, which can dispatch more time to finish the necessary operations. There is a communication computer between the server and the measured devices. when increasing the measured devices, the system becomes more complex. In order to still keep the performance of the whole system well, some more communication computers have to be installed between the server and the monitoring points. Data transmission among RTU, FEP and DB server is shown as Fig.2.

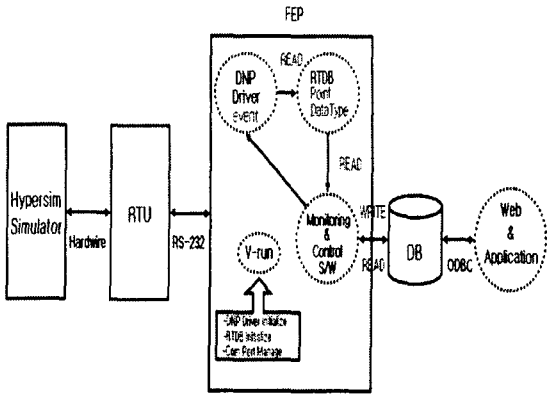

Fig. 2 Data flow of Front-End Processor

2.5 Organization of Database

Web-based SCADA system database is based on the point list analysis of SCADA system that is applied nowaday. According to the property, SCADA system data can be divided into static data and dynamic data. Static SCADA system data defines historical data that appears in power system operation, log data of event or alarm that is same with the switch action, and raw data that is based on the incident analysis. Dynamic SCADA system analogue data consists of voltage, current, real and reactive power, power factor and frequency. Dynamic digital data can depict the status of power system components, which includes circuit breaker, disconnector, power line, etc.

Data is stored in RDBMS, such as ORACLE, SYBASE and MS-SQL, on the web server, and outside applications can access database through ODBC. Moreover, data can be updated periodically according to the properties, so that the real-time characteristic can be ensured.

2.6 Web server using ASP

Due to various requests of clients, ASP technology is used on web server to supply the information through web pages. ASP and ActiveX control are adopted to compose the diverse and dynamic web page. ASP is a server-side script language that is different to static hypertext markup language (HTML). It can be used to make dynamic pages that communicate with users and can reduce resource wasting that is the serious weakness of existing CGI (Common Gateway Interface). ActiveX control is COM (Component Object Model) module operated on server side, which is the same with the client-side language, such as VBScript and Javascript. It can reduce the communication loads between server and client and display the required web pages to the users.

As shown as Fig. 3, when client requests ASP page to server, the server will search the required ASP file in home/virtual directory. The required ASP is parsed per line and ASP codes on web server are interpreted into HTML by ASP.DLL. Then the whole HTML file is transmitted to internet information server (IIS), and IIS send the results to the client users.

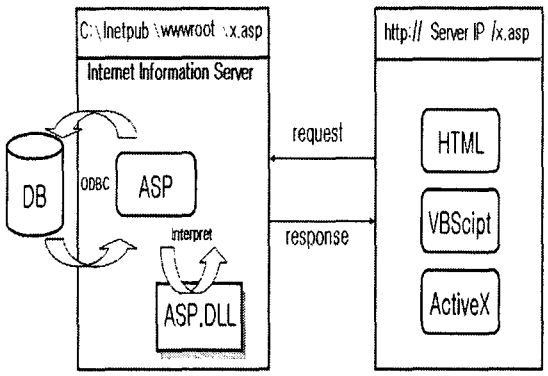

Fig 3 Communication between Web server and Client

2.7 Laboratory Implementation

In this case, Web-based SCADA system consists of six components that are shown as Fig.4.

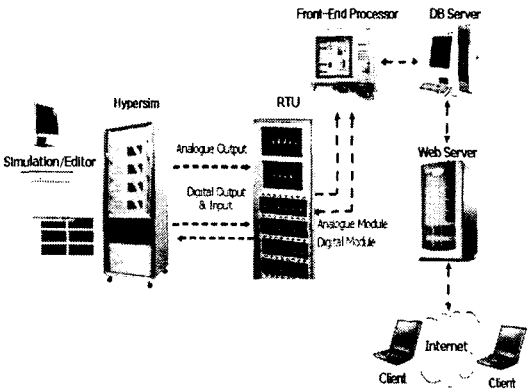

Fig. 4 Construction of the Web-based SCADA system

Real-time simulator is applied to get the real-time data and simulate the standard 154 [kV] substation model per 300 micro-seconds. The communication between real-time simulator input/output board and RTU is realized by hardwired connection. RTU communicate with FEP by DNP 3.0 protocol. Transmitted data can be stored in DB server, MS-SQL, according to their properties. When client requests information to web server, web server accesses DB server using ODBC, then required information can be sent to client. Substation monitoring display, such as CB status, voltage, current and the status of power line, can be provided to client through ActiveX control technique. It is shown as Fig. 5.

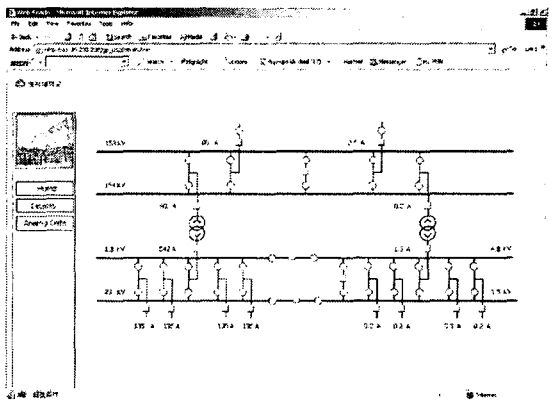

Fig. 5 The display of the substation monitoring

3. CONCLUSION

This paper has described the development procedure of Web-based SCADA system. Web technologies have been applied to SCADA system in order to realize the monitoring and control of standard 154[kV] substation model in the laboratory.

In this paper, RTU is used to collect field data that is simulated by real-time simulator. MS-SQL server is for storing static data and dynamic data, and ASP file is integrated with ActiveX control. In this way, we can display the status of components, analog data, and change the status of CBs. Therefore, a Web-based monitoring and control system of substation has been implemented. In the future, the additional functions will be realized of Web-based SCADA system, such as alarm processing, bad data depression, power quality monitoring and so on.

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[REFERENCES]

[1] T.E Dy-Liacco, "Modern Control Centers and Computer Networking", IEEE Computer Applications in Power, Vol 7(4), 1994, pp 17-22

[2] Qiu B., Gooi H.B., "Web-based SCADA display system(WSDS) for access via Internet", IEEE trans. on Power system, Vol 15(2), May 2000, pp. 681-686

[3] Duo li, Serizawa, Y., Mai kiuchi, "Concept design for a Web-based supervisory control and data-acquisition (SCADA) system", IEEE/PES Transmission and Distribution Conference and Exhibition 2002, Vol 1, Oct. 2002, pp. 32-36

[4] B. Qiu, L. Chen, Virgilio Venteno X. Dong, Y. Liu, "Internet Based Frequency Monitoring Network(FNET)", IEEE/PES Winter meeting 2001

[5] Lee, R.P.K. Lai, L.L. Tse, N. "A Web-based multi-channel power quality monitoring system for a large network" Power System Management and Control, 2002. Fifth International Conference on (Conf. Publ. No. 488), 17-19 April 2002 pp.112 - 117

[6] Ta-Kan Ma, J., Tru-Ming Liu, Lo-Fu Wu, "New energy management system architectural design and Intranet/Internet applications to power systems", IEEE EMPD '98, Vol. 1, 3-5 March 1998 pp. 207-212