Acta Technica *62* (2017), No. 6A, 79–88

The research and application of service registration and discovery in service-oriented

Yinglan Fang[2,3], Run Wang[2], Bing Han[2], Yongmei Zhang[2]

Abstract. SOA is a service-oriented reusable component model. With the increasing of service amount and the complexity of service interaction, it becomes increasingly difficult for service registration center, as an important infrastructure to achieve SOA, to manage existing services. There exists single point failure in the traditional centralized UDDI single node service registration. By constructing multitude service registration center to avoid that the application programming interface cannot be invoked by service consumers, due to system breakdown of part of service registration center described above. As the same time, multitude service registration center shares the same data source to persist service description data used to service discovery, which reduces the complexity of service discovery algorithm and the consistency of service description data in multitude environment. By introducing the mechanism of message interception to solve the hard coding problem of point to point service invocation between web services. Based on the improved service registration center, this paper proposes a software reusable development model and validates the effectiveness of the model in the actual production system member management system.

Key words. Universal Description, Discovery, Integration, Web Service Description Language, Service-Oriented Architecture; Service.

1. Introduction

Recent years, web service, as a major way to achieve Service-oriented architecture (SOA), has been researched and applied widely. By 2011, 63% of the global infrastructure market will support SOA, Web services or Web 2.0 and 60% of the money spent on software will be used for SOA, Web service, or Web 2.0. SOA is a

[1]Acknowledgment - This work was supported by the National Natural Science Foundation of China (61371143). North China University of Technology Dominant subject project (2110513600XN44).

[2]Beijing Key Laboratory on Integration and Analysis of Large-scale Stream Data, North China University of Technology, Beijing, 100144, China

[3]Corresponding Author, e-mail: jlufangy@163.com

new model that enables enterprises to integrate their business into a series of interoperable services or repetitive business tasks, enabling organizations to take advantage of existing IT technologies efficiently and repeatedly. Based on SOA, it goals can be better aligned with business goals to achieve business flexibility.

In SOA applications, almost all of the introduction to the Web Service will be involved with three roles: service providers, service consumers and service agents [1, 2]. The service provider registers the service to the service agent via the Internet and the service consumer searches the service agent for the service that they want [3]. Finally, service will be indicated by service consumer. When the number of service early is relatively small, the invocation of service is relatively simple. The service consumers can interact with the service provider directly by obtaining the service access address and building client proxy to make service invocation. With the increasing of component amount and the complexity of business, the scale of SOA is getting larger and larger and it becomes difficult for service consumer to efficiently access to the service that they want. When the service provider has changed the basic information and the access point of the service, it is difficult for the service consumer knowing whether the current service is available before calling the service. If the service provider change the access point of service or current network status is not good, the invocation of service will cast exception resulting in failure. Actually, it is indeed necessary to provide additional information using for displaying the detail of service provider. Constructing a service registration and discovery component to manager the existing service while the scale of SOA is huge is necessary. The model of service registration and discovery can be divided into centralized, distributed and mixed based on different implementation methods [4].

2. Empirical studies on service registration and discovery

2.1. Centralized service registration and discovery

There exists a single node used to register and discover service in centralized service registration and discovery (CSRD) [4]. Detail Information of all service will be persisted to this node. The service provider publishes the service to CSRD firstly. The service consumer searches the service useful to them secondly. Finally, the service consumer obtains the access point of service, constructs client proxy and equivocate the interface provided by the service. The core of traditional UDDI (Universal Description, Discovery, Integration)-based service registration and discovery is web service description language known as WSDL (Web Service Description Language). Through the mapping relationship of the WSDL and UDDI, CSRD can generate the description information of service. Service consumer only need to construct the local client proxy through the WSDL of service and equivocate the interface provided by the service. Paper [5] designs and implements the CSRD based on UDDI in SOA. Based on analysis of the UDDIv3 specification, paper [6] designs and implements a prototype of CSRD.

The advantage of CSRD is that all service information will be persisted on a single node, and the matching rule of service discovery is relatively simple. The dis-

advantage is that there exists a possibility of a single point of failure. The availability of CSRD is not guaranteed, due to system breakdown of the single node [6].

2.2. Distributed service registration and discovery

Due to the possibility of single point failure in CSRD, some scholars apply the idea of peer-to-peer network to service registration and discovery, which form a model characterized by distributed structure (DSRD). DSRD is suitable for the environment of mobile network [4]. There exists no center service registration and discovery node in DSRD and each peer in DSRD can either serve as service provider or service consumer. The service consumer sends request, using the communication mechanism of the broadcast, to the peer-to-peer network. Then, the appropriate service information in DSRD will be sent to the service consumer. Finally, the service consumer can decide which service will be chosen according to his service matching algorithm. As a result of the use of broadcast communication mechanism for service discovery, it spends more time for transferring service query. Paper [2] designs and implements a web service registration and discovery component based on peer-to-peer network architecture. By using the technical principle of peer-to-peer network, paper [4] realizes the direct communication of registration centers, reduces the quantity of the data between them and resolve the problem of data missing in data synchronization process.

DSRD uses multiple service registration and discovery nodes. Although the problem of single point of failure described in CSRD can be avoided when using DSRD, the cost of communication is larger and matching process of service query is more complex [4].

2.3. Mixed service registration and discovery

The mixed service registration and discovery model evolves on the basis of CSRD and DSRD (MSRD). Logically, MSRD is a tree structure, which is consist of groups. Each group can communicate with each other through channels. There exists a central node within each group which is consist of multiple peers. When it comes to discovering service, things becomes complex. If the service in current group meets the need of service consumer, service consumer will get the information of the matched service, including service name, access point and son on. Otherwise, the request of service discovery is forwarded to the other group [4].

MSRD evolves on the basis of CSRD and DSRD, combining multiple node into a group. It reduces the possibility of global service query and reduces the communication cost between nodes. However, with the increasing of the number of services, the service discovery algorithm is extremely complicated. Also, how to group and which node should be chosen as the central node in group should be taken into consider. The capability and flexibility of the system are not guaranteed.

Table 1. Comparison of Different Service Registration and Discovery Model

Item \ Model	Centralized	Distributed	Mixed
Number of Node	Single	Multiple	Multiple
Service Discovery algorithm	Simple	Complex	Extremely Complex
Cost of Communication	Low	High	High
Availability of Service Registration Center	General	High	High

Compared to these models described above on service registration and discovery, a new method is proposed. The flexibility of the service registry center should be considered firstly. Secondly, the service discovery algorithm should be universal. Finally, the cost of communication between nodes should be low.

3. UDDI service registration and discovery

UDDI, acting on the service publishing and discovering layer, represents the service discovery and integration mechanism in the Web Service protocol stack. Service can be published, discovered and bound based on Simple Object Access Protocol (SOAP) message [7]. Once you get the WSDL document of a service, you can analyze the document and get detailed information about the service. The document describes what function the service provides and how we can find it. Service registration is essentially publishing the WSDL document to the UDDI registry. Service discovery depends on the service publishing. The mechanism of service publishing determines the mechanism of service discovery [8].

Through the service registration center, we can establish a set of service registration and discovery specification. The specification relates to the storage model of service information and the external interface specification. The interaction model between service consumer, service provider and service registry can be established through external interface, such as publishing, query and so on. The external interface, based on XML, can be easily identified by people. By UDDI, services in SOA landscape can be reused and communicate with each other.

3.1. The core data structure in UDDI

The service registration center uses an XML document to describe the enterprise information and the service information provided by the enterprise. From the point of abstraction, the registration center manages three types of service meta data.

White pages give information about the company. This includes business identity and a description of the company. Yellow pages describe the functionality provided by the service, including standards-based industry classification methods such as NAICS. Green pages describe the technical and environmental information of the Web services provided by the enterprise, including access point and transport pro-

tocol [1].

According to the UDDI specification, UDDI registry consists of instances of four core data structure types [9]. Each type maps to a unique service entity. These entities define all information of service. Each service entity maps to a unique UUID through which the service can be found in the registration center.

3.2. Mapping relationship of WSDL and UDDI

WSDL document, which consists of description of service interface and service implementation based on XML, is used to describe how to invoke service [9]. The mapping relationship is shown in Figure 1.

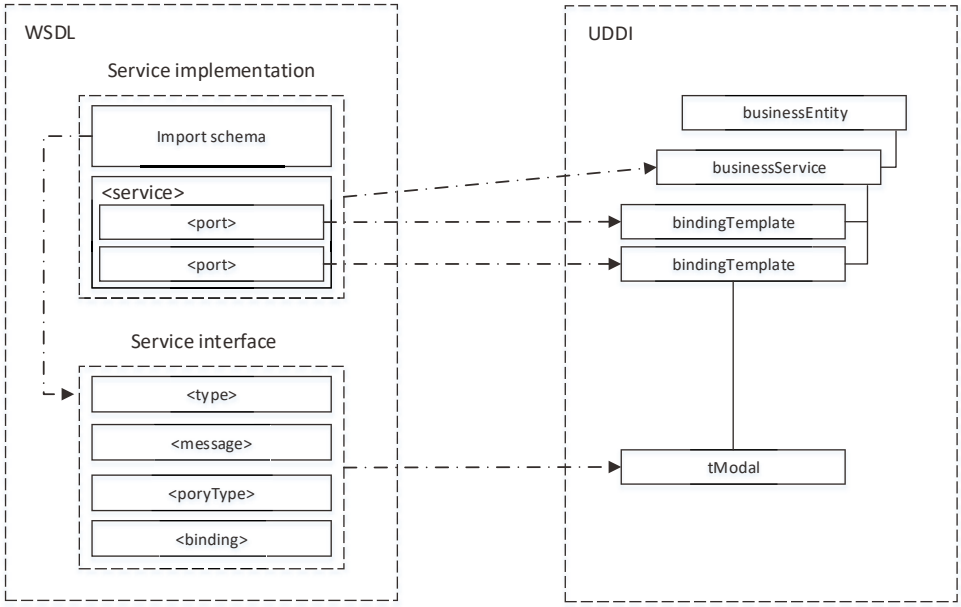

Fig. 1. The Mapping Relationship of WSDL and UDDI

4. Design of system architecture

We are about to design a system aiming to reusing and managing service in production environment. Service registration center based on apache juddi is applied to publish service and discover service. System menu component, the permission component, member management component and payment component extracted from application member management system will be published into service registration center as web service. Then we will search these services in service registration center and construct client proxy in member management system. Finally, member management system will interact with these services to achieve the relevant business logic.

4.1. Design of system interaction model

The whole system interaction model consists of service registration center based on juddi (SRS), member management system (MSS) and common service system (CSS). Juddi, an open source service registration center based on the UDDIv3 specification, is applied to publish service and discover service. MSS is a management information system in production environment. CSS is system which provide basic service for other applications. Now, we are about to integrate MMS and CSS by service registration center.

The process of service publishing is described as follow. Firstly, components will be extracted from MSS. Secondly, components will be reconstructed as service from the point of SOA. A service is a technology to deal with multiple messages interface. It returns information or modify the status of related entities and reflect the self-sufficient business functions. The service of permission in CSS is used to define the resources owned by each role. The service of member management in CSS is used to manage user information and grant role to user. The service of payment in CSS is applied to manage user's payment. The service of menu management is used to define system resource. Services described above will be published in service registration center.

The process of service discovery is described as follow. Service consumer searches service he wants in service registration center. Detailed information of service will be displayed in the form of XML. Service consumer can locate where he could find the service and what function the service provides. Client proxy, applied to equivocate service, could be built according to the WSDL document. The model is shown in Figure 2.

With the increasing of service amount, service could be deployed to different servers in distributed environment. Single service registration center could be built as a multiple node registration center based on peer-to-peer network. A heartbeat is used to detect whether the service is available. If service registration center detects service searched by service consumer is not available, the service information will not response to service consumer, which avoids the problem of service invocation failure.

4.2. Model of service invocation

When user login in MMS, client proxy in MMS will invoke the service of permission in CSS and load user's authority in MMS. The process needs interaction between MMS and CSS. The architecture of CSS has been described above. All of services in CSS, published by cxf framework, serve as web service. Various types of framework of web service is in fact servlet [10]. When using client proxy to invoke service based on SOAP request, cxf in CSS will hold up the request and decide which service should server it.

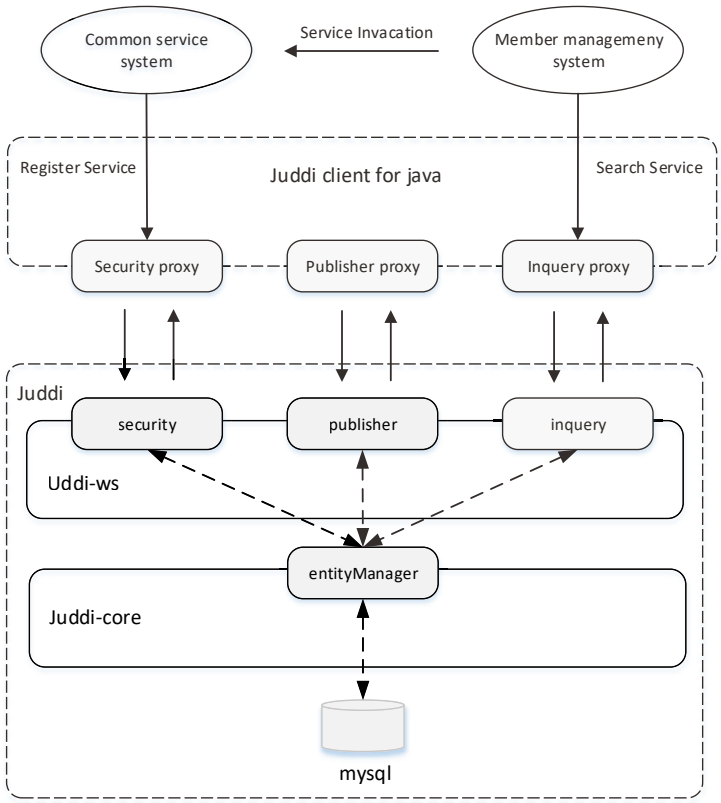

Fig. 2. Model of System Interaction

5. Experiment and analysis

The experiment environment is shown in Table 1.

Table 2. Experiment Environment

Item	description
Server	Ali cloud server
Platform	Jdk7
Database	Mysql5.5
Test tool	SoapUI
Project Management Tool	Maven3.5

The way to measure the invocation of service is successful primarily depends on whether an exception has occurred or whether the expected result is returned during the process. Figure 7 shows the result of time spent on invocation of payment interface. It can be clearly observed from the figure that the difference between service

invocation and method invocation is small, maintaining at 50ms. The whole process could be completed within 700ms. For payment scenarios in the daily application, it is OK.

The invocation of service will cast exception if parameters sent to CSS is error. Detailed exception message will be sent to service consumer for analyzing. The service of payment not only encapsulates third-party payment interface, but also exposures upper interface invocation specification to service consumer. In the process of developing enterprise application, some similar function modules may be developed more than once. We can constitute re-usability of method level or function level to service level. As application exists in the local area network, the cost of communication is relatively small. If we reconstruct application and extract components as services running on different servers, we could reuse services and reduce the risk of software development.

6. Conclusion

In this paper we have analyzed UDDI centralized service registration and discovery. We have designed and implemented multiple node service registration center used to publish service and discover service based on UDDIv3 specification. In conclusion, constructing multitude service registration center could avoid that the application programming interface cannot be invoked by service consumers, due to system breakdown of part of service registration center single point failure. By introducing the mechanism of message interception could solve the hard coding problem of point to point service invocation between web services. Finally, we propose a software reusable development model and validate the effectiveness of the model in the actual production system member management system.

References

[1] F. J. Zhang: *Application Analysis on Service Published and Discovery Technology in SOA*. Communications Technology. Beijing (2014), 275–280.

[2] K. Yue: *Underlying Techniques for Web Services: A Survey*. Journal Of Software, Beijing (2004), 448–442.

[3] Zhuhua Liao: *Literature Review on Technology of Web Services Discovery*. Journal Of The China Society For Scientific And Technical Information, Beijing (2008), 186–192.

[4] QiangWei: *Preliminary Study of Service Discovery in Internet of Things: Feasibility and Lim-itation of SOA*. Journal of Frontiers of Computer Science & Technology, Beijing (2013), 97–113.

[5] ZANG Tianxiang: *The Research and Realization of UDDI in Service-Oriented Architecture*. Transactions of Shenyang Ligong University Shenyang (2014), 87–91.

[6] Yunjian Long: *Peer-to-peer based Web service registration system*. Journal of Computer Applications. Chengdu (2014), 1983–1987.

[7] Xiuli Cao: *Research on XML Cross Platform WebService Based on SOAP Protocol*. Journal of Hubei University of Education, Wuhan (2015), 36–40.

[8] Na Liang: *UDDI and Discovery of Web Service*. Journal of Information, Xian (2003), 38–39.

[9] Xiaoyin Li: *Design and Realization of UDDI Registry Based on LDAP*. Application Research of Computers, Chengdu (2005), 144–146.

[10] Fengyun Li: *Research on Implementation Technologies of SOA Based on Web Service*. Science & Technology Vision, Shanghai (2012), 17–19

Received September 16, 2017