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Research on Process Task Customization in Service-oriented Manufacturing

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Abstract: In the service-oriented manufacturing environment, in order to meet user's process tasks demand, a Multi Granularity Resource (MGR) model and its Web Service (WSMGR) encapsulation model are proposed. MGR is described from three views, i.e., function, processes and the quality and an extended OWL-S for MGRWS is presented. Based on the above model, an application framework for MGR is constructed, providing a Service Oriented Demand model (SOD) of MGR, flow symbol string expression and a demand acquisition algorithm. Finally, based on the prototype system, through the contrast of service discovery average query time spent between the coarse grained service in this study and the traditional single granularity service, it is found that time spent of the coarse grained service in this study is obviously smaller than time spent of the traditional single granularity service, which indicates that process customization demand not only convenients user's demand expression, at the same time, also improves the efficiency of service discovery.

Key words: Process tasks, OWL-S, multi-granularity manufacturing resource, flow symbol string, QoS

INTRODUCTION

In the service-oriented manufacturing environment, a large number of similar services will compete for the same task. This situation is more serious especially for process manufacturing tasks which involved in multiple service combination. If the granularity is too small, there will be more nodes' service that needs to be optimized then construct global optimization combination scheme. But in fact, the user's demand is often changeable and a lot of customer demands are ambiguous because they only pay attention to their ultimate goal. Therefore, it is necessary to provide multi-granularity resources to cater to the needs of different granularity or fuzzy demands. A multi-granularity resource can provide users with different granularity selection and can be arbitrarily selected or combined, as long as the results meeting the user's objectives, such as Quality of Service (QoS) target value, which thereby obviate the need for the pursuit of the ideal target value and waste of a large amount of computational overhead. There are some related researches on multi-granularity resources. Guo and Li (2011) studied collecting process segment into multi-granularity resource through log in order to improve the quality of services. Ma *et al*. (2010) studied service combination optimization method based on coarse-granularity requirements was. A dynamic clustering optimization approach for multi-granularity manufacturing cloud services was proposed (Jia *et al*., 2012). These studies involve the multi-granularity resource service implementation quality, service portfolio optimization but no research on multi-granularity resource demand customization. On user needs processing, Ronghua *et al*. (2011) put forward a requirement model based on environment ontology for composition service was proposed. Wen *et al*. (2009) put forward a kind of task oriented web service discovery algorithm. A method of composition for process template-driven Web services by representing the business process as the abstract process template was proposed (Fu *et al*., 2008). These researches divided the demand of the user task into subtasks, then did the child task service matching, not involving in user's the active demand customization.

Moreover, in the face of the massive web service, the traditional keyword-based query has larger repetition of Web service, difficult to accurately select the matching resources, while the semantic based service query is to overcome this shortcoming and can realize precise service query. OWL-S provides Web service for semantic description ontology but it does not include quality of service description rules and the description of the service process is based on the operation process (Wu *et al*., 2007). Therefore, in order to express complex resource service, it needs to be extended to accommodate the multi-granularity resource modeling package. There are some researches on semantic based manufacturing resource service modeling. An extended service model with additional function and quality parameters based on OWL-S was proposed (Fan *et al*., 2009). A manufacturing service construction method based on semantic was

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proposed to support the match, selection and composition of manufacturing service during the networked collaborative manufacturing process, as well as to improve the recall ratio and precision ratio of manufacturing services (Wu *et al*., 2012). A manufacturing services concept model based on semantics was presented (Wang and Liu, 2008).

In view of the above problems, this study presents a multi-granularity manufacturing resource model and its service encapsulation model and then gives a flow tasks custom implementation mechanism.

Section 2 presents a multi-granularity Manufacturing Resource Model (MGR). In section 3, we build an encapsulation realization for MGR based on extended OWL-S. Section 4 gives a method of process tasks customization. Section 5 gives a prototype system and one experiment. Section 6 gives a conclusion and section 7 acknowledgements.

MULTI-COARSE RESOURSE MODEL

Definition 1 multi granularity resource (MGR) model: Resource includes a plurality of process resource, the flow formed by these processes resources is a continuous segment or the whole business process, which can be regarded as a unified whole resources, whose input is the process ‘s (or the whole process’s) the first process resource input and output is the process’s (or whole process’s) the end of the process resource output and resource basic information is the basic information of the procedure segment. It includes three views: Resources view (RV), flow view (FV) and quality view (QV). RV includes resource’s base information, such as name, enterprise and so on, resource’s functions, i.e., input, output parameters, etc. FV describes resource’s flow logic. QV describes resource’s business function exaction quality.

It can be expressed as follows:

$$MGR = (R, F, Q)$$

where R, Fi, Q is resources view, flow view and quality view, respectively.

Multi-granularity resources formation is necessary to meet one of the following conditions:

- It is a process resource of a business process of a manufacturing enterprise
- It is a process resource of fixed business processes of alliance, which has relatively fixed business, closely process resource, often the advantage of process

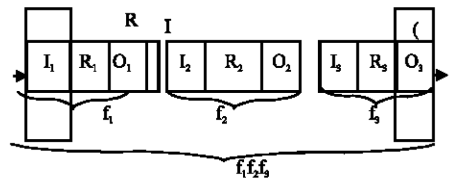

Fig. 1: Sequence flow fragment

Definition 2 web service encapsulation of multi granularity resource (WSMGR) model: It encapsulates multi granularity resource into a Web service. According to the three views, its formal can be accordingly expressed as:

$$WSMGR = (Base, Func, Flow, QoS, Ws_i)$$

where, Base describes MGR’s base information, including owned enterprise, name (i.e. MGR’s global name), Func MGR’s total function, Flow MGR’s included processes which is formed by each activities’ name and represented by process symbol string, QoS MGR’s total quality of service which includes followed four properties: time, cost, reliability, availability (In this study, only these four kinds of attributes are selected).

For example, assuming that a sequence structure business process fragment contains three resources, named R1, R2, R3 as showed in Fig. 1. R1, R2, R3 contains the process of atomic processes, respectively f1, f2, f3 and structure of the fragment is sequence, recorded as f1f2f3. They are combined into multi-granularity resource, which can be expressed as:

$$(R, f1f2f3, Q)$$

where, R expresses the newly generated MGR, f1f2f3 the MGR’s flow and Q MGR’s QoS. When the MGR is done semantics of service, it is packaged into semantic service according to the WSMGR model, of which expression is (Base, Func, f1f2f3, QoS (WS1, WS2, WS3)).When formed the MGR’s discovery, combination can be done based on its three view.

MULTI-COARSE RESOURSE ENCAPSULASION

OWL-S (Web Ontology Language for Services) is Web Service Ontology described by OWL language. It is also a kind of markup language with explicit semantic unambiguous machine understandable, which are described properties and functions of Web service. The description of Web service based on OWL-S is divided into three parts: ServiceProfile, ServiceModel and

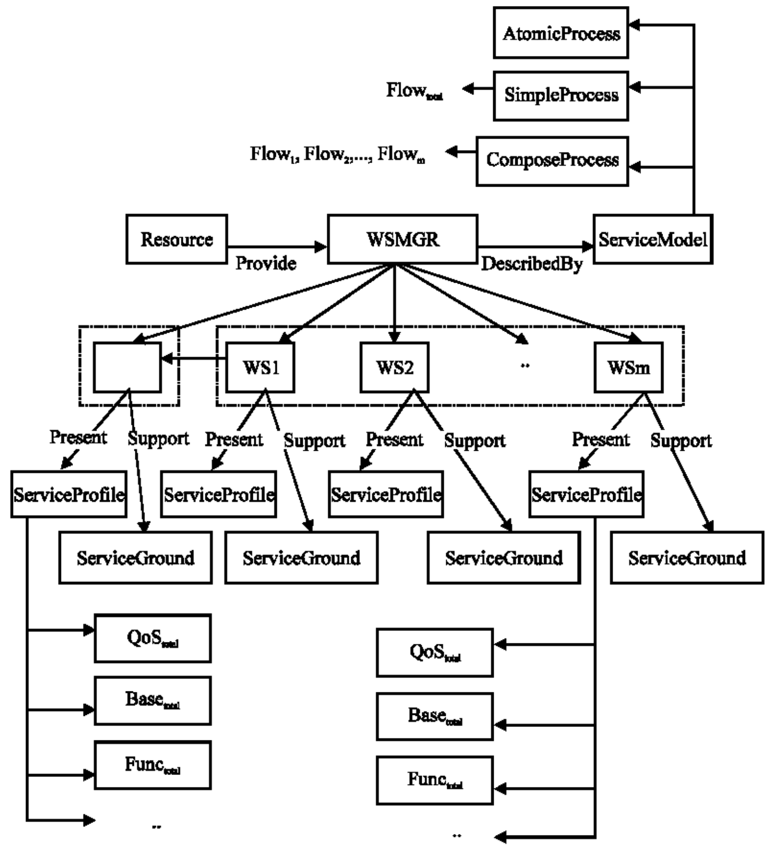

Fig. 2: Multi granularity resource web service ontology based on extended OWL-S

Service-Grounding. ServiceProfile describes what Web service is, ServiceModel specifies how to use it and ServiceGrounding specifies how to invoke it.

OWL-S is extended to cater to the multi-granularity resource service encapsulation requirements in this study, called WSMGRO. Because OWL-S has the following agreement: a Web service can have multiple ServiceProfile and ServiceGrounding, we can describe each resource service contained in MGR through accordingly ServiceProfile and ServiceGrounding, respectively, which would solve what is provided to the registration center or to the user. In the meanwhile, we introduce the QoS as the ServiceProfile attribute, which ensures that each resource QoS can be described in the respective ServiceProfile. While on multi-granularity resources overall information, such as basic information and total QoS, we can add a ServiceProfile to describe it and we have to add a ServiceGrounding accordingly to describe how to invoke the overall resource. MGR's flow can be solved by ProcessModel, which provides a combination process method. Abstract description of the whole process of MGR could be solved through SimpleProcess, which can give abstract description for MGR'flow according to different requirements of fine-grained atomic or compound process, aimed at application in process planning and reasoning based on providing a simplified composite process view for user. An extended OWL-S model is presented in Fig. 2, in which contents in the dashed box are a virtual representation.

Figure 1 is taken for an example to describe above MGRWSO's application.

In addition, WS1, WS2, WS3 has each ServiceProfile, respectively.

According to above model, ServiceModel includes AtomicProcess, SimpleProcess and ComposeProcess. For the MGR, using flow string to express its SimpleProcess, using tradition method to describe ComposeProcess.

- The MGR's flow string is as follows: f1f2f3.
- The MGR's ComposeProcess is as follows:
- <process:CompositeProcess rdf:ID = "FProcess">
- <rdfs:label> This is the top level process for F</rdfs:label>
- <process:composedOf> <process:Sequence>
- <process:components rdf:parseType = "Collection">
- <process:AtomicProcess rdf:about = "#f1"/>

- <process:AtomicProcess rdf:about = "#f2"/>
- <process: AtomicProcess rdf:about = "# f3"/>
- </process:components>
- </process:Sequence>
- </process:composedOf>
- </process:CompositeProcess>

ServiceGrounding, it is the description of execution process (e.g., the access protocols, message formats, ports, network addressing, etc.).For the MGR, its abstract description of input and output is encapsulated in transmitting message.

PROCESS TASK S CUSTOMIZATION

Process tasks oriented multi-granularity resource application framework: A process tasks oriented multi-granularity resource application framework is constructed based on WSMGR, which includes three levels as followed in Fig. 3.

- **Resource level:** It provides all manufacturing resources, including software resource, equipment resource and intelligence resource and so on. It provides material base for upper level service
- **Service level:** It is responsible for the lowerresource service and service management and provides interaction with upper application level, including two databases of services registering database and ontology database and all other management function for services
- **Application level:** Oriented user, it provides demand customization and achievement based on process customization. In addition, it includes a series of related functions, such as flow customization, constraints editor of QoS and so on

According to MGR model, user can realize tasks customization of MGR based on manufacturing business process template. The combined process task's division or merger is feasible because process task has the integrity and independence of the local. Each sub task of the process is an active node with activity attributes, such as input and output and so on and their own precursor and (or) the successor activities because the business process task can be scheduled based on workflow technology. To simplify business process expression, a method of process symbol string expression is applied in this study.

Definition 3 Process symbol string (PSS): It is a method translating flow chart into a string expression through the symbolic form, whose specific means is as

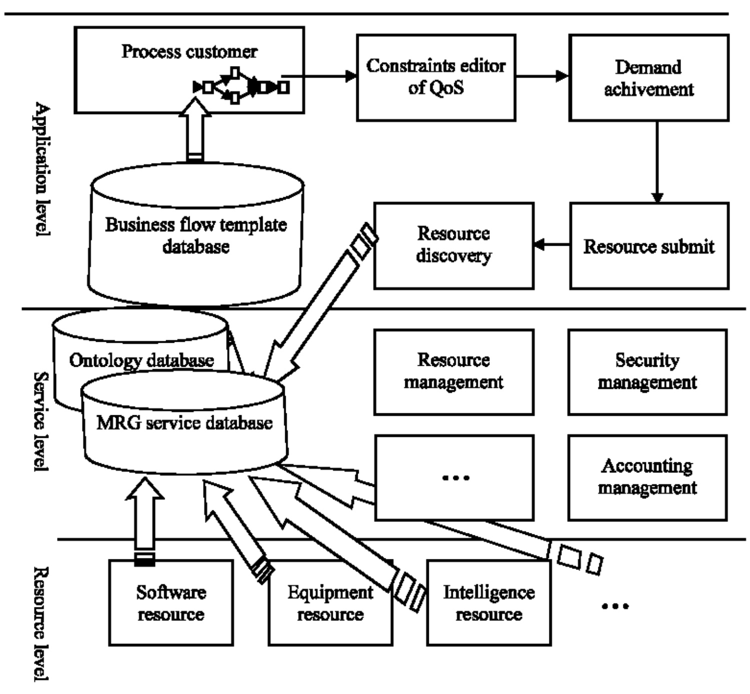

Fig. 3: A multi-granularity resource application framework Process of process customization

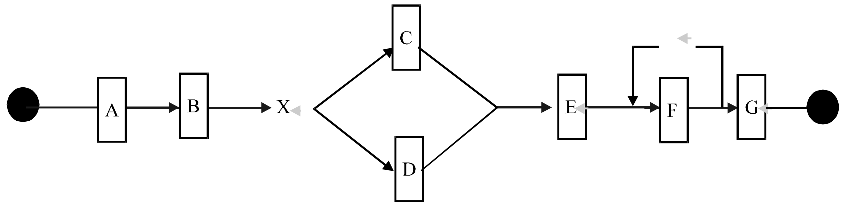

Fig. 4: Process instance

follows: For the active nodes of business processes, it is formed by using its activity name as its symbol; for business process control structure, it is formed by using corresponding control symbol, which can be set as:

{S, X, P, J, L}

where, S, X, P, J, L respectively expresses sequence, selection, parallel split, parallel merge, circular control structure. Symbols of two nodes are directly connected with dot. The scope of control structure is contained with parentheses. The whole process can be viewed as a sequence structure.

For example, one process instance is viewed in Fig.4, of which PSS is A.B.X (C.D).E.L (F).G.

At present, there are some segmentation methods of the business process[11-12], which fulfilled process partition based on Business Process Execute Language (BPEL), emphasizing automation of process partition. To realize user customization on process tasks, a viewed operation interface is provided for user, which provides a method of handmade custom. The specific steps are as follows:

- First, according to business process classification, user selects business process instance from business process template database in which all nodes of the business process are translated into string symbols. These string symbols are easy to understand their meaning
- User selects segment of the business process according to his o her own needs
- Then, user can edit QoS constraints for all nodes of segment of the business process. User can give weights for the service quality factor to represent the preferences to them
- Further, the user can also customize the multi-granularity resource through the selected segment of business process, i.e., some process nodes are combined into a granularity resource to be published. The newly generated MGR has owner total process, total QoS and total Function
- The custom procedure string is submitted to achieve resources demand

A demand model: After tasks custom, it is needed to extract the user customized task information as the user needs. Demand information must be correctly organized according to a certain format and content thus to provide clear resource request and correctly reflect real user request for the system. Therefore, It is necessary that obtained process customization information is organized and perfected based on user task customization. To this end, we construct the following manufacturing resource demand model

Definition 4 resource demand model:

$$Req = (Type, Fuc, Proc, QoS, [WS_i], W)$$

where, type expresses the process category of resource, Func = (In, Out), resource's function, Proc business process contained in resource, QoS quality of manufacturing resource and can be expressed as follows: QoS = (t, c, r, a), t, c, r, a expressing time, price, reliability and availability of resource respectively, $[WS_i]$ is the ith service contained in SWSMGR, which can be atomic activity or multi-granularity activity and be expressed as WS_i = (Type, Func, Proc, QoS), W set of user preference degree of all QoS factors, Wi weight of the ith factor. In general, the service quality factor values of the same process node from different users will be inconsistent.

Demands achievement algorithm: Resource requirement acquisition process is as follows: User obtains resource demand for each task node respectively through the process tasks customization thus to achieve demands set of the process tasks, i.e., demands are achieved by activities on process symbol string (including multiple particle composite activities). Demand belonged to the same process task is marked by task ID. Each task node's demand information is collected according to the demand model and a certain message format (file format) is used for storage, XML in this study. The algorithm pseudo code is described as below.

```
Getreq (UserString)
Step 1: xml[] : XML
Step2 : Task→UserString;
Step3 : while (Task!=null)
Step4 :{Action [i]→ Access(Task)
Step5 : if (Action [I]∉multi-granularity-resource)
Step6 :{xml[i].Func→getF(Action [I])
Step7 : xml[i].QoS→getQ (Action [I])
Step8 : xml[i].W→getW(Action [I])
Step9 : xml[i].req_ id→Task _id+user _id;}
Step 10 : else step 11: getreq (UserString ); step 12 : xml _read( xml[i]);
Step 13: i++; step 14 :Task→substr(Task,".",i)}
```

EXPERIMENT

Based on the multi-granularity resource application framework in Fig. 3, one prototype system is implemented by tools of Protégé3.1, Myeclipse6.5, MySQL, JDK6.0 and so on, in which a business process model base and business processes register are initially created and some functions such as user tasks customization and demands achievement are implemented.

To compare the method of request acquirement through task customization from this study with traditional task analysis method, based on the prototype system, their simulation services based on selected business process are constructed for the method of this study, which are construct by different size service according to the same proportion. However, for the traditional method, their atomic web services are constructed. A simulation evaluation index is adopt by the example.

Average query time means an average query time cost for one stochastic demand in the same service data, which is descripted as followed:

$$avt_i = \sum_{i=1}^{n} t_i / n \qquad (1)$$

where, t_i is executed time for the ith query. Table 1 presented a summary of performance of two sets of different scale datas, i.e., two sets of average query time. One set of data is based on coarse grain web service, called Data (1), the other single particle web servcie, called Data (2). To simplify example, particle size range of 3-5 activities for the selected business is done.

For each data set, the average result of 15 times example is taken. It is found that Data (1) composed of coarse grain resource can be searched by shorter time than Data (2) composed of single particle resource from Table 1, which is basically proportional to the number of activities contained in coarse grain resources. This is because a multi-granularity resource only as a single resource is searched but many single particle resource need to be searched by different activities respectively.

Table 1: Comparison of the average query time for two sets of data

Data (1)	vt (msec)	Data (2)	avt (msec)
20000	1.07	20000	3.33
40000	6.20	40000	18.47
60000	13.60	60000	40.07
80000	42.67	80000	122.13
100000	68.53	100000	208.40

Moreover, the resource scale increased, increasing the search time, which is no significant relationship on the proportion. This is because discovery algorithm adopt global search for the resource.

CONCLUSIONS

User's process tasks custom method based MGR provides personalized demand service custom for service-oriented manufacturing based on Semantic Web services. The main work and innovation of this study are as follows:

- Proposed a model of multi-granularity resource based on business process segmentation, providing a more flexible means for process customization. In the meanwhile, it provides a more flexible business outsourcing selection method for the user
- Constructed a WSMGR model and a extended OWL-S for MGR, providing the semantic basis and realization for MGR, respectively
- Based on the proposed model and application framework, preliminarily designed and realized a
- Process tasks custom prototype system is developed and task customization method is validated through the compared experiment with traditional method.

In the future, WSMGR's semantic discovery and composition are present study.

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