

A Web Service Based Framework for Information Integration of the Process Industry Systems

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Abstract

Many process industry subsystems were developed separately. They didn't collaborate efficiently, which makes it difficult for information integration. In this paper, a web service based framework is presented to address this problem, in which every process industry subsystem is described as a web service by web service wrapper and registered in the UDDI register centre, according to different information integration schemes, these web services can then be integrated dynamically. Also presented is the accomplishment of the framework architecture. Finally the practicability and validity of the integration technology are verified through the application in the establishment of information integration platform of TE procedure.

Keywords: system integration, web service, legacy system, agent

1. Introduction

The information integration is very important to the process industry. On the other hand, however, it is very difficult. In the past years, a number of information integration systems implemented in the process industry are based on Agent (Maguire, 1998) or CORBA technology (Object Management Group, 2002). There are some limitations in these schemes in terms of real time, security and stabilization in information communication. These systems are characteristic of point-to-point connection and difficult to maintain. They lack agility thus do not cope with change of the process systems dynamically. For a rational and better implementation of the information integration in process industry systems, a novel web service based framework is proposed in this paper.

In the proposed information integration framework, different subsystems are described as web services according to their functions. These web services are then represented with WSDL language (Yu, 2004) and their communication interfaces are defined. Finally, these web services are registered in the UDDI (universal description, discovery, integration) register centre. When different subsystems need to be integrated, it is not necessary for engineers to be familiar with inner details of each subsystem. What engineers should do is to understand the communication interface of each web service, to cope with the change of integration strategy dynamically. At the same time, web

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service wrapper is used to encapsulate the functions of the subsystem, thus ensure their safety and stabilization.

2. Information Integration of Process Industry Systems

2.1 Basic requirements for information integration

Considering the particularities of process industry systems, to implement the information integration of different subsystems, the four basic requirements must be considered. (1) The integration should be the integration of factual applications, it should support the information communication among different operation modules and isn't the simple connectivity among different process industry subsystems. (2) The integration should be dynamic; it can be changed easily when the enterprise changes integration strategy or production process. (3) To process industry systems, security and stabilization are very important, when they are integrated, the integration technology should assure their former security and stabilization in the integration framework. (4) The integration is to extend the functions of process industry systems; it can't neglect the functions of subsystems entirely (Qian, 2003).

2.2 Information integration framework of process industry systems

Considering the basic requirements for information integration of process industry systems, in the framework for information integration, every subsystem is wrapped as web service, so it is modified with a little amount, as a result, the security and stabilization of every subsystem aren't changed in the integration framework.

When process industry subsystems are defined as web services, they are registered in the UDDI register centre (Yu, 2004). When these web services are called, they may be accessed at UDDI register centre. Agents are generated accordingly and return results what we want. The information integration framework of process industry systems is shown in Figure 1.

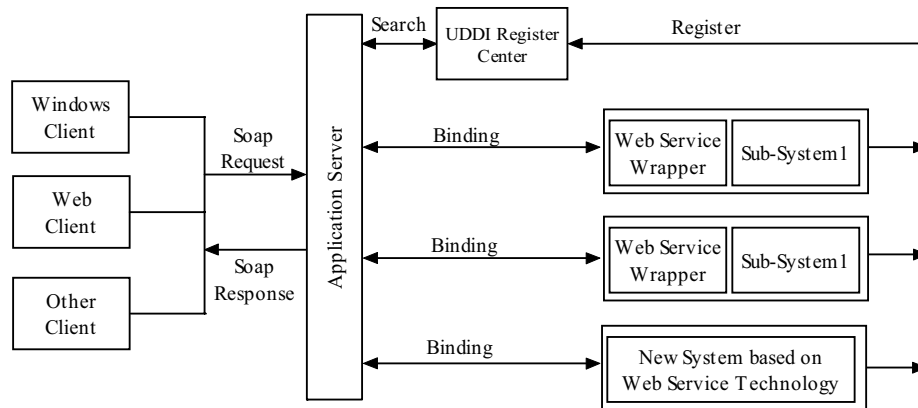


Figure 1. Information Integration Framework of Process Industry Systems

The system architecture is as follows.

(1) When a client sends a request with soap, the application server accepts the request;

(2) Application server searches web service which meets client's need from UDDI register centre;

(3) UDDI register centre returns message to application server; the message is associated with the location of certain web services and other related information;

(4) Based on the message, Application Server creates web service agents and binds the agent to the web service that meets client's need;

(5) Application Server calls the web service to serve the client request and to return results to the client.

In this architecture, web service is used to implement cooperation among different subsystems, which are regarded as web service providers; Web service wrapper encapsulates the functions of subsystems and hides the inner complexity. XML language is adopted for message communication among different web services for different operation systems. The web service technology is particularly applicable to integrate different legacy subsystems running in different operation systems and different network environment as a distributed architecture. Data and messages may communicate among them, while security and stabilization of legacy systems are retained in the information integration platform.

2.3 Peculiarities for the integration framework

The peculiarities for the integration framework are as follows.

(1) SOAP is used to implement the exchange of information among different subsystems. It uses XML to describe information and uses HTTP as transport protocol; as a result, it is possible to integrate different subsystems running in different system platforms.

(2) The functions of every subsystem are encapsulated as web services, so the characteristics of every subsystem aren't influenced in the integration framework.

(3) According to different integration schemes, process industry subsystems can be integrated dynamically.

(4) Based on web service technology, process industry subsystems can be integrated with multi-interface; this assures the agility of information integration of process industry systems.

2.4 Key technologies used in the integration framework

To implement the web service based framework for information integration of process industry systems, there are many key technologies and criterions involved, includes:

(1) UDDI (Universal Description, Discovery and Integration). UDDI is bought forward by Microsoft and Ariba and used to detect web services. By UDDI, clients can find and locate to certain web service that is provided by different corporations (of course, corporations must register the web service in the UDDI register centre firstly). The information model of UDDI is defined with XML Schema. In the proposed information integration framework, to every web service, it is registered in the UDDI register centre, when clients want to call certain web service, the UDDI register centre can implement the quick detection of web service with certain arithmetic and send information about the web service to clients, then clients can call the web service and get the return result.

(2) WSDL (web service description language). WSDL is an XML based language, and it is used to describe web service. To every web service, clients can get its

description information by its WSDL document, such as functions, parameters, and return value.

2.5 Difficulties in the integration of process industry systems

The difficulties in the integration of process industry systems are as follows.

(1) Security. To process industry systems, Security is very important (Cheng, 2003), so when we integrate different process industry systems, we must take into account this problem seriously. At present, web service technology hasn't taken pertinent measures to assure the security of web service. To us, during the integration of different subsystems, a new scheme is used to assure the security of web service. In this scheme, when a client calls a web service, the header of SOAP transfers its information, then the application server gets its information and verify its power, if the client has no access to call the web service, it is refused. According to the experimental result, this scheme is valid to assure the security of web service.

(2) Compression of alternant information. Dealing with large numbers of data is a common characteristic of process industry systems (Chen, 2002), so when we integrate different subsystems, for decreasing the time of information exchange among different subsystems, we must compress alternant information to a minimal quantity. By the extension of SOAP, we make use of certain arithmetic to compress alternant information among different web services; as a result, 85 percent of redundant information is wiped off.

(3) Discovery of web service. Real time is an important speciality of process industry systems (Shen, 1999), so it is necessary to study excellent arithmetic to implement the quick discovery of web services. In the proposed information integration framework, to the discovery of web services from UDDI register centre, an arithmetic based on ontology is brought forward. In this arithmetic, according domains and functions, different web services are classified; and client's query is standardized. This arithmetic assures timely discovery of web services, so users can get return result from web service what they call with a very short time.

3. Case Study

TE procedure is a process control case based on practical process industry, during these day, we have done some research in this field, such as, fault diagnosis system based on ART2 nerve network (developed with G2 platform) (Qian, 1999), data monitor system based on wavelet analysis (developed with Matlab), procedure attemper and optimization system (developed with Games). Based on the proposed information integration scheme, an information integration platform is developed and implemented for a case study of TE procedure. It integrates three subsystems of data collection, data reconciliation, and fault diagnosis, which run in different computers with different operation systems. The subsystems are described as web services, which are registered and called when they are needed. Real time message in XML format is communicated among the three subsystems. Issues on security and stabilization are considered in building of the system. The information integration platform for TE procedure is shown in Figure 2.

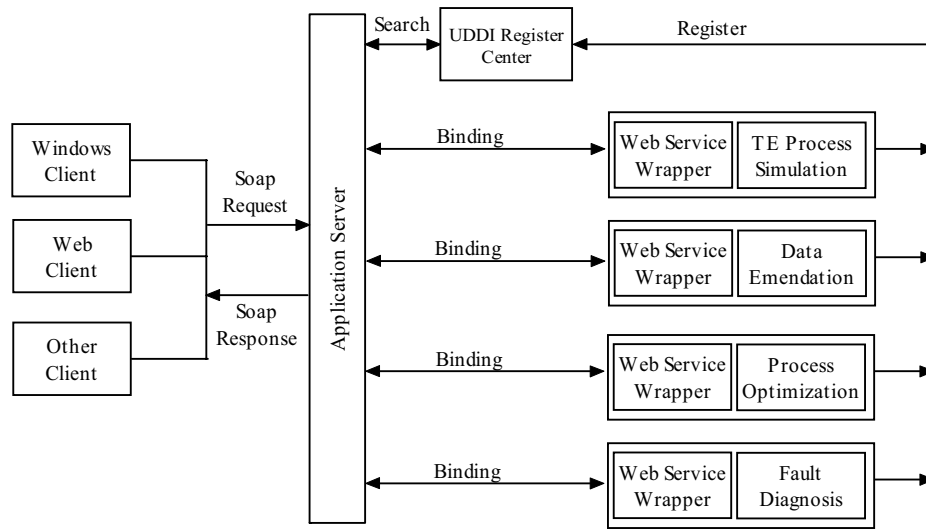


Figure 2. Information integration platform for TE procedure

When client sends a request to change the operation pattern of TE procedure, application server queries the pertinent parameters of the web service for TE procedure simulation, and then calls the web service to implement the simulation of TE procedure under certain operation pattern, subsequently the web service for data reconciliation is called to emend data that is produced from the simulation, and the web service of attemper and optimization optimizes the data, finally, the fault diagnosis system uses the data to diagnose whether there are faults during the simulation of TE procedure. At the same time, the optimal result of every certain pattern is sent to the client terminal. Under optimal condition, the values of 10 variables and cost of four patterns are shown in Table 1.

Table 1. The values of 10 variables and cost of four patterns under optimal condition

		Base	Model1	Model2	Model3	Model4
1	Feed1	63.0	60.9	12.6	90.6	99.2
2	Feed2	53.8	50.2	89.7	7.4	80.2
3	Feed3	24.6	26.3	29.6	21.8	4.0
4	Feed4	61.3	62.1	54.7	52.5	96.5
5	Recycle valve	22.2	0.9	1.0	787	1.0
6	Purge valve	40.0	21.9	50.4	9.5	45.6
7	Separator valve	38.1	40.3	35.9	29.8	60.1
8	Stripper valve	46.5	45.2	42.8	42.1	74.5
9	Steam valve	47.4	1.0	1.0	1.0	1.0
10	Reactor coolant	41.1	32.9	21.9	32.7	65.8
	Total cost \$ /h	170.6	12.1	180.8	48.3	278.2

4. Conclusions

The information integration of process industry systems is very important and difficult. Considering the peculiarities of process industry systems, a framework for information integration of the process industry systems is proposed, and the intrinsic problems that traditional technologies of information integration often meet have been solved. Finally, the practicability and validity of the integration technology were verified through the application in the establishment of information integration platform of TE procedure.

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Acknowledgements

Financial supports from the Outstanding Young Scientist Fund (No.20225620), the National Natural Science Foundation of China (No.20376025 and 20476033), and the State Key Development Program for Basic Research of China (No.G200000263) are gratefully acknowledged.