Extended Service Modelling Language for Enterprise Network Integration

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Abstract. With the development of globalization and information technology, service oriented technologies and enterprise networks are arising quickly. Supply chain management, virtual enterprise, dynamic alliance, e-business and so forth are leading intra enterprise management and networked enterprise management to the enterprise networks management and integration. At the same time, Service Oriented Architecture (SOA) triggers series of servicization progresses in enterprise management, inter enterprise cooperation, manufacturing process, as well as IT related infrastructures. CEN/TC 310/WG 1 is developing the Service Modelling Language (SML) for Virtual Manufacturing Enterprises (VMEs). Based on Model Driven Architecture, SML tries to specify the Business Service Modelling (BSM) level of the Model Driven Service Engineering Architecture (MDSEA). In the paper, MDSEA and SML are extended for enterprise networks integration. A three levels modelling framework including business process modelling, service process modelling and operation process modelling are introduced. The Collaboration Point (CP) concept is developed to describe cooperation mechanism between enterprises so as to overcome the process and data fragmentation caused by enterprise organizational boundaries. The model mapping method among the three levels are also presented in the paper.

Keywords: Service · Modelling · Enterprise network · Integration

1 Introduction

With the development of globalization and information technology, service oriented technologies and enterprise networks are arising quickly. With the development of big data, internet of things and cloud computing, the two trends are changing the features of manufacturing:

- Supply chain management, virtual enterprise, dynamic alliance, e-business and so forth are leading intra enterprise management and networked enterprise management to the enterprise networks management and integration;
- At the same time, Service Oriented Architecture (SOA) triggers series of servicization progresses in enterprise management, inter enterprise cooperation, manufacturing process, as well as IT related infrastructures.

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In order to overcome the complexity of enterprise network integration, CEN/TC 310/WG 1 is developing the Service Modelling Language (SML) for Virtual Manufacturing Enterprises (VMEs). Based on Model Driven Architecture, SML tries to specify the Business Service Modelling (BSM) level of the Model Driven Service Engineering Architecture (MDSEA) [1].

In order to answer all requirements of enterprise network integration from business modelling, analysis and design to integrated distributed manufacturing system deployment and implementation, the original SML shall be extended.

In the paper, MDSEA and SML are extended for enterprise networks integration. A three levels modelling framework including business process modelling, service process modelling and operation process modelling are introduced. The Collaboration Point (CP) concept is developed to describe cooperation mechanism between enterprises so as to overcome the process and data fragmentation caused by enterprise organizational boundaries. The model mapping method between the three levels are also presented in the paper.

2 State of Art

Enterprise modelling methods have been developed for a long time. There are several modelling methods that have been applied widely in system integration projects. KBSI developed IDEF0 and IDEF3 methods to describe the relations among functional activities and business processes [2,3]. IDS-Scheer developed ARIS™ and Event Process Chain (EPC) to describe business processes with the related enterprise information, resources, organization and products [4]. UML is widely used as computer aided software engineering tools [5]. DFD is a traditional method to program operation processes [6].

In order to use models in system operation stage and reduce the complexity of system implementation and system adjustment, some enabling methods are developed: Workflow and related technology, BPMN/BPML (Business Process Modelling Notation / Business Process Modelling Language) for business process management [7], PSL (Process Specification Language) for process model information transformation [8], BPEL (Business Process Execution Language) for Web service application [9]. BPEL is developed to orchestrate services and deploy the solution as a Web service.

In order to present a systematic framework to support enterprise modelling based systems engineering, series of system architectures are developed. Zachman Framework, ARIS, CIMOSA, PERA and GERAM are the widely accepted some. Model Driven Architecture (MDA) describes a methodology to design and develop a software system step by step based on modelling and model mapping. Based on MDA, MDSEA presents a three levels modelling framework: business service modelling, technology independent modelling and technology dependent modelling [1].

In the “Service Modelling Language Technical Specification” developed by CEN/TC 310/WG 1, business service modelling (BSM) level modelling constructs and relationships are defined, some templates are also developed in the specification. However, the specification does not define the bottom two levels modelling methods, and it does not discuss how to map models from one level to another one. Therefore it is necessary to extend relative methods to present a total solution to model based enterprise network integration.

3 Service Oriented Modelling Framework for Enterprise Networks Integration

In the authors' research, the MDSEA is extended as the process modelling architecture depicted in Fig.1. The levels depict business process modelling across partner companies, service process modelling in every collaboration point, and operation process modelling (orchestration modelling) for service implementation [10,11].

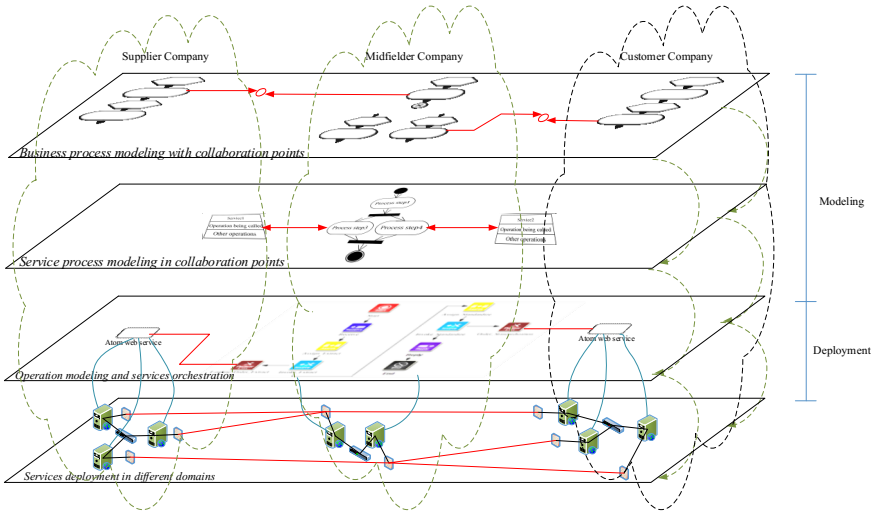


Fig. 1. Process model-driven mechanism of extended MDESA

(1) Business process modelling presents a model for operating businesses. Based on the model, analysts can identify collaboration points (CPs) that are shared by a company and its partner companies, so as to reduce modification of original business processes and information systems (ISs).

(2) Service process modelling depicts detailed operations in a CP. It distinguishes web services located in outside ISs and intra-ISs and designs a flow to integrate these web services together.

(3) Service orchestration transfers service process models to a BPEL-based operation model so that codes can be generated.

UML (unified modelling language) is the core modelling language of MDA. It presents a set of modelling languages for object-oriented programming. It is a computer aided software engineering tool. However, there is still a gap between the business model and software model in the MDA. UML is not suitable for business modelling, and it cannot be run directly. Currently, no modelling language can satisfy the requirements from business logic to computing logic. Therefore the extended MDSEA includes three-layer models: an extended event-driven process chain, UML and BPEL.

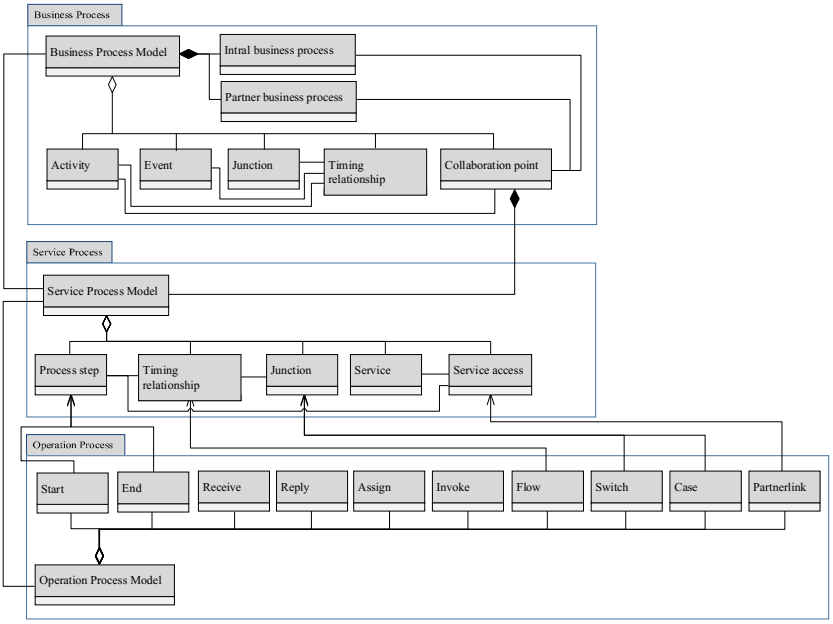


Fig. 2. Meta model of the three levels process modelling

To describe and design business logics among intra-enterprise ISs and their partners, an extended process modelling technique which is based on the concept of collaboration point (CP) is developed [11,12,13,14]. CP is located on the boundary of various computing environments. It presents the interface for process interoperations to cross over different computing environments as shown in Fig.1. The interface can support data exchange, command transferring, and monitoring.

Inside a CP, there is a complex operating logic that needs to be modelled and analyzed. CPs are realized as a set of web services, their operation/service modelling method is based on several common graphic symbols in UML. Detailed texts can be supplements besides the graphic language [11].

BPEL is a web service orchestration language. It presents sophisticated concepts and methods to link web services together and offer a complex function. Based on the concepts of BPEL, a service process can be transferred to a service orchestration model.

The meta-model of extended MDSEA process modelling is shown in Fig.2, in which constructs and their relationships are depicted. To simplify the meta-model, notations' relationships of operation process modelling are not shown in Fig.2. Their syntax and semantic rules can be found in BPEL technical documents [8,9].

4 Business Process Modelling Language for Enterprise Networks Integration

In enterprise network environments, an enterprise has business processes within its boundary. Some of these processes may interoperate with business processes of its

partners in enterprise networks. Therefore, it is necessary to develop a mechanism to define the associations between different scenarios.

Collaboration Point is located on the boundary of scenarios that presents the interface for processes interoperation cross over different scenarios as shown in Fig. 3. The interface can support data exchange, command transferring, monitoring and so forth. It can be realized as a web service invoking interface, an agent or a broker.

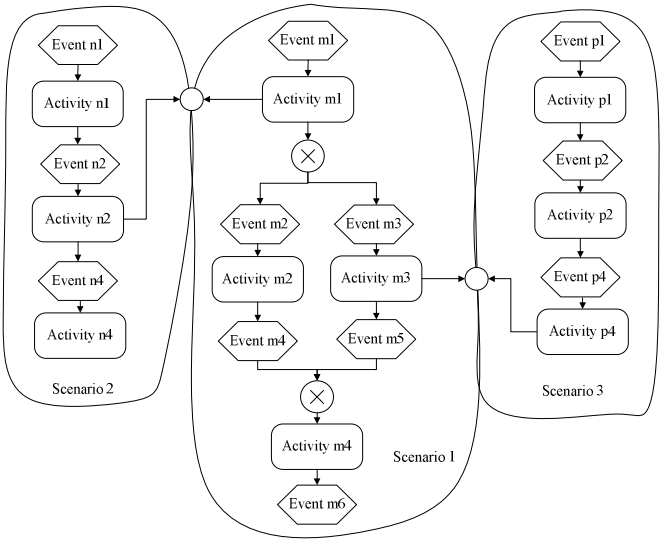


Fig. 3. Collaboration points between scenarios

In enterprise network environments, it is hard to design intra business processes with partner enterprises processes jointly. Few of partner enterprises will customize their service logic to satisfy a single enterprise's requirement. It is also very difficult to adjust the enterprise's business processes and ISs. Therefore, CPs will combine processes in different scenarios and minimize modifications of these processes.

While integrating cross scenarios processes, in order to keep integrity of business logics, the CP is not a simple API access or web services invoking. CPs include complex operating logics to complete a series of operations. These operations, including cross scenarios accesses, could be encapsulated as web services. Based on the APIs library of cross scenarios, through services encapsulation of APIs, services development and orchestration, the orchestrated process service will realize the function of a CP.

5 Service Process Modelling in Collaboration Point

Inside a CP, there is a complex operating logic which needs to be modelled and analyzed. Because CPs are realized as web services, its operation/service modelling method is based on several common graphical symbols in UML. Detailed texts can be supplements besides graphical language. The major model elements and model expressions list as follows [11]:

(1) Use UML Class Diagram to express services, as shown in Fig.4. Service names and operations are marked respectively in the Class Diagram. Service names need to be nouns or gerunds, such as “order service”, “order information enquiry service”. General names for operations are verb phrases, such as “enquire order information”.

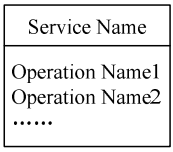


Fig. 4. Single service

(2) UML Collaboration Diagram expresses the relationship between services and service users, as shown in Fig.5. Services and service users are connected by double arrowed solid lines, showing the interactive relationship between them. If the service includes a number of operations, then the operation called by users is isolated from other operations. Receiving and sending messages are noted above and below the lines and the arrows indicate the direction of the transmission of information.

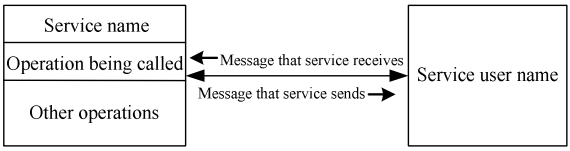


Fig. 5. Interactive relation between services and service users

(3) Combining the ideas of UML Activity Diagram and Collaboration Diagram, we express the interactive relationship between process services and their member services, as shown in Fig.6. The relationship diagram of services and service users is a basic form. The process service acts as the public service user of all the member services, and it calls the operation in a certain member service in a specific process step,

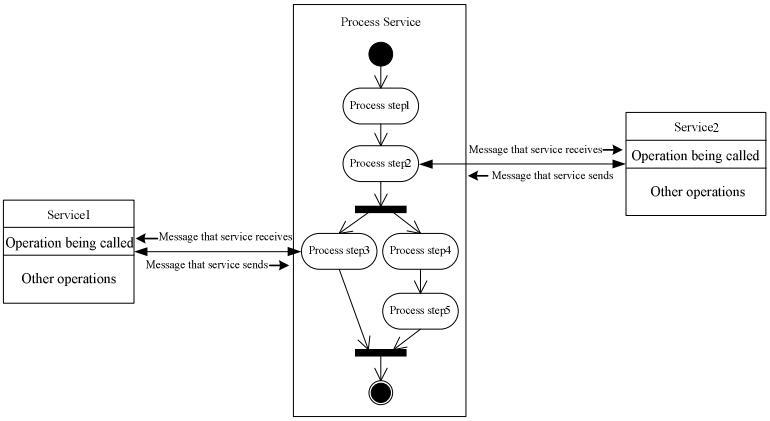


Fig. 6. Interactive relationship between process services and their member services

in other words, the operation in a member service achieves a specific process step. To express the relationship clearly, we draw the business process model by using UML Active Diagram and connect services and corresponding process steps with arrowed solid lines, showing that the process steps are achieved by this service operation.

6 Operation Process Modelling and Model Mapping Method

Operation/service model describe the operating logic in a CP. In order to implement the model, based on principles of MDA, the service process model shall be mapped to a run-time model and then transferred to run-time codes.

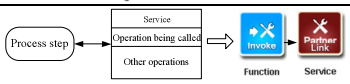
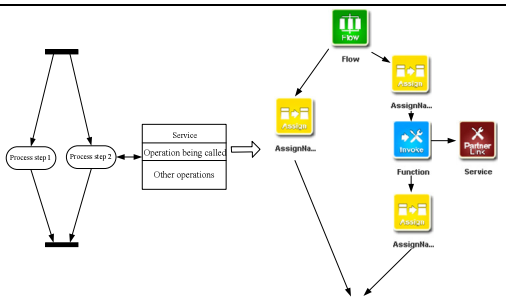
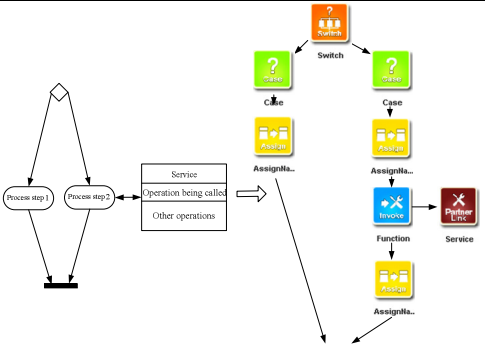
BPEL is a web service orchestration language. It presents a serious concepts and methods to link web services together and offers a complex function. Based on the concepts of BPEL, we developed a new service orchestration notations and language. Deferent from BPEL, the graphic description of services orchestration is mapped directly to Java codes and then deployed as standard web service. The notations of the orchestration language and related illustration are shown in Tab. 1.

Table 1. Notations of service orchestration method

Activity	Icon	Function
Start		Represent the beginning of a orchestration service process
End		Represent the end of a orchestration service process
Receive		Do a blocking wait for a matching message to arrive
Reply		Send a message in reply to a message that was received through a <receive>.
Assign		Update the values of variables with new data.
Invoke		Invoke a web service.
ParnterLink		Represent a called web service
Flow		Specify one or more activities to be performed concurrently.
Switch		Select exactly one branch of activity from a set of choices.
Case		Condition that one branch could run

Based on above concepts, a service process shown in Fig. 6 can be transferred to a service orchestration model, as shown in Tab. 2.

Table 2. Transformation from service processes cross over scenarios to services orchestration model

Semantic Transformation	Notation Replacement	Note
Process step		Process step is mapped to Assign
Service access		Collaboration point means there is an interface between two business processes. It can be replaced by an Invoke action with a Partner-Link which represents service access.
AND Junction		The couple of AND junctions can be transferred to a program sequence started with Flow.
XOR Junction		The couple of AND junctions can be transferred to a program sequence started with Switch and Cases.

Similar to the service orchestration, the business logic/flow editor can link services encapsulated from different applications in different ISs to form a complete automatic flow for a business process.

7 Cases Studying

The authors' research team implemented the modelling architecture and methodology in several projects. Detailed technologic discussion can be found in the authors' published papers.

In the reference [10], the modelling architecture with relative integrating platform is implemented in a grain trade e-marketplace construction project. In the same paper, a call centre information/service convergence project is also discussed.

The methodology is also used to solve problems of multi public cloud services integration [13,14].

8 Summary and Conclusion

In order to model inter processes collaborations among intra ISs and partner enterprises' ISs, the extended MDSEA for enterprise network integration has three modelling levels: business process modelling cross multiple scenarios with CPs, service process modelling within a CP, and services orchestration / operation process modelling to implement the CP.

Business process modelling presents a view to understand how the business system operated. Based on the model, analysts can find out CPs between the enterprise and its cloud vendors, so as to reduce modification of these business processes.

Operating/service logic modelling presents a view to understand how the CP can realize processes integration across public clouds and intra ISs, with which web services are distinguished and identified, and the flow logic among web services is also decided.

Based on the three levels modelling architecture, cross scenarios process integration principle is linked with its software realization.

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