Web-based Approach on Application Services Composition for PSS

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ABSTRACT: In order to find the applicable resource services to satisfy the customer’s demand quickly, the product service system should provide all resource information in a collaborative integrated environment. The approach on application services composition was proposed. It concluded a new composition framework, which comprises the web-based semantic definition for business messages, the methodology of constructing visualized integrated processes based on Business Process Execution Language (BPEL), and the strategy of vocabulary-based business rules. The service interactions and physical entity were depicted too. Finally quality of service multi dimensional model for the modeling of requirement and service matching and combination employed semantic approach were adopt to find out the appropriate composition service that satisfied the user constrains could be selected from service set.

1 INTRODUCTION

In traditional product sales, the focus is often on developing products that are cheap to manufacture and enable a profitable aftermarket consisting of service, spare parts and consumable. However, manufacturers in developed countries today regard services more crucial and service activity is increasingly being important into design space. Such offerings from such design are the industrial product-service systems (PSS). PSS offerings consist of combinations of physical products, services and systems that have been integrated and optimized from a lifecycle perspective in relation to the customer value [1]. Usually the physical products and services are belong different departments or companies. By the development of computer technology and network technology, the large-scale collaborative work, which is cross-agency, cross-section and cross-region can come into true. However, the companies have a large number of applications to support their business information systems and data resources. It is difficult to build the business process work together to achieve effective sharing and use of resources.

In addition, there are many business systems across administrative domains in great demand uncertainty and dynamic polygons, the need to adjust their business activities in accordance with the progress of the business and context information constantly. It is difficult to build the business logic to complete the desired function. Therefore, a business-user-centric, easy to understand, be able to demand the allocation of resources to build the business logic of a virtual computing environment, users do not care about the underlying details of the flexibility to build their own network of collaborative applications, which can concentrate in the business itself .

Users need the PSS to be able to recommend immediate services available to them. The selection of the resource requirements depend on the resources and services available relations resource information resources [2]. Resource demand is the input information is the dynamic data. The resources relationship is the static data, and the available resources with the disposal of information dynamically changing data. In order to quickly find the applicable resource services , to avoid user or system aimlessly in order to access the service, will provide all departments resource information contained aggregation service available resources in a collaborative integrated environment, resources, instant notification of changes integrated collaborative environment, resources, information gathering will change.

Web Service is not only an efficient approach to build web-based application services for company, but also it is convenient for inter-platform implementation and business processes integration. Web-based application services composition method is necessary to integrate several different services into a unite service, and the united service can offer the business shared interactive information.
2 MESSAGE COMPOSITION

Messages composition is built on web-based resources description framework (RDF), it is a methodology of encoding, exchanging and reusing for structured data, and it provides a basic data model and syntactic rule to describe different structured data with XML-based message definition [3].

Structure of message is the abstract data model for actual business messages. The basic data model is comprised of three parts. The first is resource. They can be described by RDF. The second is property. It depicts the characteristics of resource. The third is declaration. Declaration is consisting of resource and its property.

Due to the property denotes the relationship between resource and model, the data model can be expressed by ontology relationship graphic. Additionally, we make out XML as the syntactic rule. However, it is tedious if we depict a complicated business message by RDF/XML directly, so we can get a XSD-based expression for message after simplifying the syntactic structure, as Figure 1 shown.

When constructing the basic structure of message, we often meet some record-type item, such as the “Item” element in Figure 2, it comprises a set of different commodity, like this, it can be denoted by mode of package or array.

(2) Adding correspond operators between the source and destination. (3) Linking the counterpart in service. In order to implement more complex mapping, such as loop, iteration, customer-defined script can be constructed in the function library.

3 TECHNOLOGY OF APPLICATION SERVICE COMPOSITION

The framework provides the method of composition, the logic constraint, communication ports setting and other management strategy by mechanism. Several different application services can connect to a united complicated service by composition. The key points lie in how to define, descript and run a composed process [4].

3.1 Composition process definition

Composition process denotes a set of operations and its relationship by meeting some business demands. According to data-flow diagram, the composition process can be divided into two parts: transformation flow and transaction flow. It includes message database and operators beside receiving and sending channel in a composed process as Figure 3 shown.

Message database: it is a global message container in the whole process; include XSD-based message structures and message instances. Additionally, when shifting, receiving and sending the messages, they all communicate with database.

Operator of process logic: they define the operation on messages. Transaction units handle messages with operator such as judgment, branch, and selection. Transformation units handle it with operator such as copy and mapping.
Channels: it defines the mode of receiving and sending messages. By setting network protocol and bondage style, messages can be received or sent with the need of different application services. The receiving channel is consisting of 4 phases: decoding, disassembling, verification and analyzing as Figure 4 shown.

Decoding unit deals with the message with the format of MIME or secures MIME, and transforms it into XML format. Moreover, it can work with decipherment and verification about digital signal. Disassembling unit transforms the flat file into XML and analyzes the structure of XML file. Flat file might be a set of unstructured records such as CSV file. Verification unit has the ability of validation checking the structure of message. Analyzing unit tries to be certain of the message sender identity and looks for system user-id from message database by digital signal. Otherwise, the message is identified with anonymous.

The structure of sending channel is similar to receiving channel. It is made of two phrases only: assembling unit and encoding unit. XML format can be transformed into the format which receiver can understand in assembling unit. On the other phrase, all messages can be packed with the format of MIME or S/MIME, digital signal and message encryption.

3.2 Composition Rules

Composition rules provide the strategy that is adaptive to variety business process, we develop some rules to satisfy the demand of process constrains. By rules, business strategy can be modified dynamically by rule framework which comprises vocabulary definition, rule compilation and rule distribution as Figure 5 shown.

Vocabulary definition: Vocabulary is the decision element that is made of noun and verb. The noun links data field in data source and the verb links related operation to the noun. For instance, we create three noun phrases like “order quantity”, “invoice quantity” and “transport quantity”, and a verb phrase “decide payment quantity”. Each noun phrase links a data source and all phrases will be used next step.

Rule compilation: Based on “IF-THEN” logistic, if rule condition is true, then system performs related operators defined by verb phrases. Rule condition includes predicate, it denotes the logical decision such as “greater than”, “less than”, “equal to” and operators such as “And”, “Or”, and “Not”. For example, rule expression is:

$$\text{IF} \quad \text{And (order quantity = invoice quantity, order quantity = transport quantity)};$$
$$\text{THEN} \quad \text{Decide payment (order quantity)};$$
$$\text{ENDIF}$$

Rule distribution: All rules are stored in rule-base after they designed to constrain some business processes. A group of rules is applied a special process and each rule in this group will be executed for integrated business processes.

3.3 Port binding

The composed application service platform is connected to other disperse application services by Port. There are two types of port. One is the internal private port. Connecting with the services each other is within the same firewall, there are so many protocols to this kind of port, such as Http, Ftp and File and so on. The other is the external public port. Receiving or sending messages is through company firewall by this type port, Web service is the representation of port and it is open to other companies’ application services by means of SOAP protocol.

Due to the differences of protocol, we can bind these ports directly for internal private type, that is, all ports assigned to definite receiving or sending location and its protocol. On the other hand, as for
external public port, web services URL must be known specifically. After port binding, all messages can be in or out from application service.

### 3.4 Composition distribution

By these previous steps, all messages, logistics, rules and ports are stored in related database, and the composition process programmed by BPEL-based assembly. After programs compiling, the composition service runs by mode of middle-ware in operation system. In addition, service management is indispensable to guarantee for composition service on executing properly. Service monitor provides a set of tools for monitoring running state; all activities recorded into event log database. It is easy to find error when service runs incorrectly. Service security control is depended on Passport-based user role authentication in operation system and digital signature in SOAP message header. Furthermore, all messages communicate by SSL.

Exception handling is for errors found by service monitor, transaction adopts into "roll back" process over backward. Regard to those suspend task, the corresponding process can be restart after service parameters configuration.

### 4 METHOD TO FIND SERVICE BASED ON CUSTOMER’S DEMAND

The service resources can be Resource = <A, P, f>. A is a property of a collection of resources. The property of resources is a static property SA and a dynamic property DA. P is the set of the resources property value. Moreover, the resource property values have a static property value S-P and a dynamic property value D-P. f is the property of the resource mapping on its range. Since the mapping f corresponding description is not linear, using intermediate symmetric Gauss membership functions for attribute mapping fuzzy quantified.

The service action is B= <Resource, Per-Res, Post-Res>. The Resource is the service resources. Per-Res and Pos-Res represent the state before and after the service action status respectively. The services function also is F = <Col-Res, Con-Behavior>. The Col-Res is the operation collection of resources for this function. In addition, the Con-Behavior is the conditional functions. The user demand model is Request= <U, G, Re, Cri-R>. U is the service object corresponding use cases. G =< function-G, quality-G.> Re= {Sequence, Parallel, Selection, Loop} means the relationships (sequential, parallel, selection, loop) for each element in the set of representative nodes. Cri-R = {Criteria relationship} is a constraint relationship between user demands [5-6]. With continued growth in the number of services, the operating environment also reflect the significant dynamic characteristics, thus the automated service composition becomes critical. The process of the services composition is as shown as Figure 6.

![Figure 6. The process of the service composition.](image-url)
In the product service system, the users' dynamic information integration will integrate together by the service discovery and combination. The customer demands can be satisfied with the ontology method and the quality of service indexes. When selecting the services, if the evaluation values are same, the service occupied less resource should be select. If the evaluation values are same and the services occupied the same resource, the system should select any resource for combination randomly. Here the indexes include time, cost, accuracy, reputation, reliability and availability. Finally based on the semantic similarity, the services can be gotten by calculated the similarity. The similarity of services can be represented by similarity $= <R, D>$ worked out by the following formulas.

$$\text{dis}(R, D) = \sum_{i=1}^{\min\text{Length}(R, D)} \text{weight}(i)$$

$$\text{density}(R, D) = \frac{T}{\text{sibling}(R) + \text{sibling}(D) + T}$$

$$\text{sim}(R, D) = \alpha \times \frac{\lambda}{\text{dis}(R, D) + \lambda} + \beta \times \text{density}(R, D)$$

$$\alpha + \beta = 1$$

5 EXAMPLE

If there is a service enterprise offered the air transit service, its process is as shown as Figure 7. In the process, Resource = {waybill, entrustment, transport, assignment, dispatch-list, c-document}.

There are five types of service such as the transportation service SI, the warehouse management service SII, the air transport service SIII, the proxy management service SIV, the consignment management service SV and the customs declaration service SVI. The action and states of them are as shown as in table 1.

![Figure 7. The air transit service process.](image)

Table 1. The action and states of services.

<table>
<thead>
<tr>
<th>Resource</th>
<th>Per-Res</th>
<th>Post-Res</th>
<th>Col-Res</th>
<th>Con-Behavior</th>
</tr>
</thead>
<tbody>
<tr>
<td>SI</td>
<td>waybill</td>
<td>without entrustment</td>
<td>entrustment</td>
<td>entrustment</td>
</tr>
<tr>
<td>SII</td>
<td>transport</td>
<td>without dispatch-list</td>
<td>dispatch-list</td>
<td>dispatch-list</td>
</tr>
<tr>
<td>SIII</td>
<td>waybill</td>
<td>transport</td>
<td>assignment</td>
<td>transport</td>
</tr>
<tr>
<td>SIV</td>
<td>entrustment</td>
<td>waybill</td>
<td>assignment</td>
<td>waybill</td>
</tr>
<tr>
<td>SV</td>
<td>transport</td>
<td>waybill</td>
<td>dispatch-list</td>
<td>waybill</td>
</tr>
<tr>
<td>SVI</td>
<td>c-document</td>
<td>waybill</td>
<td>c-document</td>
<td>waybill</td>
</tr>
</tbody>
</table>

The properties of service are time, cost, accuracy, reliability, reputation and availability. And the user's demands of these properties can be described as: the time value is less than 0.9, the availability value is more than 0.65, the accuracy value is more than 0.85, the reliability value is
more than 1.6, the reputation value is more than 1.0 and the cost is less than 1.2. Assuming the random quality of service values of the candidate service sets are as shown as in table 2 and the weights of every property for every service are same.

Then according to the user’s demand, the final service combination project is as shown as Figure 8.

<table>
<thead>
<tr>
<th>Service</th>
<th>time</th>
<th>cost</th>
<th>accuracy</th>
<th>reliability</th>
<th>reputation</th>
<th>availability</th>
</tr>
</thead>
<tbody>
<tr>
<td>SI-1</td>
<td>0.127</td>
<td>0.792</td>
<td>4.269</td>
<td>2.607</td>
<td>3.188</td>
<td>1.493</td>
</tr>
<tr>
<td>SI-1</td>
<td>0.340</td>
<td>0.934</td>
<td>1.335</td>
<td>2.726</td>
<td>4.984</td>
<td>1.544</td>
</tr>
<tr>
<td>SII-1</td>
<td>0.699</td>
<td>0.352</td>
<td>1.960</td>
<td>4.824</td>
<td>1.734</td>
<td>3.131</td>
</tr>
<tr>
<td>SIV-1</td>
<td>0.704</td>
<td>0.679</td>
<td>1.727</td>
<td>2.669</td>
<td>3.301</td>
<td>2.474</td>
</tr>
<tr>
<td>SV-1</td>
<td>0.279</td>
<td>0.656</td>
<td>2.055</td>
<td>1.199</td>
<td>1.239</td>
<td>3.502</td>
</tr>
<tr>
<td>SVI-1</td>
<td>0.277</td>
<td>0.814</td>
<td>2.404</td>
<td>4.121</td>
<td>3.591</td>
<td>3.034</td>
</tr>
<tr>
<td>SII-2</td>
<td>0.158</td>
<td>0.490</td>
<td>0.957</td>
<td>1.609</td>
<td>2.477</td>
<td>1.018</td>
</tr>
<tr>
<td>SII-2</td>
<td>0.187</td>
<td>0.506</td>
<td>4.643</td>
<td>2.413</td>
<td>3.577</td>
<td>1.335</td>
</tr>
<tr>
<td>SIII-2</td>
<td>0.340</td>
<td>0.965</td>
<td>1.172</td>
<td>1.199</td>
<td>4.653</td>
<td>0.831</td>
</tr>
<tr>
<td>SIV-2</td>
<td>0.779</td>
<td>0.158</td>
<td>4.303</td>
<td>1.427</td>
<td>0.891</td>
<td>4.848</td>
</tr>
<tr>
<td>SV-2</td>
<td>0.286</td>
<td>0.971</td>
<td>1.922</td>
<td>1.736</td>
<td>4.200</td>
<td>1.528</td>
</tr>
<tr>
<td>SII-2</td>
<td>0.679</td>
<td>0.163</td>
<td>3.153</td>
<td>3.348</td>
<td>0.929</td>
<td>0.960</td>
</tr>
<tr>
<td>SI-3</td>
<td>0.142</td>
<td>0.916</td>
<td>3.194</td>
<td>2.787</td>
<td>4.246</td>
<td>1.756</td>
</tr>
<tr>
<td>SII-3</td>
<td>0.446</td>
<td>0.823</td>
<td>2.351</td>
<td>4.100</td>
<td>2.947</td>
<td>1.831</td>
</tr>
<tr>
<td>SIII-3</td>
<td>0.171</td>
<td>0.585</td>
<td>1.580</td>
<td>4.600</td>
<td>1.676</td>
<td>2.743</td>
</tr>
<tr>
<td>SIV-3</td>
<td>0.163</td>
<td>0.751</td>
<td>4.412</td>
<td>2.477</td>
<td>3.596</td>
<td>2.787</td>
</tr>
<tr>
<td>SV-3</td>
<td>0.646</td>
<td>0.392</td>
<td>3.488</td>
<td>1.445</td>
<td>3.927</td>
<td>2.225</td>
</tr>
<tr>
<td>SVI-3</td>
<td>0.766</td>
<td>0.352</td>
<td>1.582</td>
<td>4.611</td>
<td>1.939</td>
<td>4.121</td>
</tr>
</tbody>
</table>

Figure 8. The service sets which satisfy the user’s demand.

6 CONCLUSION

The RDF-based semantic framework provides an approach to denote message variety uniformly. In additionally, port, channel and mapping about messages satisfy the demand of communication through all kinds of network. BPEL-based language depicts the composition process. Thus, the customization to integrate more complicated application services into one virtual service can come into true. Vocabulary can be as the judgment source in composition rule, with logic predicate and relational expression. Finally, the service discovery and selection and the combination of process can be realized by reusing and combining atoms services to generate large-grained services.

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