POWER SYSTEM INFORMATION INTEGRATION TECHNIQUE BASED ON SERVICE ORIENTED ARCHITECTURE

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ABSTRACT

It is important to integrate the information on the automation systems developed by different vendors for power system control. This paper presents a new power system integration technique based on a service-oriented architecture. The SCADA demonstration system has been developed to establish the feasibility of the proposed architecture.

INTRODUCTION

In the case of power automation systems used in the past, information integration could be achieved by defining common communication standards and by exchanging data according to these defined standards. However, owing to the recent deregulation of the power industry and the introduction of renewable energy resources, it has become difficult to achieve interoperability of heterogeneous devices and automation systems in the power systems. In order to solve the problems associated with information exchange between heterogeneous systems, various studies on the power system control combined with the IT technology have been pursued.

Reference [1] introduces Strategic Power Infrastructure Defense (SPID) system which proposes XML based client/server structure for information exchange. Weak point of the SPID is lack of flexibility and extensibility during the information exchange. Reference [2] proposes Distributed Autonomous Real Time (DART) system as a solution of information security problem which is the most important issue in large scale real time automation system. In this study, integrated message and data related IT technology are described, however, specific method of configuring web-based integrated information system is not presented. Reference [3] proposes design method of web service-based defense system for accurate wide area defense system design and simulation. However, this study does not consider overall power system information integration problem as it only deals with information sharing problem between engineer and automation system.

Methods to solve the problems of information integration and information exchange in power system have been introduced, however, each of these still has technical limitation. Therefore, in order to develop integrated information system with the independence of platform while securing interoperability between dispersed systems, more self-regulated and flexible approach and technology will be required.

In order to have smooth sharing of information resources by automation systems for dispersed power, this paper presents web service-based self-regulated information exchange methodology which has become the highlighted issue. In the integrated system applied with web service technology, each of the automated systems are registered in the registry after realizing various information possessed by them into the service unit. Afterwards, when specific automation system requires function or information of other system, the function will be used after retrieving the service from the registry. The greatest advantage possessed by web service is that the message to be used in accordance with the usage of service is based on XML. Therefore, with web service-based information exchange structure, smooth approach to desired information resources with the independence of platform can be realized at any time and place by the system which can analyze XML.

COMPONENT AND APPLICATION STRUCT URE OF WEB SERVICE

Power information integrating architecture

Web service-based power information integrating architecture is comprised of power information service consumer, power information service provider, power information service intermediary, etc. All automation systems dispersed at power network will be the subject, and even unit modules constituting automation system are included in the architecture element. Fig. 1 illustrates web service based architecture. In Fig. 1, service consumer and provider are not specifically stated. It is because of the fact that, due to the characteristic of power system, decision making shall be conducted by collecting information of other systems in order to optimize the function of all dispersed automation systems. Therefore, all automation systems perform the role of service consumer and service provider simultaneously.

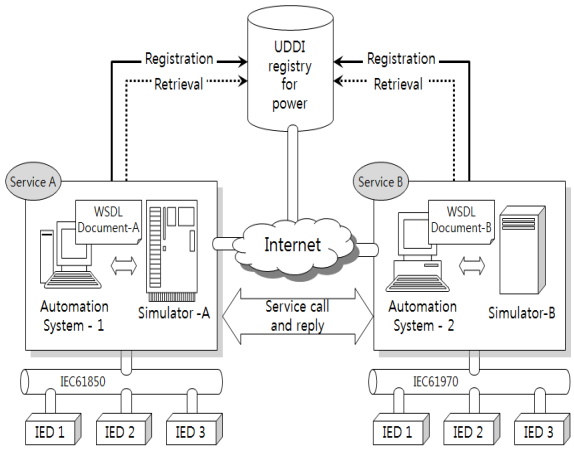

Fig. 1 Web based power system information integration

Behaviors of each component of web service-based power system architecture are as follows.

Power information service consumer

Consumer means all power automation systems, and when information of other system is required for system operation, service will be retrieved through UDDI registry for power. In addition, consumer grasps the location of system from which information service is provided from retrieval result, characteristic of service, location of WSDL document which describes the service, etc. Afterwards, information service is called in accordance with the method defined in WSDL document and information of other system is collected.

Power information service provider

Each automation system classifies information possessed by itself and realizes the information service corresponded to this. At the same time, they define user interface required for the service call with WSDL document. Realized service are managed in the hosting environment of the internal server, and characteristic and location of provided service, WSDL document URL, etc., are registered at UDDI registry for power so that they can easily be found by consumer.

Power information service intermediary

Information service intermediary supports the service realized by each automation system so that it can easily be retrieved and used by consumer, and the service provider uses developed service for the purpose of wide distribution to consumers.

Behaviors between above 3 components have the principle of communication with the independence of platform regardless of their realization environment, therefore, the web service standards, i.e., SOAP, WSDL, UDDI are applied. In addition, these standards are being applied with the form of reflecting the characteristic of power system data, and web service-based power information integration architecture is constituted through organic combination of each of the automation systems with the basis of standard. In order to integrate heterogeneous devices within each of the power automation systems, international standards of existing IEC61970, IEC61850, etc. are used. In other words, for the power information integration architecture presented by this paper, corresponding constitution is completed by applying web service technology for integration between systems and applying specialized international standard for system module unit.

INFORMATION EXCHANGE METHOD BET WEEN POWER AUTOMATION SYSTEMS

Power information integration system

Web service-based power automation integration system is used to describe smooth information exchange mechanism between dispersed systems. Each of the automation systems performs computation and control which are adequate to system design purpose by collecting system data from IEDs at normal times. Performance result data are stored and managed at internal server, and if required, they are used by other automation systems. Automation systems define the information requested by other system in advance, realize information providing service to suit to this, and improve the accessibility for service by registering to UDDI of service management system. For example, when information of GIS system is required by CORBA-based DAS system, service provided by GIS system from service management system is retrieved by DAS system. Based on retrieval result, DAS system selects the service adequate to the objective from retrieval result list, and downloads WSDL document of corresponding service from GIS system and performs parsing. Afterwards, service request message is transmitted with the basis of user interface defined in WSDL document, and in the case of information service of GIS system, type of requested information is retrieved and replay message will be transmitted. Consequently, from the application program of DAS system, desired information will be able to be outputted to the user by utilizing reply message of GIS system.

During the course of calling information service of GIS system and receiving the result by CORBA-based DAS system, messaging is conducted with the basis of SOAP-based XML document, therefore, information resources with the independence of realizing platform of GIS system can be approached. Therefore, as long as it is through web service, free approach to information resources of different areas can be accomplished by automation systems in power network, and simple

connection can be realized even if new automation system is incorporated. However, on the other side of such freedom, another danger element is existed though. In other words, when web service with various advantages is scattered in the power system, problem is how to find out corresponding services exactly. As a solution for this, service management system is used. Developed service is registered in accordance with the classification system which is defined in advance to the UDDI registry of service management system and it will systematically be managed. Therefore, service can easily be found and used by the user, and for any kinds of service, the location, platform, realizing language, etc. can independently be utilized.

At present, power system is stayed at information integration phase between internal equipment of automation system for power, however, it would become the environment in which information integration of system inside only cannot have the competitive power because future power system will gradually be enormous in scale and operational environment will frequently be changed. In connection with this, more efficient and flexible approaching method compared to the existing one will be provided by the power information exchange structure presented in this paper to the dispersed power system information resources. Therefore, more efficient and accurate control of power system with complicated connection can be conducted. In other words, at the time of performing decision making by operator, optimized decision making and control can be achieved by performing integrated computation through inclusive collection of information provided by each of the automation systems.

Message exchange model

For SOAP message exchange models, there are request and reply model, recursive model, broadcasting model, etc., and in general, the most frequently applied model is the request and reply model. In this paper, request and reply model is basically applied and in accordance with the characteristic of information service, broadcasting model is also utilized. For various information scattered in power system, each of its frequency of use can be differed in conjunction with the characteristic. Namely, for the information which must be acquired by all systems or with high frequency of use, it is inefficient to retrieve and call the service whenever they are required. Therefore, in this case of information, it is advantageous to apply broadcasting model. Each of the automation systems classifies the information required by all systems among information resources possessed by oneself and defines it as essential information. At this moment, essential information service is transmitted to other system through real time broadcasting as shown in the Fig. 2.

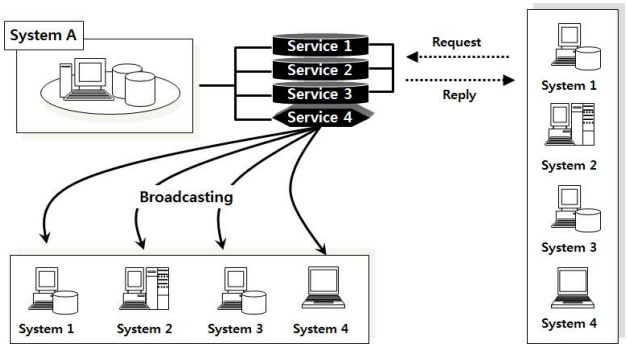

Fig.2 Message exchange using the broadcasting

In addition, when the frequency of use for a specific information service is very high, the process of requesting and receiving the service whenever it is required will exceedingly be repetitive and inefficient. Even in this case, inconvenience of automation system which requires information resource can be solved by registering one's own URL address to power information service and transmitting information of corresponding information service through broadcasting with fixed time interval even if there is no request for the registered system.

CASE STUDY

In order to verify the serviceability of the methodology presented in this paper, a demonstration system based on SCADA system was constructed and communication test was conducted.

Web service based SCADA demonstration system

For demonstration system, network-based system was constructed by connecting to the network with 2 units of windows XP-based computer, 6 units of measuring equipment, 1 unit of power generation device, 1 unit of communication converter, etc. Among functions of SCADA system, the data collection function was realized with power information service, and this service provides effective value of voltage and current, the state of circuit breaker collected by IED, etc. to consumer. Names of these services are GCV(Get Current and Voltage) service and GBS(Get Breaker States) service, respectively. Fig. 3 shows the demonstration system constructed for performance verification.

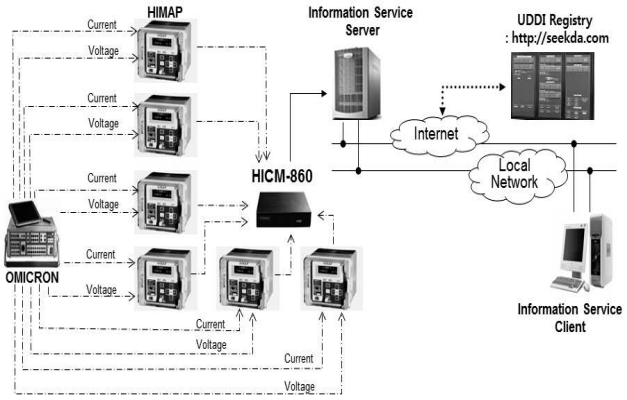

Fig.3 Configuration of performance test system

Power information service consumer is utilized for requesting and receiving data from server and received information is outputted on screen through client application program. Power information service provider furnishes GCV service which provides effective value of voltage and current, i.e., the data received from instruments, and also provides GBS service which shows the state of circuit breaker. In order to receive and output above information, client application program is realized, and basically, functions such as WSDL document request and reception, power information service call, call result output, etc. are included. In addition, in order to increase readability of service call result value, the function of visualizing for each type of receiving data is added. Functions such as WSDL document parsing and request, reply SOAP message generation, message conversion, etc., are internally performed by application program.

Communication test result

In order to verify serviceability of information integration methodology presented in this paper, two kinds of power information service were called through client application program, and the data received and the data provided by power information service were compared. In addition, contents of WSDL document describing service interface was confirmed at the same time, and SOAP message which is automatically generated through the parsing of this was compared and confirmed with server side WSDL document In order to judge accuracy of the two SOAP message generated, they were compared and analyzed with WSDL document received, and it could be understood that the SOAP message structure defined in this document and the structure of generated SOAP message were corresponded. In other words, it could be understood that the name of parameter described in <type> element of WSDL document and the name of remote procedure were corresponded. Finally, the name of SOAP message described in <message> element and the name of generated power information SOAP message were corresponded, therefore, it could be understood that SOAP message was accurately created. Fig. 4 is the screens in which GCV and GSB service are called with client application program and their result are outputted.

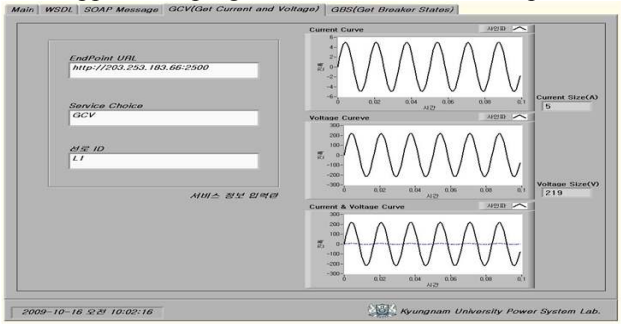

Fig.4 Result of calling CGV service

CONCLUSION

For conducting mutual information exchange between automation systems for power, the most difficult problem is that each of the automation systems has been constructed under heterogeneous environment. To solve this problem, the web service-based information exchange method proposed in this paper provides the method adequate for solving information exchange problem between automation systems heterogeneous in realizing language, and with independence of platform by utilizing standard communication protocol, XML message and internet. Serviceability of the proposed information exchange method was verified through the demonstration system constructed for SCADA system.

Acknowledgments

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