

Research on an Information Application Integration Platform Based on SOA and Web Service

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Abstract

The construction of enterprise information is facing more or less heterogeneous system integration problems in the deepening process. On the basis of analyzing the advantages of service oriented architecture (SOA) and Web service technology in realizing heterogeneous system integration, a fast and flexible enterprise information system integration scheme based on combining SOA and Web service technology is proposed to solve these problems of poor information sharing capability and business adaptability. This integration scheme uses the advantages of self described and contained application module and platform independence and programming language independence to implement the complex aggregation. The SOA is used to implement the standard and loosely coupled application architecture by using the characteristics of Web service. So this integration system provides a great solution to messaging communication with different enterprises or inter-enterprise. And it can effectively reduce the maintenance cost, shorten the adjustment time, improve the execution efficiency and make the enterprise with more competitive.

Keywords: *Service-oriented architecture (SOA); Web service; service component; application system; integration scheme*

1. Introduction

With the continuous strengthening of the construction of enterprise information, the rapid development of computer technology and the application of the Internet, the information exchange between enterprises or inter-enterprises are strengthened. Because the application systems of the large and medium-sized enterprises are different. These systems use the different programming languages and realization platform in the developing [1]. The data exchange format and communication protocol are different, so it is very difficult to implement information transmitting and sharing for enterprises between different systems. It can not effectively integrate the original application systems with the new application systems, which construct a lot of information islands in enterprises. These existing information islands not only make each system to occupy a large amount of hardware resources, but also make a variety of important business data of enterprises not to effectively share and use. Modern enterprises urgently require all departments and business partners to share real-time information in order to adapt to the increasingly complex and sophisticated business processes, the continuous changes of customers and fierce market competition. The goal is to meet the challenges of the ever-changing market. So the urgent work of enterprise information construction is to combine the enterprise business process, integrate enterprise IT resources, solve the connectivity problem of information island and optimize the use of information systems for constructing information application integration platform. This will be convenient to the call and query of customers, increasing the new application system.

Service oriented architecture (SOA) is a solution for designing and setting up the loosing coupling software system, it can publish business functions in the manner of

programmable and accessible services, and the other application can use these services by using the published and findable interface [2]. In recent years, the SOA has been widely applied in system integration. Kulkarni *et al.*, [3] proposed a generic implementation framework. Web services are an instantiation of service-oriented architecture (SOA) that strictly follows XML standards for messaging and invocation. Rao [4] proposed application meta-model of service-oriented architecture (SOA) and integration strategy of ERP system based on SOA. Then a service-oriented architecture based ERP system integration framework (SOERPIF) is proposed. Yang *et al.*, [5] constructed a high-quality information integration platform based on basic concepts and methods of service-oriented architecture and analyzing the information integration theory of virtual enterprise. Yang and Xin [6] proposed the integration model of EIS based on adopting the loose coupling application program component technology (SOA). Canales *et al.*, [7] proposed contribution for carrying out adaptive and intelligent Web-based Education Systems (WBES) that take into account the individual student learning requirements, by means of a holistic architecture and Framework for developing WBES. Meng *et al.*, [8] proposed an enterprise integration platform (EIP) based on service-oriented architecture (SOA) to achieve information integration, process integration and application integration of enterprise. Contreras and Sheremetov [9] addressed the issues of industrial application integration in business processes using agent-enabled service-oriented architectures (SOA) within the enterprise. Lämmer *et al.*, [10] proposed a procedure for the integration of enterprise systems. The procedure model starts with decomposition into Web services. Zimmermann *et al.*, [11] proposed an architectural decision modeling based on these dependencies explicit and serves as a foundation for knowledge management tools. Fang *et al.*, [12] proposed an integrated platform for real estate agency-based on service-oriented architecture (SOA) to enhance the efficiency of surfing the Internet. Zhang and Zhang [13] proposed an integrated service model based on three loosely coupled perspectives according to the service's business logic, interface, and implementation to effectively align business and IT using a service-oriented architecture (SOA). Pahl *et al.*, [14] proposed a solution for the integration of business information systems based on SOA and Web services. Cheng *et al.*, [15] proposed a service oriented framework based on web services, web portal, and open source technologies for construction supply chain integration. Bostjan and Podgorelec [16] proposed a method for automated execution of Web Services. Based on Web Service execution automation, the proposed approach is bridging the gap between ontology based integration and service oriented architecture by enabling dynamic and transparent integration of information. Parlanti *et al.*, [17] proposed a service-oriented approach based on SOA, the Service and application integration system for network-centric data integration. Liu *et al.*, [18] proposed new architectural approaches of dynamic service integration for NEC to adapt to evolution occurring in services and capability for constructing next-generation software-intensive military systems. Seth *et al.*, [19] an architecture that uses SOA principles to create an overall strategic plan and focus how architectural context support the use of cloud computing. Li *et al.*, [20] proposed an integrated information systems based on service-oriented architecture (SOA), EAI, workflow management and grid computing for healthcare. Shen *et al.*, [21] proposed an agent-based, serviced-oriented approach for integrating data, information, and knowledge captured and accumulated during the entire facility lifecycle from its project planning, design, construction, component procurement. Park *et al.*, [22] proposed a novel integrated model that combines the advantages of both SOA and WOA seamlessly. They employ the proposed model to design an actual financial software suite and validate its effectiveness using the well-known function point analysis. Chang and Lu [23] incorporated two major theoretic frameworks, medical decision support systems and web services, and applies them to diagnosis and treatment in order to help users find appropriate recommendations and solutions when encountering medical decision problems. Tapia *et al.*, [24] proposed the integration of the Hardware-Embedded Reactive

Agents (HERA) Platform into the Flexible and User Services Oriented Multi-agent Architecture (FUSIONat). Li *et al.*, [25] proposed a framework to integrate applications deployed in public clouds and intra information systems. A run-time platform is developed and a cross-computing environment process modeling technique is also developed. Stefanescu *et al.*, [26] proposed an approach to service integration based on a domain-specific language for service choreographies. Conde *et al.*, [27] proposed a service-based framework to facilitate such interoperability. It supports the export of functionalities from the institutional to the personal environment and also the integration within the institution of learning outcomes from personal activities. Martínez-Carreras *et al.*, [28] describes and detailed the elements for building the next generation of integrated business environments (IBE) and to analyze the features of ESBs as the core of this infrastructure. Lamprinakos *et al.*, [29] described the design and implementation of such platform that enables the deployment of services to follow-up the patient's health status based on a set of monitored parameters per disease and to profile user's habits and diagnose deviations from their usual activities. Luo *et al.*, [30] proposed a new agent-based service-oriented integration architecture for chemical process automation system.

Enterprise application integration (EAI) is used to solve the information interaction and sharing between different existing application systems. With the incessant improvement of computer technology and enterprise informatization, almost enterprises need integration framework to solve the alternation problem of different IT systems. EAI provides an open framework to implement system integration according to the enterprise business requirement and rapidly add new application system. Traditional EAI exist low-lying data security and unclassified business process and so on. Web service, especially Web service based on SOA provided the valid design method of system software to develop the system architecture model by using services. This paper proposes a loose coupling information application integration platform based on SOA and Web service in order to better improve the reusability and extension capacity.

The rest of this paper is organized as follows. Section 2 briefly introduces Web service and service oriented architecture (SOA). Section 3 gives the idea of enterprise application integration. Section 4 gives the scheme of enterprise application integration platform. Section 4 gives the describing of information application integration platform. Finally, the conclusions are discussed in Section 6.

2. Web Service and Service Oriented Architecture (SOA)

2.1. Service Oriented Architecture (SOA)

SOA is a solution to design and construct the loosing coupling software system for publishing business functions in the manner of programmable and accessible services. The key conception of SOA is SERVICES, each application of SOA is regarded as service for calling and managing. The SOA defines the design principles:

- (1) The functions are divided into less and reused model by using modularization.
- (2) The clients and servers of loosing coupling do not require the close dependence.
- (3) The encapsulation encloses function modularization.

W3C defined the SOA: the provider of services provides the ultimate results for users by accomplishing a set of work. The ultimate results usually change the status of users, provider or both. To a certain extent, the SOA is a model to be used for designing, developing, deploying and managing the discrete logic units in computer environment. So the SOA has some advantages:

- (1) It can rapidly integrate the third software.
- (2) It can use the business flow management tools to easily deploy composition system.

(3) It can safely update independence services by using the management and control platform.

(4) It can divide development tasks and keep distributed harmony development according to services.

There are three roles in the SOA. They are service broker, service provider and service requester. The SOA framework is shown in Figure1. Service broker registers and makes classifications of the published service providers, it also provides search services. Service provider publishes its own services, and also makes response to the request. Service requester seeks requisite services by using services broker, and makes use of the services. The components of SOA must have one or more of the above mentioned roles. These roles carry out such operations as find, publish and bind. The operation of Find is to help service requester to find special services help by Service broker. The operation of Publish is to help Service provider to register its own function and interface. The operation of Bind is to help Service requester to use the provided services in deed.

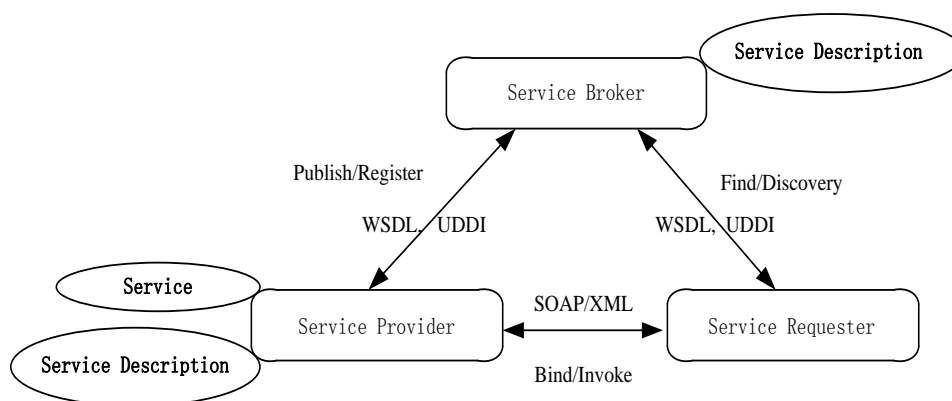


Figure 1. The SOA Framework

Service is a basic task in the SOA and it lies in abstract layer between business requirement and bottom technology. In the process of designing the software system based on the SOA, the dynamic relation between function requirements and acquired services, the relation between services and bottom technology of the implemented services are understood. Then the basic services must meet the requirement of definition definitude and function singularity in the SOA. So each single deployment services often rely on the else application system. Finally, the service process organization is used to implement the whole system function.

2.2. Web Service

Web service is a class of general service name from the Internet. It uses Extensible Markup Language (XML) to receive or send the message and is not constrained by any operating system or programming language. The Web service provides a new development model for establishing distributed Web application. The wide popularization, simplicity and platform neutrality of Web service has brought incomparable advantages of SOA to promote the rapid development of SOA technology and provide a good technology for system integration based SOA. Under the guidance of SOA, the enterprise informatization construction is to develop enterprise resources according to the reasonable size into service, then the business process of enterprise is constructed by the service choreography. At the same time, the legacy of the enterprise information system is packaged into service to participate in the business process in order to provide the enough flexibility for dealing with the business process reengineering because of market changes,

managing enterprise IT resources, providing a good environment and improving the utilization efficiency.

Web service combines the advantages of component-oriented methods and web techniques. It can publish, locate and transfer modularized application in the web. The provided functions of Web service may be simple, but they contains the extraordinary complicated business logic. Once Web service is deployed, the other applications can find and request them. The key techniques of Web service are shown in Figure2.

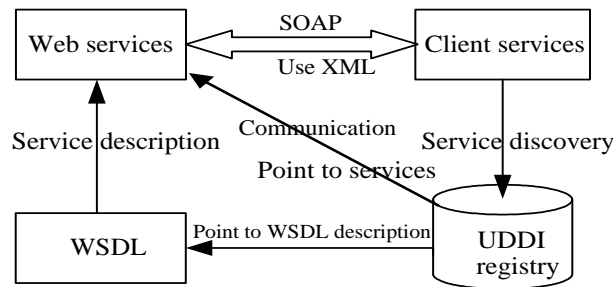


Figure 2. Key Techniques of Web Services

From the Figure 2, the kernel of Web service is service. Web service represents a kind of implementation of SOA, and they are the most popular one. In addition, when the components of SOA interact, three operations in the SOA can process. So some standardized techniques are used in Web service, such as Universal Description, Discovery and Integration (UDDI), Web Services Description Language (WSDL), Hyper Text Transfer Protocol (HTTP), Simple Object Access Protocol (SOAP), and XML and so on. Web service is becoming the best selection to develop application of SOA. The hierarchy framework of Web service includes network, transport, messaging, service description, service publication /discovery, service flow and so on, shown in Figure 3.

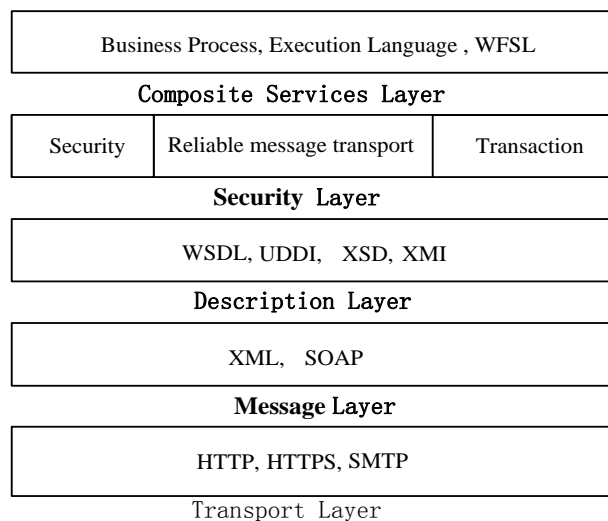


Figure 3. The Hierarchy Architecture

2.3. The Hierarchy Based on Web Service and SOA

Business organization optimizes their business processes, then the business and IT organization optimize their services. The implementation of service uses infrastructural components. The hierarchy based on Web Service and SOA is shown in Figure4.

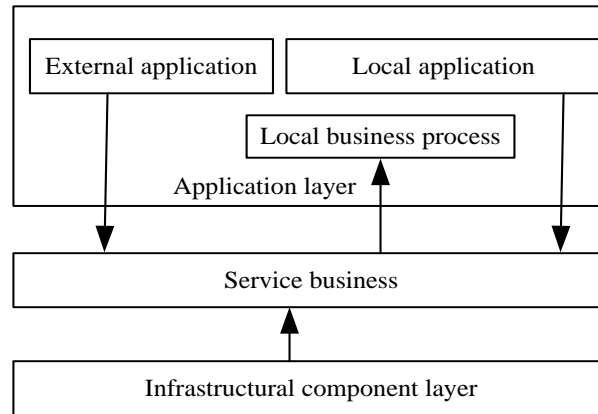


Figure 4. The Hierarchy Based on Web Service and SOA

Application layer includes the local application and external application. A business process is consisted of a series of activities. A basic activity corresponds a service. Since business process is made up of services, the business process becomes a service flow.

3. The Idea of Enterprise Application Integration

In the integration of information system, the SOA and Web service can be used to improve the traditional integration scheme. According to the opening and interoperability of SOA, services can be conveniently shared on different environment and platforms. The reusability is the key concept in the SOA. It can encourage the use of existing services, objects and applications to construct a new system integration. The framework of SOA has the loose coupling, distributed character, flexibility and reliability characteristics. Web service can be used to realize the data and business connection between the systems. For example, in order to obtain the basic information from the information system, Web service is designed, then other information system can get the basic information by using Web service. For each subsystem, the provided outside information is provided by using Web service, and other systems can obtain the relevant information by calling these Web services. At the same time, the enterprise service bus (ESB) is used to achieve SOA. The ESB is a technology based on combining traditional middleware technology, Web, XML services, and so on. It provides the most basic link in the network and is a necessary element to build the enterprise nervous system. The ESB is one of the best methods to achieve the best SOA. It is taken as the basic structure elements of distributed services on the network, the ESB integrated method uses the basic structure of asynchronous and message oriented communication, then the system is regarded as a discrete distributed service. The ESB is used to construct the independent Web service, all business functions and service forms in the service layer is exposed to the outside of system. The other information systems can access the service by the service agreement in order to obtain an ideal scheme for realizing the seamless connection between data and service of information system. In addition, the SOA is independent to the platform and language, so it is not necessary to consider the implementation of the environment. Compare with other integration technologies of systems, the service oriented integration is the ideal selection for solving information system integration.

4. The Scheme of Enterprise Application Integration

The essence of Web service is the XML based middleware for enterprise application integration with advantage of simplicity, interoperability, flexibility, dynamic feature and low cost. So the framework based on SOA is designed by combining the traditional EAI technology and Web service. The integration is transformed from application oriented

integration to the service oriented integration. The scheme of enterprise application integration based on SOA and Web service is shown in Figure 5.

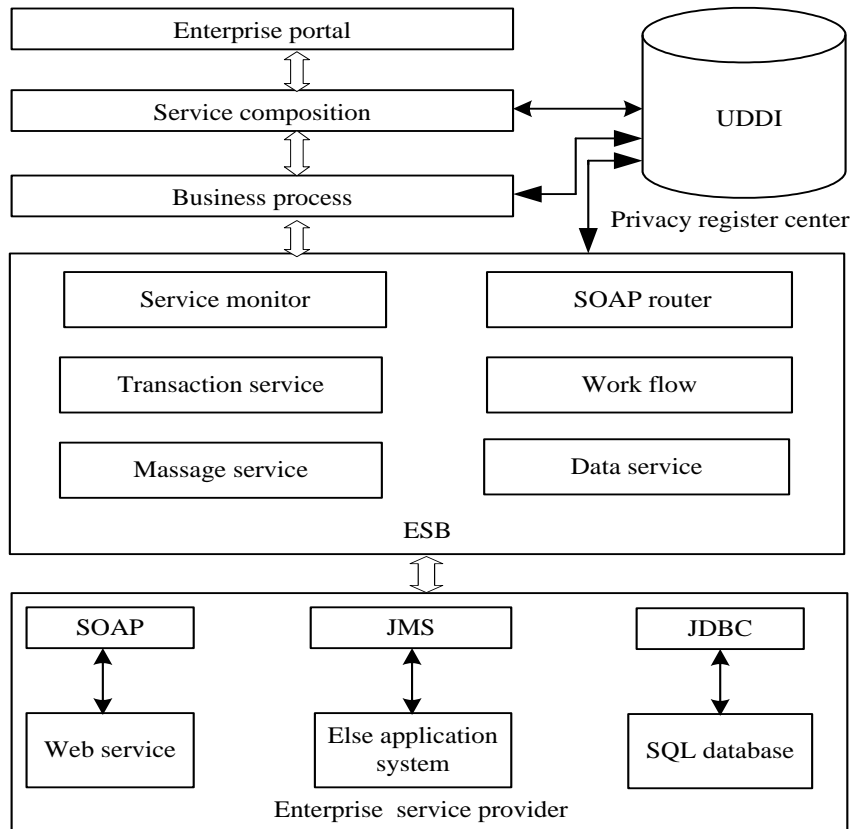


Figure 5. The Scheme of Enterprise Application Integration

5. The Detail Describing of Enterprise Application Integration

In the enterprise application integration scheme based on SOA, Web service and middleware, the application systems mainly are existing systems or new application based on Web Service. The existing application systems are selected to be encapsulated into a web service component. Then a WSDL file is generated to describe the system function and calling method. The description file of services is published by using UDDI API in UDDI registering server. The detail describing of enterprise application integration is given as follows:

5.1. Enterprise Portal

Terminal interface of users integrates all applications and services for particular clients in order to provide a reusable, highly efficient, consistent interface for supporting different access methods, unified management authentication, authorization and so on. Enterprise portal is used to provide Web service in order to obtain more flexible EAI.

5.2. Service Composition

It is the problem of composing autonomous services to achieve new functionality. Service composition has the potential to reduce development time and effort for new applications. The web is a particularly interesting domain for service composition for several reasons. The increasing numbers of interesting services are moving online and the web is fast transforming from a collection of static pages to a provider of numerous useful

services. The Web service conform to the standard HTTP protocol, which easily integrates a framework.

5.3. Business Process

It is an activity or set of activities that will accomplish a specific organizational goal. It may often be visualized as a flowchart of a sequence of activities with interleaving decision points or as a Process Matrix of a sequence of activities with relevance rules based on data in the process. Business process management (BPM) is typically performed by business analysts, who provide expertise in the modeling discipline; by subject matter experts, who have specialized knowledge of the processes being modeled; or more commonly by a team comprising both. The business objective is often to increase process speed or reduce cycle time; to increase quality; or to reduce costs, such as labor, materials, scrap, or capital costs. In practice, a management decision to invest in business process modeling is often motivated by the need to document requirements for an information technology project.

5.4. Enterprise Services Bus (ESB)

Middleware technology mainly adopts SOAP-oriented message to standardize the message processing and control information flow by using hub. When the target server is down or overloaded, the transmitting data wait in the temporary message queue. Message is sent once and only once in order to ensure the reliability of enterprise application integration. The mechanism of message notification is suitable for event-driven application. In addition, the message middleware supports the synchronous and asynchronous communication.

(1) Service monitor

It is used to monitor and manage the services, such as service objective management, dynamic monitoring management and security management and so on.

(2) SOAP router

It is used to realize the message transmission of SOAP. The router can find the corresponding component of Web service and transmit the request of SOAP to the request component by analyzing router in detail.

(3) Transaction service

Because the distributed and loosely coupled application environment is not suitable for the traditional transaction technology, IBM, Microsoft and BEA propose WS-Transaction services to realize the transaction-driven asynchronous invoking by using JMS WSN.

(4) Work flow

The WSFL is used to define each step in the business process, then a complete business operation is regarded as a series of activated activity in sequence. It can be divided into the flow model and global model.

(5) Data service

It includes supporting reliable transmission with various protocols, multiform communication models and persistent storage and transaction semantics, and so on.

(6) Message service

It includes dynamic data conversion, data sharing, data synchronization *etc.* ESB provides all kinds of data conversions. Data sharing provides the users with unified data view and query interface.

5.5. Enterprise Service Provider

It includes existing application systems and new application systems based Web service. Then these systems are encapsulated into the standard component of Web service. For existing application systems, the integrating key is the encapsulation and packaging. The first, the WSDL file of service is generated. Then the framework of SOAP is developed on the server. Finally, the component of Web service is converted into the XML format. The enterprise application integration platform is responsible for registering and invoking. Enterprise components of services is registered by using the UDDI. It is a database, directory services or XML.

6. Conclusion

This paper analyzes the current existing problems in the process of enterprise information application integration. Then the idea of SOA and Web service technology are also analyzed in detail. Because the SOA can meet the requirements of various kinds of information integration and take on crossing platform, flexibility and easy expansion. So a fast and flexible scheme of enterprise application integration based on SOA and Web services is proposed to improve the poor information sharing capability and business adaptability in this paper. In this scheme, application system of enterprise is regarded as a group of services, which are rearranged these services in order to meet the needs of the enterprise. The SOA is used to implement the standard and loosely coupled application architecture by using the characteristics of Web service. The scheme provides a great solution to messaging communication with different enterprises or inter-enterprise, and simplifies the maintenance and reduces the maintenance costs. But for security authentication, service charges transaction processing and reliability and so on, they need to be further studied in the future.

References

- [1] G. Lewis, E. Morris and D. Smith, "Service-oriented migration and reuse technique(SMART)", Proceedings of the 13th IEEE International Workshop on Software Technology and Engineering Practice, IEEE Press, (2005), pp. 222-229.
- [2] S. Haul, "Information sharing in a supply chain", International Journal of Technology Management, vol. 20, (2002), pp. 373-387.
- [3] N. Kulkarni, S. K. K. Mani and S. Padmanabhuni, "Web services: E-commerce partner integration", IT Professional, vol. 7, no. 2, (2005), pp. 23-28.
- [4] Y. Rao, "Application model and integration strategy of SOA-based ERP system", Computer Integrated Manufacturing Systems, CIMS, vol. 12, no. 10, (2006), pp. 1570-1576.
- [5] J. Yang, G. Li and D. X. Ai, "Information integration of virtual enterprise based on service-oriented architecture", IFIP Advances in Information and Communication Technology, vol. 251, (2007), pp. 282-293.
- [6] X. Yang and Z. H. Xin, "A study on the integration model of EIS based on SOA", IFIP Advances in Information and Communication Technology, vol. 254, (2007), pp. 627-633.
- [7] A. Canales, A. Peña, R. Peredo, H. Sossa and A. Gutiérrez, "Adaptive and intelligent web based education system: Towards an integral architecture and framework", Expert Systems with Applications, vol. 33, no. 4, (2007), pp. 1076-1089.
- [8] X. J. Meng, X. Zhang, R. X. Ning and Y. Song, "Enterprise integration platform based on service-oriented architecture", Chinese Journal of Mechanical Engineering (English Edition), vol. 21, no. 3, (2008), pp. 36-40.
- [9] M. Contreras and L. Sheremetov, "Industrial application integration using the unification approach to agent-enabled semantic SOA", Robotics and Computer-Integrated Manufacturing, vol. 24, no. 5, (2008), pp. 680-695.
- [10] A. Lämmer, S. Eggert and N. Gronau, "A procedure model for a SoA-based integration of enterprise systems", International Journal of Enterprise Information Systems, vol. 4, no. 2, (2008), pp. 1-12.
- [11] O. Zimmermann, J. Koehler, F. Leymann, R. Polley and N. Schuster, "Managing architectural decision models with dependency relations, integrity constraints, and production rules", Journal of Systems and Software, vol. 82, no. 8, (2009), pp. 1249-1267.

- [12] Y. M. Fang, L. Y. Lin, C. H. Huang and T. Y. Chou, "An integrated information system for real estate agency-based on service-oriented architecture", *Expert Systems with Applications*, vol. 36, no. 8, (2009), pp. 11039-11044.
- [13] L. J. Zhang and J. Zhang, "An integrated service model approach for enabling SOA", *IT Professional*, vol. 11, no. 5, (2009), pp. 28-33.
- [14] C. Pahl, Y. L. Zhu, V. Gacitua-Decar, "A template-driven approach for maintainable service-oriented information systems integration", *International Journal of Software Engineering and Knowledge Engineering*, vol. 19, no. 7, (2009), pp. 889-912.
- [15] J. C. P. Cheng, K. H. Law, H. Bjornsson, A. Jones and R. Sriram, "A service oriented framework for construction supply chain integration", *Automation in Construction*, vol. 19, no. 2, (2010), pp. 245-260.
- [16] G. Bostjan and V. Podgorelec, "Automating ontology based information integration using service orientation", *WSEAS Transactions on Computers*, vol. 9, no. 6, (2010), pp. 547-556.
- [17] D. Parlanti, F. Paganelli and D. Giuli, "A service-oriented approach for network-centric data integration and its application to maritime surveillance", *IEEE Systems Journal*, vol. 5, no. 2, (2011), pp. 164-175.
- [18] L. Liu, J. Xu, D. Russell, J. K. Davies, D. Webster, Z. Y. Luo and C. Venters, "Dynamic service integration for reliable and sustainable capability provision", *International Journal of Systems Science*, vol. 43, no. 1, (2012), pp. 79-96.
- [19] A. Seth, H. Agarwal and A. R. Singla, "Integrating SOA and cloud computing for SME business objective", *WSEAS Transactions on Computers*, vol. 11, no. 3, (2012), pp. 77-87.
- [20] L. Li, R. L. Ge, S. M. Zhou and R. Valerdi, "Guest editorial integrated healthcare information systems", *IEEE Transactions on Information Technology in Biomedicine*, vol. 16, no. 4, (2012), pp. 515-517.
- [21] W. M. Shen, Q. Hao and Y. J. Xue, "A loosely coupled system integration approach for decision support in facility management and maintenance", *Automation in Construction*, vol. 25, (2012), pp. 41-48.
- [22] S. Park, J. M. Choi and H. Y. Yoo, "Integrated model of service-oriented architecture and web-oriented architecture for financial software", *Journal of Information Science and Engineering*, vol. 28, no. 5, (2012), pp. 925-939.
- [23] C. C. Chang and H. M. Lu, "Developing and integrating heterogeneous medical decision support systems on a web service platform", *Advances in Information Sciences and Service Sciences*, vol. 4, no. 19, (2012), pp. 205-210.
- [24] D. I. Tapia, J. A. Fraile, S. Rodríguez, R. S. Alonso and J. M. Corchado, "Integrating hardware agents into an enhanced multi-agent architecture for Ambient Intelligence systems", *Information Sciences*, vol. 222, no. 1, (2013), pp. 47-65.
- [25] Q. Li, Z. Y. Wang, W. H. Li, J. Li, C. Wang and R. Y. Du, "Applications integration in a hybrid cloud computing environment: modeling and platform", *Enterprise Information Systems*, vol. 7, no. 3, (2013), pp. 237-271.
- [26] A. Stefanescu, S. Wiczorek and M. Schur, "Message choreography modeling: A domain-specific language for consistent enterprise service integration", *Software and Systems Modeling*, vol. 13, no. 1, (2014), pp. 9-33.
- [27] M. Á. Conde, F. García-Peñalvo, M. Alier, E. Mayol and C. Fernández-Llamas, "Implementation and design of a service-based framework to integrate personal and institutional learning environments", *Science of Computer Programming*, vol. 88, (2014), pp. 41-53.
- [28] M. A. Martínez-Carreras, F. J. García Jimenez and A. F. Gómez Skarmeta, "Building integrated business environments: analyzing open-source ESB", *Enterprise Information Systems*, vol. 9, no. 4, (2015), pp. 401-435.
- [29] G. C. Lamprinakos, S. Asanin, T. Broden, A. Prestileo, J. Fursse, K. A. Papadopoulos, D. I. Kaklamani and I. S. Venieris, "An integrated remote monitoring platform towards Tele-health and Tele-care services interoperability", *Information Sciences*, vol. 308, (2015), pp. 23-37.
- [30] N. Luo, W. M. Zhong, F. Wan, Z. C. Ye and F. Qian, "An agent-based service-oriented integration architecture for chemical process automation", *Chinese Journal of Chemical Engineering*, vol. 23, no. 1, (2015), pp. 173-180.

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