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A Study on the Construction of Tourism E-commerce System Based on Semantic Web Services

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Abstract: This paper presents a novel method of constructing a tourism e-commerce platform based on semantic web services. In order to solve the puzzles of web services discovery, system adaptability, automatically assembling and calling caused by bad system semantic interoperability in tourism e-commerce based on traditional web services, we construct a novel tourism e-commerce system framework based on semantic web services, which uses semantic services layer to replace the representation layer in the traditional model. Experiment proves that the framework owns the superiority of platform irrelevance, system highly seamless integration, high semantic interoperability and intelligence, and can solve the low semantics in tourism e-business system well.

Keywords: semantic web services, tourism e-commerce, ontology

1. INTRODUCTION

It is well known that, as the combination of modern electronic business idea and tourism industry, tourism electronic commerce has become the inevitable demand for the reform of modern information society. It makes good use of advanced computer network, communication technology and electronic commerce basic environment to integrate the internal and external resources of tourism enterprises to achieve the tourism products online distribution and sales, and finally provide a knowledge sharing, commerce exchanging and communication platform for tourists and tourism enterprises. Along with the development of economical and global integration, the resources sharing and Enterprise Application Integration under the open network environment become the focus of business application area. Web services has been recognized as an ideal information system construction technology by the scientific and industrial world for the features such as loosely coupled, standard protocols and high degree of integration. In order to make full use of the existing web services on Internet and deal with the fierce competition in the future, it is necessary to build a highly intelligent, automatic e-commercial platform for the industry.

However, the traditional web services structure is not flexible to maintain and reconfigure automatically^[1]. Now, web services based on semantics enables the computer to understand the content of the communication between different users, so as to realize the automatic detection, calling and assembly of web services. In this way, semantic web services has become an ideal way to realize electronic commerce. This paper expounds the basic structure and characteristics of semantic web services, analyzes the deficiencies of the traditional web services, and puts forward a novel tourism e-commerce solution based on semantic web services.

2. THE DEFICIENCIES OF THE TOURISM E-COMMERCE SYSTEM BASED ON TRADITIONAL WEB SERVICES

2.1 Web services

Web services, as a kind of web components which can be described, released, positioned and called by any network, is an Internet application oriented to service. It can configure, combine dynamically to finish from

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simple call to the complex business processes without special design. Through the construction of web services, we can find a programmable Internet.

The basic structure of web services^[2] consists of three participants, service providers, service requestor and service agent, and three basic operation constitutes, releasing, searching and binding. As shown in figure 1, service provider releases its service to a directory of the service agency. When the service requestor needs to call one service, he uses the providing directory by service agency to search the service, and obtain the information on how to call this service. Then he will call the released service by service

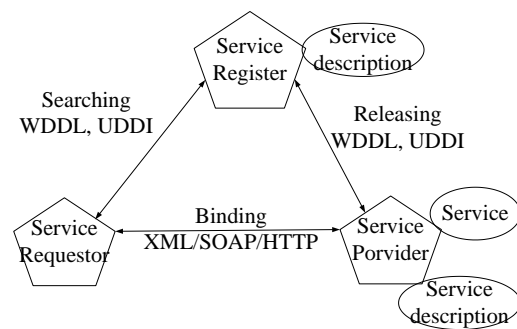


Figure 1. Basic Structure of web services

provider according to the above information. When the service requestor gets the required information about the calling service from the service agent, the communication will proceed between the service requestor and provider without the help of service agent. The dynamic and automatically description, releasing, searching and using of web services are all relying on service-oriented architecture (SOA) to complete. The key technologies of web services include the following: WSDL (Web Services Description Language) used to describe services; UDDI (Universal Description, Discovery, Integration) used to release and search services; SOAP (Simple Object Access Protocol) used to execute service calls. Obviously, using web services in electronic commerce system can improve the interoperability between shared objects and provide automatic, instant integrated operation and can reduce the complexity of the system through packaging.

2.2 Existing problems

The deficiencies of the application of the traditional web services in tourism e-commerce include the following three aspects^[3].

2.2.1 The deficiencies of web services discovery

The electronic commerce application based on web services can provide customers different types of web services, and the required solving problems for web services discovery is to find the required services for customers to send out web services requests. In the traditional web services system, WSDL which describe these services is unable to express the semantic information of web services well. Furthermore, the describing dynamic information by WDSL is limited to static web service, not including any information relevant to service executive processes. However, the execution of required service in the practical application is dynamic. For example, when the customer needs to reserve hotel, because hotels belong to the category of tourism facilities, all the relevant tourism services such as tour guide, tourists, leisure activities, etc will be selected, but the traditional UDDI is unable to realize it.

2.2.2 The deficiencies of adaptability

In the traditional web services, the function and structure of system is fixed and can't realize the dynamic integration of business services. However, the transaction of tourism e-commerce in the reality is dynamic and will alter with the change of external environment. So the traditional web services are difficult to adapt the complexity of the change of tourism e-commerce.

2.2.3 The deficiencies of automatic assembly and call

As we know, there exist many complicated applications in e-commerce transactions, and these applications need to combine many simple web services to complete. Because the actual application demand is diverse, the corresponding assembly method is also different; the works of assembly and call can only finish by computer automatically, but not finish by the artificial work. In the traditional web services, if one of the web services in

the web services combination is revoked, the programmer must personally to seek appropriate substitution to ensure their combination.

In addition, there exist some problems in the construction of tourism e-commerce such as the separation of network, division of departments, information islet, scatter of information, lack of intelligence, and semantic interoperability. And these problems also can not be solved by traditional web services.

3. THE CONSTRUCTION OF TOURISM E-COMMERCE SYSTEM BASED ON SEMANTIC WEB SERVICES

3.1 Semantic web services

Semantic web services is a kind of web services which applies the semantic web technology to the web services to realize the automatic discovery, call and synthesis of web services. Moreover, the application of semantic web services is based on two premises: (1) the referenced ontology can support automatic reasoning; (2) the intelligent agent can understand the concept of ontology^[4]. In order to realize the two premises, the ontology form language such as OWL or OWL-S is needed to make the semantics expressed by ontology get unified.

OWL is a kind of web ontology language with definition and instantiation, and it provides three kinds of child languages with increasingly expressive ability, OWL Lite, OWL DL and OWL Full, respectively applied for the specific communities of implementers and users. Moreover, OWL-S provides three kinds of ontology, ServiceProfile, ServiceModel and ServiceGrounding^[5-7].

The basic idea of semantic web services is to use web services description language WSDL to describe the ability, position and interface of web services. Using OWL-S ServiceProfile to register web services to ensure the service providers and customers to find each other. And all kinds of applications can call web services through SOAP to realize data exchanging.

3.2 The framework of tourism e-commerce system based on semantic web services

The traditional tourism e-commerce system based on web services can solve the problems of information islet to some extent, but it's unable to solve the deficiencies of semantic interoperability between different systems. Furthermore, the business components in traditional systems are lack of intelligence. In this paper, we put forward a novel tourism e-Commerce system based on semantic web services(Semantic Web Services Based Tourism E-Commerce System Framework, SWSTESF). The structure of SWSTESF makes good use of semantic web services to give web resources more clear and perfect semantics to make the computer can understand the content on the web, and realize the intelligent process of web data and services. With the aid of OWL-S technology, we can combine semantics and web services to realize the coupling between application services and form high reliable system.

Meanwhile, by using the combination of intelligent agent technology and semantic web, the web services task can complete automatically and reduce human intervention, and realize the intelligence and automation of web services, and obtain the advantages of environment independent, active integration and automatic maintenance.

As shown in figure 2, the whole framework of SWSTESF is constituted by the interface layer, semantic web services layer and the application layer.

3.2.1 The interface layer

This layer is mainly consisted by WSDL of web services, describing the information about web interface and location. WSDL, as the descriptive language for web services, can make different types of services distributed in different places and different systems interaction. The function of the interface layer is to realize the storage and management of messages and acting as the access to receive service request by platform.

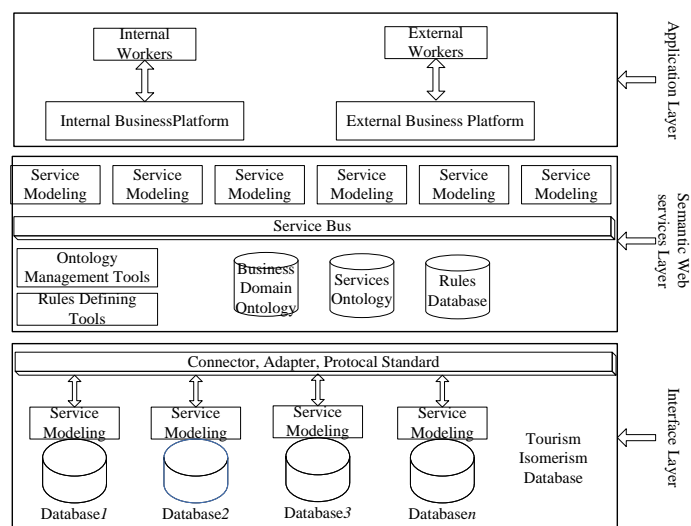


Figure 2. The Framework of SWSTESF

3.2.2 Semantic web services layer

In this layer, the tourism e-commerce experts can realize the following things: constructing tourism business domain ontology, service ontology and rule libraries by ontology management tools (such as Protégé) and rules defining construction tools; finishing business process design by OWL-S service model and assembling web services components to realize complex business processes which can support tourism business collaboration; through registration service, realizing the services registration, inquiring and semantic mapping work of application system, and expanding service discovery and evaluation function based on semantic content expansion with the aid of traditional registration mechanism UDDI, and establishing the semantic mapping between UDDI and OWL-S services description to support two kinds of different types of service discovery mechanism; obtaining the optimal service with the semantic matching of the services in the service registration, and assessing the service according to the service matching and running situation to establish service evaluation mechanism and guarantee the quality of service (QoS).

3.2.3 The application layer

This is the top layer of the framework, the main function is to provide querying interface for internal and external users or other systems, and allow users to adopt uniform interface to access all the data sources, and show inquiring results to users or deliver results to other systems.

3.3 The superiority of SWSTESF

The superiority of SWSTESF model lies in using semantic web services layer to replace presentation layer in the traditional tourism e-commerce. Web services layer applies semantic web services technology to achieve good interoperability between tourism business applications. Meanwhile, semantic web services technology can reduce the burden of developers and ignore the details of the internal realization mechanism, service operation platform, development language and the compatibility of varies of computing standards. In this model, the application of intelligent agent technology is mainly focusing on business cooperation and system operation autonomously, and let the intelligence to replace the role of operator and free the man to be decision makers and managers. Meanwhile, semantic web provides semantic information and necessary reasoning mechanism for intelligent agent and web services, which brings tourism e-commerce platform in distributed environment good intelligence, and various tourism business application can realize semantic interoperate seamlessly, and overcome the shortage of the current tourism e-commerce platform. In a word, this model can provide a novel

and feasible solution to tourism e-commerce operation and system integration^[8].

- Platform irrelevance. All of the tourism business services such as description, registration, searching and calling are based on the messages of XML format. As XML is a completely cross-platform marked language, it can transmit through Internet with any Internet protocol.

- System highly seamless integration. With UDDI system structure, various services can interconnect through the Internet. For example, we can use the functions provided by the encapsulated tourism business service through the browser, such as reserving hotel, purchasing tickets, searching scenic spots navigation, etc. In addition, tourism business service itself can also communicate or call other functions provided by other tourism business services conveniently.

- Information discovery and integration. Tourism business service providers can register the semantic describing information of their own services in UDDI register centre through Internet, and in this way can these services be found and used by any tourism business consumers, and also become the component to integrate stronger function of tourism business services.

- Distributed application system. Tourism e-commerce platform is a distributed application system, and owns stronger openness and flexibility.

- Collaborative, semantic interoperability. In the semantic web environment, because all participates can easily understand the meaning of the information, the information sharing and exchanging can be guaranteed, and the cooperation and semantic interoperability can be achieved easily.

- Owning intelligence. In the semantic web services environment, intelligent agent has stronger ability to make decisions, and tourism business services can execute well with the aid of intelligent.

4. THE REALIZATION OF TOURISM E-COMMERCE SYSTEM BASED ON SEMANTIC WEB SERVICES

4.1 Construction of tourism business domain ontology

One of the puzzles of semantic web services research is the construction of domain ontology. With the participation of the tourism electronic commerce experts, we can make full use of the existing tourism e-commerce thesaurus to complete the innate structure of tourism business resources domain ontology; then we can continuously extract new concept case to realize the gradually updating and perfection of tourism business information resources ontology during the processes of semantic information extraction and instantiation to tourism information resources. As shown in figure 3, the tourism business information resources ontology obtaining model contains four phases——information selection, concept extraction, domain focus relationship study and ontology assessment. The four phases correspond with ontology circulate acquisition methodology and complete the construction of tourism information resources ontology from the two layers of original acquisition and acquired study.

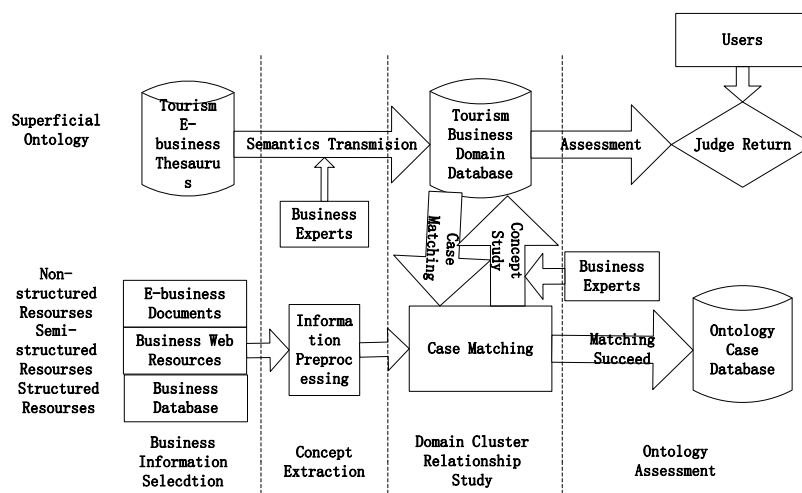


Figure 3 Model of Ontology Acquisition for Tourism E-commerce System

4.2 Finding of web services

As to service finding, it is a series of behaviors that the customers find the service they want in various kinds of services to carry out the request of web services. Web services finding is one important part of SWSEDIF framework, and UDDI is one of the solutions, but not very good solution to the semantic constraints and the matching problem. Fortunately, OWL-S/UDDI matchmaker by CMU (Carnegie Mellon University) has provided us a good solution. Matchmaker consists of a communication module, an OWL-S/UDDI converter, and an OWL-S match engine. On the one hand, all external requests will be loaded into matchmaker by communication module, and communication module will transfer advertisements and inquiries passed to OWL-S/UDDI converter. Then all the advertisements and inquiries described with OWL-S will be translated into UDDI format to transfer to external UDDI register centre. On the other hand, communication module will transfer requests to the OWL-S match engine, and OWL-S match engine will use Ontology matching request and service to find the appropriate service ^[9].

4.3 Web services combination

Service combination includes a series of atomic services, the control flow and data flow among various services. The goal of web services combination is to reduce the time and expense in developing, integrating and maintaining web services. MindSwap's Web Service Composer ^[10] can lead the user to assemble different services dynamically to carry out the assembled task and complete it according to the types and semantics of the service output and input. There exists an ontology database to store the existing services in Composer in order to search the matching service according to the capacity of these services. When services matching, the output service whose parameters are same to those in input service will be matched first, and the output service belonging to the subclass of input service will be matched later. The above matching rules are similar to the type matching in oriented object, but the classes in OWL are precisely defined and owning semantic information. Through classes matching, the traditional types matching and present semantic matching are realized in web services combination.

4.4 Realization of system

In this part, we take ZhangJiajie tourism e-commerce platform as an example to illustrate the realization and application of tourism e-commerce system. In the platform, we construct a gateway management server, unified user portal, a tourism ontology database and a UDDI registration centre. In the outer layer of UDDI

centre, OWLS/UDDI Matchmaker is constructed. Tourism management bureau, scenic spots, travel agencies, hotels and other departments all establish their own intelligence agent subsystem to carry out semantic service encapsulation to their existing application system, and release them to the tourism business portal and register in the UDDI.

Through the unified portal, all types of users can easily use all kinds of services in their own authority. Experiments show that the system can effectively solve the mentioned puzzles of lack of intelligence and semantic interoperability for tourism e-commerce, and is practical and superior. However, the relevant technologies of semantic web services aren't mature yet, and the platform needs to be further improved. The main specific implementation processes of constructing e-commerce platform based on semantic web service are as follows:

Step 1: constituting domain concept norms. Constructing domain ontology with the guidance of domain experts and setting standard concept describing norms. As to the field of tourism, the main concepts of entity ontology include tourists, hotels, resorts, travel routes, etc. The main concepts of behavior ontology include reservation, navigation, inquiry and analysis, etc. The above description has set the basis for realizing business service interoperability and virtualization.

Step 2: constructing business service standards. As we know, business service standards are usually obtained through behavior analysis in business logic domain. Taking domain case "tourism route inquiring" for an example, we should firstly find the relevant behavior concept "inquiring" in ontology database and its entity concept "tourism route", then we can obtain the general profile of corresponding business service function. Secondly, we can select the concepts relevant to the business function as characteristic concept, for example, "sites", "tourism starting point", "tourism end" and "tourism time" are the concepts relevant to "tourism route", and obtain the profile of business features. Lastly, we can establish the relationship among all concepts of demand norm side and the concepts of relevant features. For example, in the business service of tourism route inquiring, in order to get all tourism route information in the given time, the users should fill in the start and destination of the route. And the relevance of feature "tourism time" and "sites", "tourism starting point" and "tourism end", "reservation" and "output" is needed to set up. In this way, we can get the demand standard profile.

Step 3: service executing. After setting up the mapping of web services and business services, business services can be properly executed. When the user use "tourism route inquiring" business service, the system will automatically select a most appropriate web service to compute the expected result for the user according to user's input and the constructed mapping in the process of virtualization.

5. CONCLUSIONS

The combination of semantic web and web services has provided a good solution to tourism e-commerce data integration. This paper puts forward the framework of tourism e-commerce based on semantic web services, analyzing the key technical problems of the framework realization, and proves the feasibility of the structure by the case analysis. However, the realization and application of semantic web services technology in tourism e-commerce is very complex, some urgent puzzles such as ontology mapping and evaluation, ontology consistency, ontology construction in relations extraction, automatic semantic tagging, application of semantic web services in P2P, etc are needed for us to do further research.

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