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Model Transformation of Collaborative Business Process into Mediation Information System

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Abstract: Partner information systems (IS) must interact to efficiently support collaboration in an enterprise network. One way to reach this goal is to promote IS interoperability. Assuming a service oriented approach of the software architecture of each individual IS, the use of a mediation IS is described to bind the services of individual IS systems. The knowledge captured in collaborative process models expressed in Business Process Modelling Notation (BPMN) is considered as a basis of collaboration requirements. Therefore, it will be the prime material used in order to build an UML model of the mediation system. Transformation language mechanisms that support the resolution phase of this particular problem are explained.

Keywords: Collaborative information system, mediation, interoperability, model transformation, process model.

1. INTRODUCTION

From a well defined and perfectly shared environment into which companies were searching to enforce their leading positions, the economic and industrial reality is evolving towards a dynamic, chaotic behaviour with an ever changing context where companies have to adapt regularly their strategy and partnership. In such an environment, flexibility is largely recognised as necessary, if not mandatory. If the price to pay for flexibility is not negligible, once achieved, flexibility could reveal as a determinant factor to catch new opportunities for a company (to grow on new markets, or to make new products, for example). Since a long time, quest for more flexibility is a strategic goal for modern managers. However, a new characteristic appears in the last decade, what was addressed as an inside company problem has extended beyond the initial perimeter to become a network defined problem including many partners. The ability to work with other organisations is now estimated as one of the most important challenges that companies, and especially SMEs, have to face with.

Directly influenced by this contextual evolution, collaboration between enterprises is a challenge which can be resumed by those words : "far away, faster, stronger"

- Far away : connecting costumers, partners or suppliers is now a worldwide activity,
- Faster : volatile and opportunist alliances substitute to old and regular cooperation
- Stronger : collaboration seems to be very intensive because exchanges and work sharing are emphasized (data, information, software, services, business processes etc.).

Enterprise networking and integration has to be taught differently in this tricky context. Integration of well defined organisation components, we mean components that are easily connectable and provide the expected functionalities, is a fair solution. For each enterprise component, an appropriate information system is a part that contributes to satisfy the integration requirements on efficient communications and high added value business services. This is the purpose of our subject to define how this part of each component interact with others in a collaborative information system used at the network activity level.

1. MEDIATION FOR INTEROPERABILITY

2.1 Conceptual aspects

Interoperability can be defined as "the ability of a system or a product to work with other systems or products without special effort from the customer or user" (Konstantas *et al*., 2005). It is a possibility to realise an integration, not the only one (Vernadat, 2006), but it promotes the idea that integration has to be prepared using standards, reference frameworks or architectures so that the act to connect others looks like a "plug and play" action.

Our aim is to develop the ability to interoperate in a pertinent manner, to enable a transition from an insulation of partners (which try to compensate their lack by an open information system) to a feasible integration of their information systems into an ad-hoc system of systems. Other experiments have been made on the same type of problems. (Grangel, *et al*., 2006) have created the concept of Model Driven Interoperability to cover the needs of connecting enterprise components with minimal effort by their information systems. We have many assumptions in common with this work, and even if the choices of model languages is different, the approaches to solve the problem are quite similar.

An information system is a system that process information. Data flows are orchestrated by business processes and launched by related process orders. Applications are resources that are providing the services to perform the information processing. The first part of figure 1 is an illustration of such a system replicated on three enterprise components. However, at the network level, relations between these three entities may be more complicated to define and to control than at the individual level. As proposed in (Bénaben *et al.*, 2006) , putting information system interoperability into practice in an heterogeneous environment requires an intermediate system, called mediation information system (MeIS) which provides three services (Aubert, *et al*, 2002):

- Data management
- Application management
- Collaborative process control and monitoring

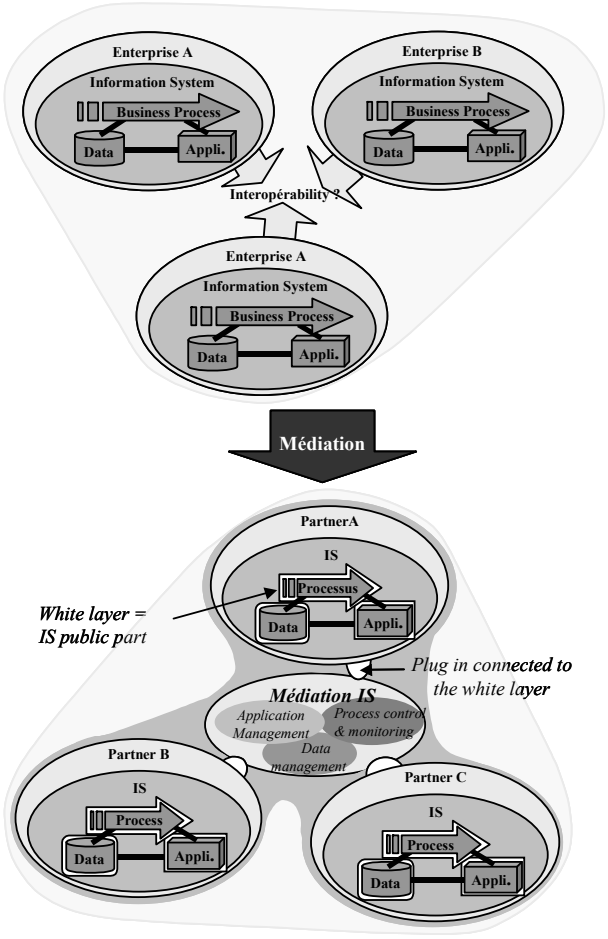

Fig. 1. The concept of mediation information system as an intermediate between IS of partner

The proposed MeIS will be considered as an agent that helps in federating partners into a whole.

In order to address the problem of the MeIS logical architecture, the assumption that each partner IS is based on a service oriented architecture (SOA) is formulated. Each partner is able to publish in its public part the services that are implied in the execution of collaborative processes. Each of the three centralised functions introduced in the conceptual definition of the MeIS given above can therefore be implemented in the following terms :

- An ontology based knowledge management of data
- A partner's service registry
- A workflow management system to support collaborative process executions

Furthermore, a set of specific MeIS services will be added to complete the system architecture. They are related to communication QoS (security, tracability,..) or to more added value contributions shared by all partners (like specific information tracking or dissemination, for example).
Starting from this high level definition of the MeIS, collaboration is designed and developed at the business level in three steps :

- Partners find a deal on how they will coordinate their actions. The result is formalised in a process model that will explicitly show their coordination
- Each partner defines its own profile corresponding to the data and services he will provide and deliver during collaboration, following the specifications of the process model
- Partners under the supervision of the entity responsible for the mediation define the specific services that should be added to complete the collaboration design

2.2 MDA approach of MeIS design

Having defined the business network dynamics and how the logical part of the MeIS could be structured, the interest is focused on the MeIS specification. A UML model of the logical part of the MeIS is chosen as a target specification. Then, the problem is formulated as a transformation of the business collaborative process model onto a predefined archetype of the UML model following well known Model Driven Architecture (MDA) principles (OMG, 2003).

Two main aspects are essential in the engineering principles promoted by MDA:

- Use of different models at each abstraction levels : from conceptual (CIM for Computer Independent Model) to logical (PIM for Platform Independent Model, and PM for Platform Model), and from logical to physical layers (PSM for Platform Specific Model). The models are in closed connections and passing from one layer to another one must be facilitated by transformation tools
- Separation of concerns by splitting implementation choices from specifications of business needs (Business track). Technology is defined by the choice of the implementation platform in a generic way (Technical track). By the way, the ultimate solution is a mix of information coming from these two tracks that are processed in order to produce the PSM.

The Y symbol is frequently used to summarise those principles, as shown in figure 3. In the following, we only consider the business track and will explain the transition

from the CIM layer to the PIM layer, called a vertical transformation in MDA vocabulary. The CIM is the collaborative process model written in Business Process Modelling Notation (BPMN) language. The BPMN formalism aims to support process management for technical and business stakeholders by providing a graphical notation that is rather intuitive, and able to represent complex process semantics.

A simple example of a collaborative process is proposed in Fig. 2. The mediation takes place between a customer and a supplier for a trading transaction. At a first glance, the two pools of partner, and the middle MeIS pool are visible. Message flows are the only arrows that cross the border of a pool. The coordination is therefore explained by the realisation of those communications.

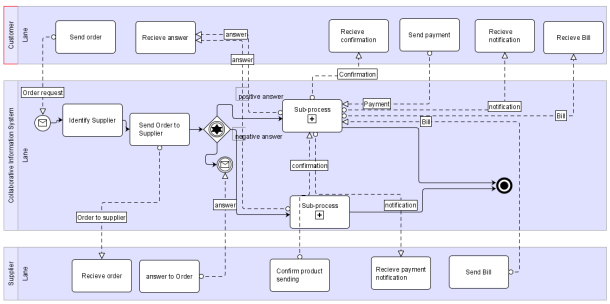

Fig. 2. A BPMN collaborative process model

The PIM is a logical model, i.e links between software components, of the mediation information system using the assumption of the service oriented architecture. For the elaboration of this model, UML is a largely recommended language.

It is an important question to know if the model transformation performed will give enough information to specify the MeIS. A BPMN model is a process centric view of the system. By comparison with the four points of view of the ISO 19440 standard, a BPMN model covers mainly the functional view, and partially the information and the organisational views. The result is that the transformation will not completely provide all information needed by the MIS model. A deficit on the data structure is evident, because the concept of message flows in BPMN is not well supported by data models. Those data models have to be studied in parallel to the transformation of process models. Considering the resource view of ISO 19440, services are software resources supposed to be qualified and available. By consequence, a major part of the specification seems to be provided by the transformation of BPMN collaborative models under the set of assumptions made.

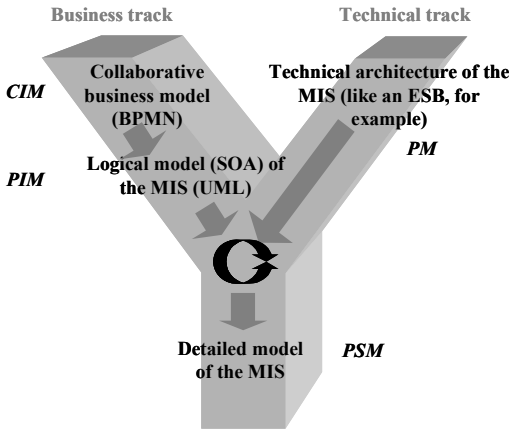

Fig. 3. MDA process engineering principles

1.1. Model transformation

We briefly remind the role that mappings assume in a model transformation. When performing a model transformation from a model A to a model B, a mapping of both meta-models A and B has to be performed. The elements included in the meta models have to be put in correspondence so that transformation rules could be defined (InterOp NoE deliverable TG 5.2, MoMo).

The first meta model is the collaborative process meta model. The language BPMN is used with a systematic approach into which pools of partner and CIS pool form a matrix of containers showing the coordinated entities. The main language components appears on the class diagram of Fig.4. There is a mix of basic language elements (like gateway, events, message flow,…) and specialised components (like pools or tasks that explicitly refer to collaboration entities).

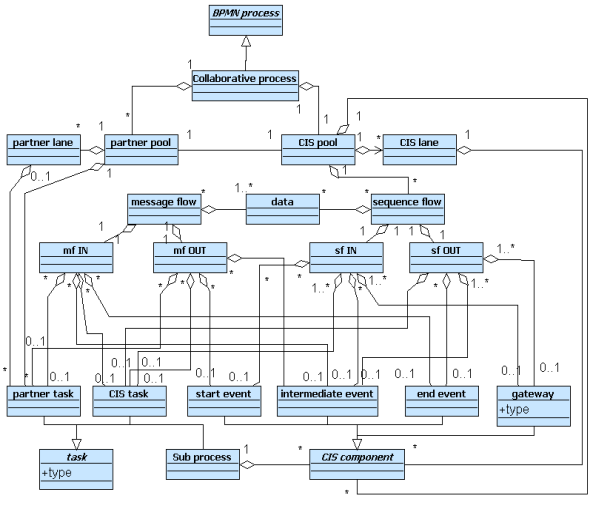

Fig. 4. Collaborative process meta model (source meta model)

The MeIS meta model described in Fig. 5 is closed to the PIM4SOA model (Benguria *et al.*, 06). Three packages are

proposed corresponding to three views of the final result on the business track :

- Services view : services that are used in the collaboration are described, they are business reachable computing functionalities with a known location on the communication network
- Information view : data are exchanged by messages between services, they are defined here in their structure by a data model, and also as a communication utility by identification of the emission and reception services
- Process view : interaction amongst services and coordination aspects are specified by the control of processes described here

The source and target meta model of the transformation function are further detailed and justified in (Touzi, b, 2007). It is not possible to explain here, due to limited space constraints, the objects and the relations that rely them in each meta model. However, we hope that the following dedicated to the mappings of those meta models that lead to the transformation rules will give some lights about the equivalences that are used.

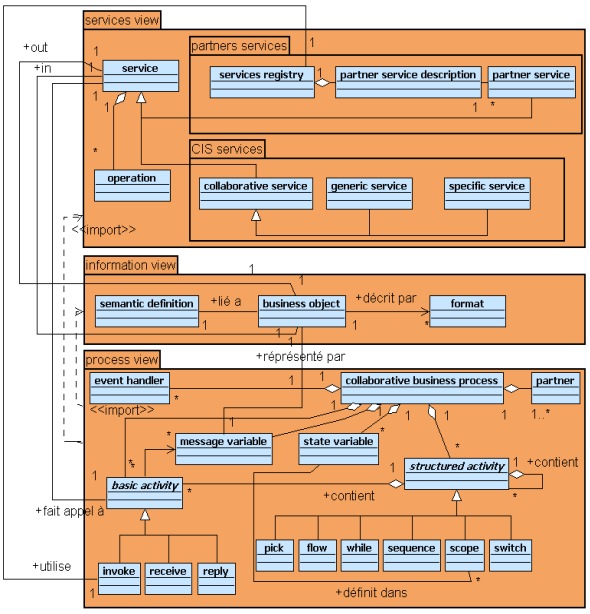

Fig. 5. Meta model of the SOA based MeIS (target meta model)

1.2. Transformation rules

Transformation rules are classified in two categories :

1. basic generation rules are used in a first time to create elements of the target model. Most of these rules are defined by a direct mapping between meta model elements.
2. binding rules are applied in a second time to draw the links between the elements resulting from the previous phase. Existing relations in the source model are transformed into relations in the target model.

2.4.1- Generation rules

Fig. 6, Fig.7 and Fig.8 try to summarise the set of rules (also called derivation laws) that are applied during transformation. The rules are represented by circles located in the middle of two class diagrams. The class diagrams are subgraphs which are parts of the primitive meta models. On the left part of each figure is the subgraph of the source meta model, and on the right part is the subgraph of the target meta model. The rules have to interpreted in the following manner : "When an object is identified in the collaborative process model, it belongs to meta model class of the left side subgraph linked to the rule. Then, it will be transformed in an object instantiated from the class of right side of the figure. We mean that it will become an object in the mediation information system of the network".

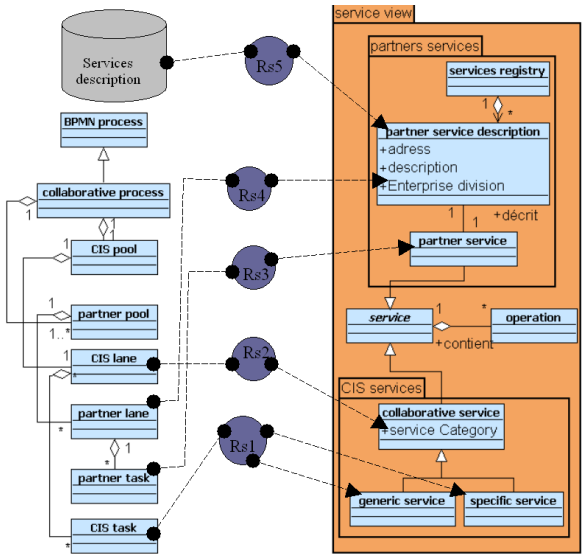

Fig. 6. Localisation of transformation rules for basic generation of the service view

The service view of the MeIS model is represented in Fig 6. On the left part, the pool and lane classes are mapped on the different entities services of the right part (partners or CIS services). Rs1 rule gives the links from tasks in the collaborative process model to services listed in the registries, either specific or generic ones. It can happens that many solutions are possible to select a service, in this case an annotation is put on the task of the process model to solve the conflict. Rs2 to Rs5 rules provide solutions for the structure and organisation of services

With the same logic, Fig 7. introduced two transformation rules applied for the information view. As indicated before, the transformation is not sufficiently developed in this domain. Transformation provides syntactic indications that helps to create business objects (Rules Ri1 and part of Ri2). However, the problem of translation refers to semantic interpretation that we do not include in this part of the study (Remaining part of Ri2 is probably not a robust solution).

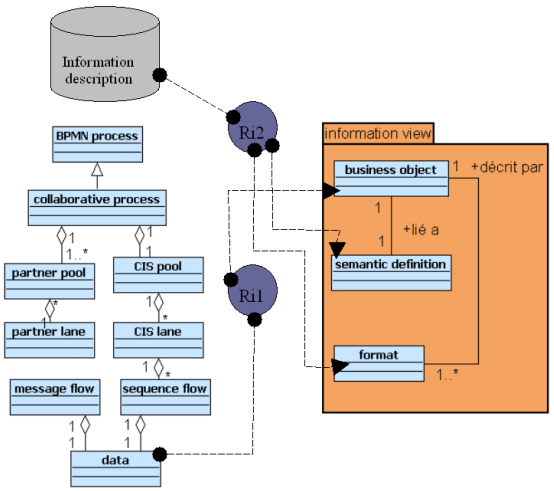

Fig. 7. Localisation of transformation rules for basic generation of the information view

In contrast, Fig 8. is the most developed part of the transformation procedure with nine rules. The "process view" package has been designed using specifications of the BPEL meta model language. BPEL is one of the most popular candidate for specification of web services process execution. Some of the rules in Fig. 8 are adaptations of recommendations provided by BPMI when they address the problem of BPMN graph conversion to BPEL well defined XML sentences (BPMI, 04), (Ouyang *et al.*, 06). It concerns rules Rp3 to Rp6, and rules Rp8 to Rp9. Rules Rp1, Rp2 and Rp7 participate to the definition of coordination activites.

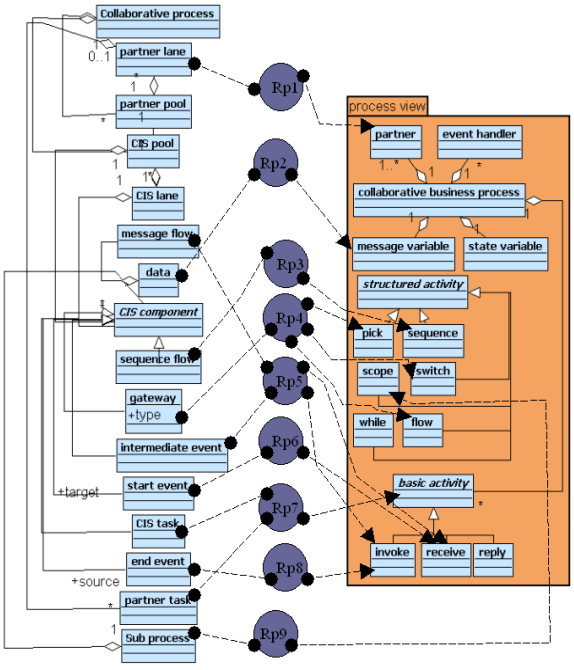

Fig. 8. Localisation of transformation rules for basic generation of the process view

2.4.2 Binding rules

The binding rules can be used to build the interactions between the elements of the MeIS model coming from the generation rules appliance. The links could be inside a MeIS package or between two different packages (dependence). The goal is to define in the target model the necessary relations that exist in the source model. The relations may be of different types like inheritance, composition aggregation or simple association. Three binding rules Rb1 to Rb3 are given in the following as an exemple.

Rb1 : sequence ordering

A *sequence* element issued from Rp3 rule is associated with two basic activities into the same process package.

Rb2 : information processing

A *service* from service package is related to a *business object* of the information package.

Rb3 : service identification

A *basic activity* of the process package is linked to a *service* of the service package.

3. CONCLUSIONS AND PERSPECTIVES

A prototype of transformation tool has been developed from this theory. It is based on three open source tools that run in the IDE **Eclipse©** platform. **Intalio designer©** is a BPM tool that helps user to specify the BPMN model. The **Atlas Transformation Language** (ATL)© can use a process model in the XML format coming from the BPM tool in input, and produce the UML model of the MeIS in output. Its is the heart of our transformation system. The **TOPCASED©** tool is a computer aided software environment that can perform a graphical edition of the UML model. A series of simple case studies have been defined and examined in order to begin the validation of the approach (Touzi, 07, b).

We are aware that it is relatively not frequent to have networks of organisation that are able to draw a collaborative process of their predicted common activities. In (Rajsiri *et al.*, 07), we study the contribution of a knowledge based methodology to help in the process model design. The PIM solution that we have produced has been one of the components selected in the JonES project (French project ANR/RNTL 2005). JonES main objective is to test a complete MDA approach in the frame of an Enterprise Service Bus technology (Target Platform). The solution developed is open source and has been designed by the ObjectWeb community (Petals ESB).

Lastly, in order to improve the solution, we are also involved in the **IsyCri** Project (French Project : ANR/CSOSG2006). The problem to solve in the development of interoperability between actors in a crisis context. Risk management processes are not known explicitly, and can be found or refined during operations depending on the understanding of the situation. A mediation system still serves as a strong basis for the "business" and software architectures, and the transformation tool is used in recursive engineering execution of the MDA approach.

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