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PROCESS TASKS ORIENTED MULTI-GRANULARITY RESOURCES MODELLING AND APPLICATION 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 model (MGR) is proposed, which is described from three views, i.e. function, processes and the quality. Then a Web service encapsulation model of MGR is constructed and an extended OWL-S for its encapsulation realization is presented. Based on the above model, a application framework for MGR is constructed, and a service oriented demand model (SOD) of MGR is build. In order to simplify the customization of process, a method of process customization based on flow symbol string is put forward, which can provide user with customizing process tasks through business process template, and with multi-granularity manufacturing resource customization and edit of the resources constraint QoS-based. And then a demand acquisition algorithm is designed. Finally, the prototype is provided to verify the validity of the model and its algorithm.

Keywords: *Process Tasks, OWL-S, Web Service Encapsulation, Multi-Granaunilty Manufacturing Resource, Flow Symbol String ， Qos*

1. INTRODUCTION

In the service-oriented manufacturing environ_ ment, the existence of a large number of similar services will increase service selection computation overhead because they 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 demand is 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 demand. 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 Chunli et al. [1] studied collecting process segment into multi-granularity resource through log in order to improve the quality of services. MA Jianwei et al. [2] studied service combination optimization method based on coarse-granularity requirements, which organized service instance into a kind o f service set, representing a service node, and then achieved global optimization combination for these sets according to the business process. JIA Weiqiang et al. [3] proposed a dynamic clustering optimization approach for multi-granularity manufacturing cloud services, in which an analytic framework is given to organize manufacturing cloud services in the order of granularity scales through the decomposition of manufacturing needs. 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, YE Ronghua et al. [4] proposes a requirement model based on environment ontology for composition service. This model is based on the concepts — intention which is defined on one environment entity and task which is a set of

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associated intentions. Wen Junhao [5] put forward a kind of task oriented web service discovery algorithm. FU Yanling et al. [6] proposed a method of composition for process template-driven Web services by representing the business process as the abstract process template. 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 [7] 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. 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. FAN Feiya et al. [8] proposed an extended service model with additional function and quality parameters based on OWL-S. WU Jingjing et al. [9]proposed a manufacturing service construction method based on semantic ,to support the match, selection and composition of manufacturing service during the networked collaborative manufacturing process, as well as to improve the recall ratio & precision ratio of manufacturing services. WAN Qifeng et al. [10] presented a manufacturing services concept model based on semantics, which consisted of resource constitution view, basic information view, function view, quality of service view, accessing view and status view, and canonical presentation was given to describe the manufacturing services by using formal language.

These researches provided reference for semantic service modeling and service package of resources, but did not involve on multi-granularity resource semantic service modeling.

In view of the above problems, this paper 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 manufac_ turing 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. Section 6 gives a conclusion, and section 7 acknowledgements.

2. MULTI GRANULARITY RESOURCE 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:

(1) It is a process resource of a business process of a manufacturing enterprise;

(2) It is a process resource of fixed business processes of alliance, which has relatively fixed business, closely process resource, often the advantage of process.

Definition 2. Web service encapsulation model of multi granularity resource (WSMGR): 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, WSi).Where Base describes MGR's base information, including owned enterprise, name(ie. 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 paper, only these four kinds of attributes are selected).

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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.

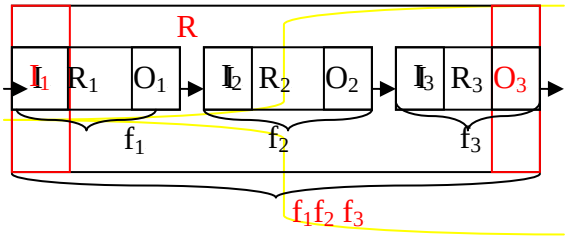

Fig.1 Sequence Flow Fragment

3. BASED ON THE EXTENDED OWL-S MULTI-GRANULARITY RESOURCE ENCAPSULATION

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 unders_ tandable, 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 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 paper, called MGRWSO. 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.

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

(1) ServiceProfile

According to above model, this part includes MGR's overall Base, overall QoS, and overall Func information and so on. For the MGR, its MGRWSO's ServiceProfile contents are as follows:(R,Q,(I1,O3)),where R is overall Base, Q is overall QoS,(I1,O3) is overall Func.

In addition, WS1, WS2, WS3 has each Service_ Profile respectively.

(2) ServiceModel

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>

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</process:CompositeProcess>

(3) 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.

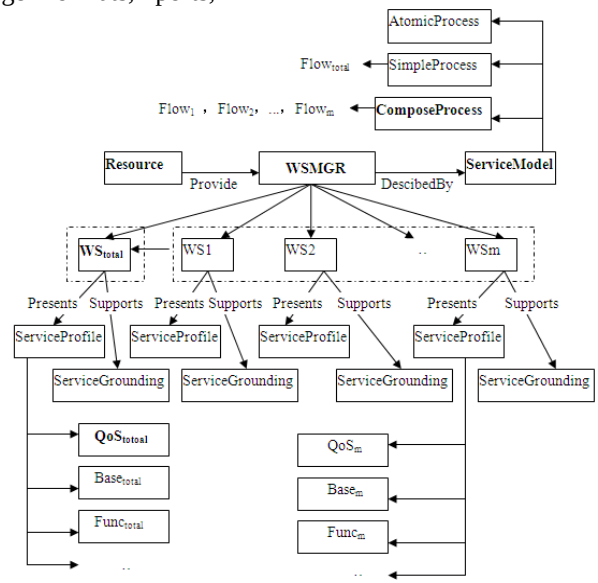

Fig.2 Multi Granularity Resource Web Service Ontology Based On Extended OWL-S

4. PROCESS TASKS CUSTOMIZATION

4.1 Process Tasks Oriented Multi- Granu_ Larity 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.

(1)Resource level: It provides all manufac_ turing resources, including software resource, equipment resource, and intelligence resource and so on. It provides material base for upper level service.

(2)Service level: It is responsible for the lower resource 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.

(3)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.

4.2 Process Of Process Customization

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 paper.

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 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.

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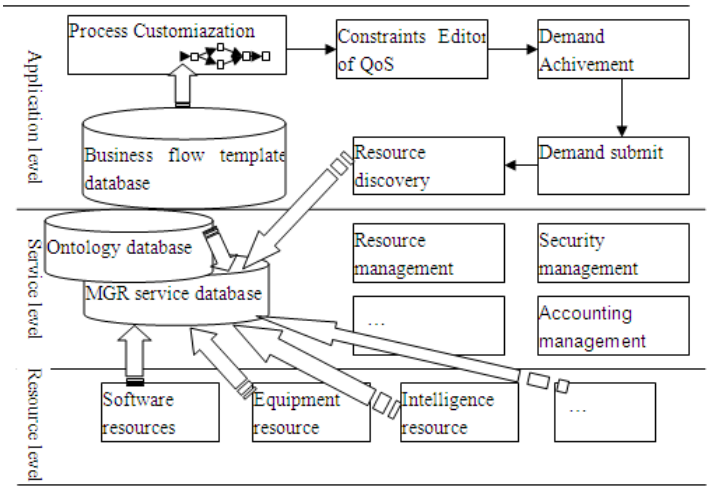

Fig.3 Process Demand Customization Framework

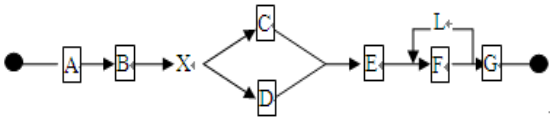

Fig.4 Process Instance

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:

(1) 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.

(2) User selects segment of the business process according to his o her own needs.

(3) 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.

(4) 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.

(5) The custom procedure string is submitted to achieve resources demand.

4.3 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, [WSi], 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, [WSi] is the ith service contained in SWSMGR, which can be atomic activity or multi-granaulity activity and be expressed as WSi=(Type, Func, Proc, QoS), W set of user preference degree of all QoS factors, Wi weight of the ith factor and .In general, the service quality factor values of the same process node from different users will be inconsistent.

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4.4 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 paper. The algorithm pseudo

getreq(*UserString*)

*step*1 : *xml*[] : *XML*

*step*2 : *Task* ← *UserString*;

*step*3 : *while*(*Task*!= *null*)

*step*4 : {*Action*[*i*] ← *Access*(*Task*);

*step*5 : *if* (*Action*[*i*] ∉ *multi* – *granularity* – *resource*)

*step*6 : {*xml*[*i*].*Func* ← *getF*(*Action*[*i*]);

*step*7 : *xml*[*i*].*QoS* ← *getQ*(*Action*[*i*]);

*step*8 : *xml*[*i*].*W* ← *getW*(*Action*[*i*]);

*step*9 : *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*)}

code is described as below.

5. IMPLEMENTATION OF PROTOTYPE SYSTEM

Based on process demand customization framework in Fg.4, one prototype system is imple_ mented 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 custom and demands achievement are implemented. The prototype system has been obtained preliminary application in one enterprise.

5.1Design Of Business Process Template Library And Resource Library

On business process template library, in order to unify the different enterprise resources, according to the general structure of the manufacturing enterprise, business processes are classification organized and standardized by department, and relate resources which are accessed from resource registry library(viewed in Fig.5). After planning organization, the following data tables are preliminary designed for business process template library.: Sector classification table, Production department flow table, Sales department flow table, Planning department flow table, and Human department flow table. Business process resources registry library classically register resources information based on WSMGR, and denote semantic Ontology information for resources based on Ontology library, which includes tables as followed: Production department activities table, Sales department activities table, Planning department activities table, Human department activities table and so on. The following examples are given for HR Tables 1, 2, 3.

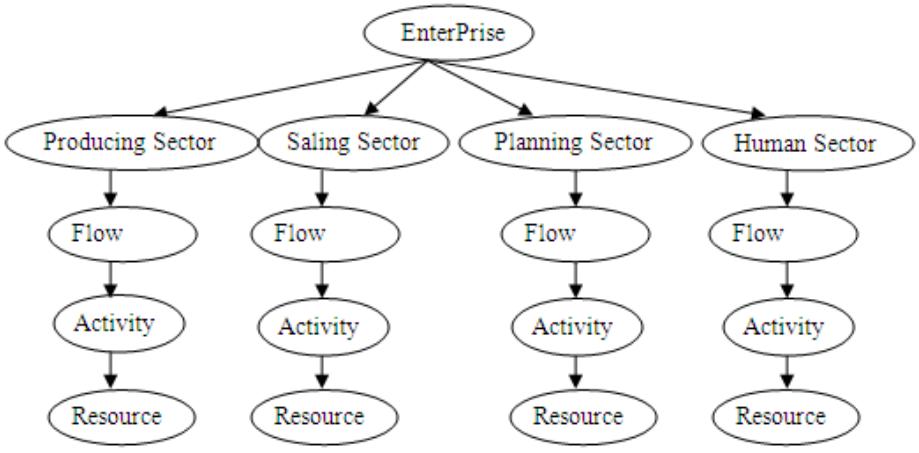

Fig.5 Resource Organization Architecture Of Enterprise Business Resources

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Tab.1 Sector Classification Table

Sector	Sector name	Remarks
01	Production Department	-
02	Sales Department	-
03	planning Department	-
04	human Department	-

Tab.2 Business Flow Table Of Human Sector

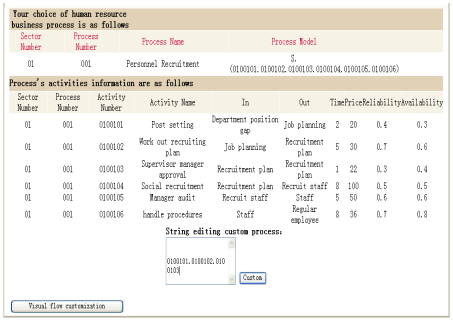
Sector No.	Flow No.	Flow Nmae	Flow Model	Remarks
01	001	Staff recruitment	C（01.P（02.03））04. 05. 06	-
01	002	Employee turnover	01.P(02. 03)C(04. 05.06).07. 08. 09	-
01	003	Personnel training	01. 02. 03.X（04C（05. 03. 04））. 06	-
01	004	Performance management	C（P（01. 02）.03）.04.05. 06. 07.P（08. 09） 10	-

Tab.3 Activity Table Of Human Sector

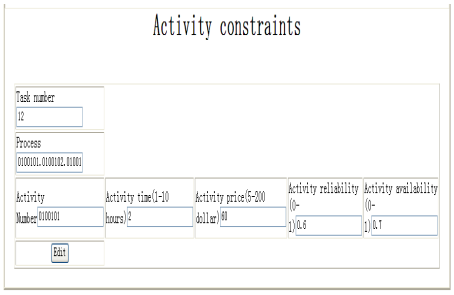
Flow No.	Activity No	In	Out	Remarks
001	06	Employer,employee,paper	Result(passor fail)	-
002	01	Termination application	Approval	-
003	04	Paper, employees, employer	Result(passor fail)	-
004	01	data	collection	-
…	…	…		…

5.2 Function Design And Realization

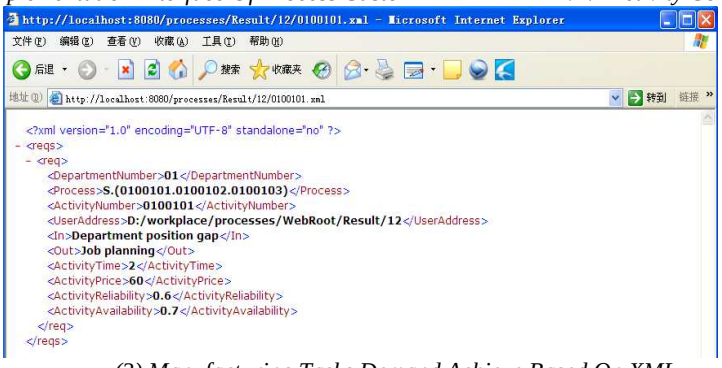
Based on the above framework and model, the flow customization system is preliminarily designed, and based on the business process model library the task customization function is implemented. In Fig.6, (1) is the main interface of the system, （2） is process customization implementation effect chart,(3) is chart further editing QoS to the various activities of the customization process, (4) is the final achieved user needs based on XML file.



(1)Implementation Interface Of Process Custom



（2）Activity Constraints Edit



(3) Manufacturing Tasks Demand Achieve Based On XML

Fig.6 Process Tasks Custom

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6. CONCLUSION

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 paper are as follows:

(1)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.

(2) Constructed a WSMGR model and a extended OWL-S for MGR, providing the semantic basis and realization for MGR,respectively.

(3) Based on the proposed model and application framework, preliminarily designed and realized a process tasks custom prototype system, obtained final demand results by process customized task.

In the future, WSMGR's semantic discovery and composition are our work.

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