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COLLABORATIVE PROCESS DEFINITION USING AN ONTOLOGY-BASED APPROACH

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This paper presents an ontology-based approach dedicated to automate the specification of collaborative processes for virtual organization networks. Our approach takes as input the knowledge coming from the characterization of network and produces as output a BPMN (Business Process Modeling Notation) compliant process. The collaborative network ontology (CNO) including deduction rules has been defined in order to accomplish this approach under two keys (i) some specific attributes of the considered collaboration included network and participant (ii) collaborative processes inspired from the enterprise Process Handbook (MIT). This CNO coupled with a reasoning engine will be used with an editor, provided by EBM WebSourcing, to model the network and build the collaborative process of a given collaboration. A model transformation will be applied after that to convert a collaborative process of the editor to a BPMN relevant one.

1. INTRODUCTION

Nowadays companies tend to open themselves to their partners and enter in one or more networks in order to have access to a broader range of market opportunities. The heterogeneities of partners, the long-term relationships and establishing mutual trust between its partners are the ideal context for the creation of collaborative networks. The interoperability is a possible way toward the facilitation of integrating networks (Konstantas et al., 2005) (Vernadat, 2006).

General collaboration issue of every company is to establish connections with their partners. Partners collaborate principally through their information system. The concept of collaborative information system (CIS) has been evolved to deal with the interoperability issues. According to (Touzi et al., 2006), this concept focuses on combining the information systems of different partners into a unique system.

Developing such a CIS concerns the transformation of a BPMN (Business Process Modeling Notation) collaborative process model into a SOA (Service Oriented Architecture) model of the CIS. This is based on the Model Driven Architecture (MDA) approach (Millet et al., 2003), as discussed in (Touzi et al., 2007). The BPMN supports the Computation Independent Model (CIM) of the MDA, while the SOA-based CIS supports the Platform Independent Model (PIM).

Hence, our research focuses on the CIM model. We assume that partners are able to express informally and partially their collaboration requirements. However, how to make these requirements more formalized and completed? The schema below shows the approach of how we answer this question:

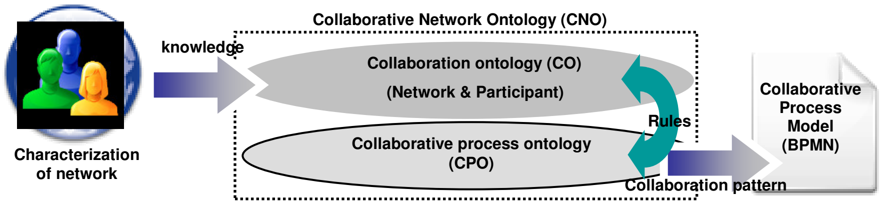

Figure 1 - Our approach for defining a BPMN

The approach has been developed on a basis of ontology and deduction. The main idea is to use ontology and deduction rules to automate the specification of collaborative processes. Thus, defining the collaborative network ontology (CNO) including the deduction rules is essential. The CNO itself consists of the collaboration ontology (CO), collaborative process ontology (CPO), and the deduction rules. The deduction rules establish the interactions between the two ontologies inside the CNO. The corresponding between the role and service concepts defined in the CO and the CPO respectively makes the deduction possible, according to (Malone et al., 2003) and (Sobah Abbas Petersen, 2005).

The approach starts at receiving the knowledge from the characterization of network, expressed by partners. The knowledge will be imported into the CO. Then the rules will be executed in order to derive new knowledge in the CPO or complete missing knowledge in the CO. Finally, the collaboration pattern matching the network will be extracted and will be transformed later into BPMN relevant process.

The paper is focused firstly on introducing the CNO and the deduction rules. Secondly, the supporting tools and a scenario will be presented. At the end, the on-going works will be discussed.

2. CNO AND DEDUCTION RULES

As we have described previously about the ontology-based approach shown in the figure 1, this section aims at introducing the main part of the approach regarding the CNO and the deduction rules.

2.1 Collaborative network ontology (CNO)

The domain of interest for developing the CNO relies on the collaborative network domain especially for designing collaborative process (Rajsiri et al., 2008).

The CNO, as shown in the figure 2, is composed of two ontologies which are (i) the collaboration ontology (CO) including network, and participant, and (ii) the collaborative process ontology (CPO). Each ontology defines the concepts, relations between concepts and properties. A knowledge base built under this ontology covers these two ontologies.

The following paragraphs will describe these two ontologies:

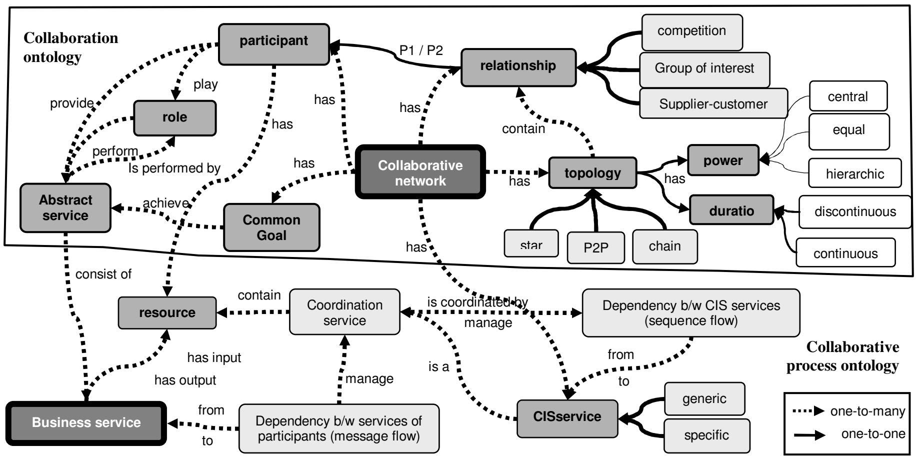

Figure 2 - CNO composing of Collaboration and Collaborative process ontologies

Collaboration ontology (CO)

The CO, as shown in the figure 2, concerns the characterization of collaborative network (e.g. common goal, relationship, topology) (Rajsiri et al., 2007) and the participant's details (e.g. role, abstract service).

A collaborative network ha1s common goals (e.g., group same products to buy together) and participants. Common goal achieves abstract services. Participants play roles (e.g., seller, buyer, producer) and provide abstract services (e.g., marketing and sale, procurement) corresponding to the roles they play. A network can have also several topologies which have duration and decision-making power characteristics and contain relationship.

Collaborative process ontology (CPO)

The CPO, as shown in the figure 2, is an extension of the concepts developed by the MIT Process Handbook project (Malone et al., 2003) and integrates the collaborative process meta-model (Touzi et al., 2007).

Business service concept explains task at functional level (e.g., obtain order, deliver products, pay against invoice). Each of them has input and output resources (e.g., machine, container, technology). Two business services will be dependent to each other when they have a common resource according to (Malone et al., 2003). Each dependency will be associated to a coordination service (e.g., manages flow of materials, manage sharing of resources). The concepts of dependency and coordination are related because coordination is seen as a response to problems caused by dependencies. This means a coordination service manages a dependency.

CIS service is considered as a coordination service as discussed in (Touzi et al., 2006) since CIS is defined as a mediation system managing the collaboration, dealing with the data and applications of participants.

2.2 Deduction Rules

The interactions between these two ontologies can be established via the deduction rule. Rule is written as antecedent-consequent pairs. The antecedent is referred to the rule body and the consequent is referred to the head (O'Connor et al., 2005).

The deduction rules should cover the organization of collaborative networks (e.g. goal, service, topology) and management of resources (coordination service, dependency). Five groups of rules have been defined: (i) role and abstract service, (ii) business service, (iii) dependency, coordination service and CIS service, (iv) common goal, and (v) topology. The following paragraphs provide some examples of rules of the first three groups:

Rule1: role → abstract service

(Sobah Abbas Petersen, 2005) affirms the existing of relation between role and activity. The aim of this rule is to derive abstract services when a role is provided which is in the first group. This rule can be explained for instance: if participant "A" plays role "seller" then the participant "A" provides abstract services "sell service", "sell product", "sell items from stock", etc. However, this rule will run fine when each role in the knowledge base has already been predefined its corresponding abstract service.

Rule2: abstract service → business service

This rule is in the second group, interesting in the deduction of business services when an abstract service is provided. For instance, if participant "A" provides abstract services "sell product" then the participant "A" provides also the business services "obtain order", "prepare products to deliver", "transfer invoice", etc. However, this rule will run fine when each abstract service in the knowledge base has already been predefined its corresponding business services. The idea of separating two levels of services into abstract services and their related business services comes from the MIT Process Handbook (Malone et al., 2003).

Rule3: resource → dependency → coordination → CIS services

Regarding the third group of rules, the aim of this rule is to derive dependencies when two business services have a common resource as discussed in (Malone et al., 2003). For instance, if the "place order" service of a buyer produces a purchase order as output and the "obtain order" service of a seller uses a purchase order as input then a dependency of purchase order between these two services will be established.

Once the dependencies have been established, we will deduce coordination and CIS services from dependencies. The relation between dependency and coordination is discussed in (Crowston, 1994), while the coordination service comparable with the CIS service is talked in (Touzi et al., 2006). For instance, if the dependency contains resource "purchase order" then the coordination service which is managed the resource "purchase order" is "manage flow of document" and then these coordination service is also the CIS service.

3. SUPPORTING TOOLS AND APPLICATION SCENARIO

Previously we have discussed about the ontology and the deduction rules. In this section, we will focus on the development of tools supporting the approach including the ontology, and the rules.

The figure 3 shows that the approach is composed of four parts: (i) knowledge gathering, (ii) knowledge base and deduction of collaboration pattern, (iii) extraction of collaborative process related to given collaboration cases, and (iv) BPMN relevant process.

A simple scenario will be experimented in order to illustrate the principles of the approach. The application covers the first three parts except the complements in the third part. The schema below shows the four parts of the ontology-based approach with tools using at each part:

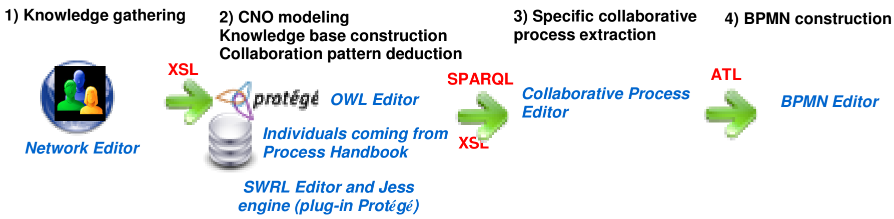

Figure 3 - Four parts of the ontology-based approach and the supporting tools

Part 1: Knowledge gathering

The knowledge to be gathered is composed of: (i) characteristics of network which concern the relationship between each pair of participants and common goal, and (ii) participants' details concerning their roles and services in the collaboration context. Role and service are mandatory to have at least one of them since they can be completed by each other by deduction.

To gather the knowledge, we have developed a tool called "Network editor (NE)". It will be used to facilitate the consultants of EBM WebSourcing to define, and characterize manually the collaborative network of their clients.

Result of the scenario: the network scenario has three participants: A, B, and C which play role buyer, seller, and distributor respectively. The supplier-customer relationships are continuous, and hierarchic, established between A-B and A-C. The common goal of the network is to distribute goods. The figure below shows the characterization of the studied network:

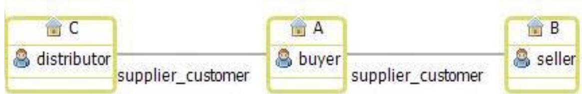

Figure 4 - Characterization of the network

Once the collaborative network model has been defined, and all involved participants have agreed on it, we will enter now to the second phase of the part 2.

Part 2: CNO modelling, knowledge base construction and collaboration pattern deduction

The part 2 can be separated into two phases: (i) knowledge base preparation and (ii) collaboration pattern deduction. The first phase concerns the preparation of the knowledge base and its fundamental components which can be applied in any cases. The second phase will be performed after importing new individuals to the knowledge base.

In the first phase, the knowledge base will be created, and populated by some individuals. The knowledge base will contain only standard individuals (e.g. business services, roles, coordination services…). Constructing a knowledge base requires an ontology which is the CNO in this case.

The CNO has been informally defined as discussed in the section 2.1. We need to formalize it with a rigorous syntax and semantic language. According to (Young et al., 2007), OWL (Web Ontology Language) is good at representing the semantic objects but weak in process definition. Similarly the PSL (Process Specification Language) has a strong process representation capability but is weak in representation of objects. Hence, in this work the formalization of the CNO in order to construct a knowledge base is written in OWL using the Protégé (Rajsiri et al., 2008).

The deduction rules, discussed in the section 2.2, will be written in SWRL (Semantic Web Rule Language). They will be saved as a part of the ontology (O'Connor et al., 2005). This is an example of the Rule1 (role → abstract service), discussed in the section 2.2, written in SWRL: Participant(?x)^playRole(?x, ?y) ^ performAbstractService(?y, ?z) → provideAbstractService(?x, ?z).

The individuals coming from the dataset which is an OWLized[i] version of the MIT Process Handbook will be stored in the knowledge base in their corresponding classes and properties.

The second phase starts once the collaborative network from the NE has been characterized and imported to the knowledge base as a new individual.

To be able to import, a transformation of the collaborative network model to the OWL model supporting the knowledge base is required. We do the transformation at this phase using the XSL (eXtensible Stylesheet Language).

After importing, the deduction can be performed by executing the SWRL rules with the Jess engine (O'Connor et al., 2005). The Jess is in charge of creating new OWL concepts and then inserting them into the knowledge base.

Result of the scenario: after performing the deduction, new individuals and properties are created and inserted in the knowledge base. For instance, the participant "C" as distributor performs "deliver" service, "A" as buyer performs "place order", "pay" services. Once the rules have been executed without any errors, we can start the next part.

Part 3: Specific collaborative process extraction

In this part, we try to extract and illustrate collaborative process. The queries, written in SPARQL, are required here to execute in order to extract from the knowledge base only the collaboration pattern that matches to the input network.

Then the collaboration pattern obtained will be restructured and transformed into a corresponding collaborative process using the XSL. The collaborative process will be illustrated on the "Collaborative process editor (CPE)".

The users of the CPE are the consultants of EBM WebSourcing. Once the collaborative process has been produced, the users are in charge of completing and validating the collaborative process by adding some missing elements (e.g. type of gateways, events).

Result of the scenario: after querying, the obtained pattern will be transformed into a relevant collaborative process respecting to the CPE model. However, the collaborative process obtained is just a solution for the given use case and based on the CNO shown in the figure 2. It is possible to have other solutions corresponding more or less than the proposed one. The process shown in the figure 5 was already simplified for the readability reason of the figure. Normally the obtained collaborative process is more complicated.

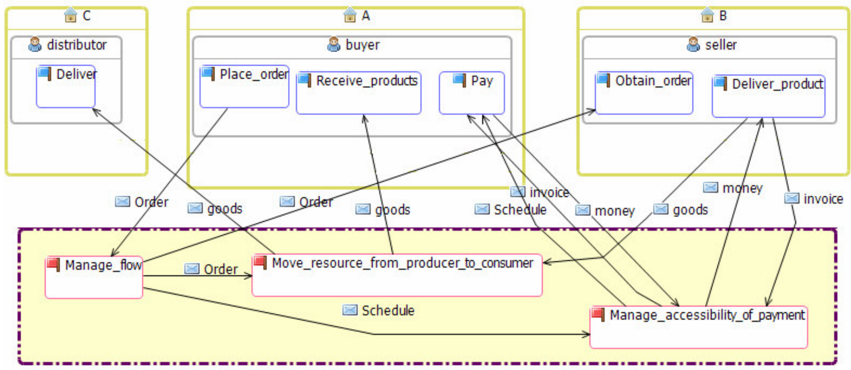

Figure 5 - Collaborative process

Part 4: BPMN collaborative process construction

What we are waiting for at the end is not the collaborative process which is compatible with the CPE but with the BPMN. Thus, a transformation of collaborative process from the CPE to the BPMN model is needed.

The transformation language we use here is the Atlas Transformation Language (ATL). ATL is QVT (Query, View and Transformation) compatible which is a specialized language that has been developed under the Object Management Group (OMG). The main purpose of this language is to allow the transformation between models (Touzi et al., 2007).

Result of the scenario: not provided.

4. PERSPECTIVES

The ontology-based approach aims at automating the specification of BPMN collaborative processes by taking as input the informal knowledge coming from the characterization of network. The approach uses the ontology (CNO) and the deduction rules to accomplish the aim.

Since, during the conceptualization of the CNO, we have integrated the meta-model of collaborative process. Thus, this can guarantee the conformity of the result obtained from the part 3 (Figure 5) of the approach to the BPMN model. We can see that the actual collaborative process is really near the BPMN but still not complete. There are some missing elements such as gateways and events. These elements are needed to be implemented before transforming to the BPMN compliant process because they can make process more dynamic. Other complements that should also be done in the part 3 are validating process and removing worthless elements or dependencies.

Our current work is focused on adding the dynamic aspect by completing the actual result of the part 3 by taking into account with gateway and event elements as well as validation. After that, we will handle the transformation into BPMN collaborative processes.

5. REFERENCES

1. Crowston, K. A Taxonomy of Organizational Dependencies and Coordination Mechanisms (Working paper No. 3718-94): MIT, Sloan School of Management, 1994.
2. Konstantas D, Bourrières JP, Léonard M, Boudjlida N. Interoperability of enterprise software and applications, INTEROP-ESA'05, Geneva Switzerland, Springer-Verlag, 2005
3. Malone TW, Crowston K, Herman GA. Organizing business knowledge – The MIT Process Handbook, ISBN 0-262-13429-2, Chapters 1 and 3, 2003.
4. Millet J. and Mukerji J. MDA Guide Version 1.0.1, available on http://www.omg.org, 2003
5. O'Conner M, Knublauch H, Tu S, Grosof B, Dean M, Grosso W, Musen M. Supporting rule system interoperability on the Semantic Web with SWRL, 2005.
6. Petersen SA. The role of enterprise modelling in virtual enterprises, Collaborative Networks and Their Breeding Environments, Springer, 2005.
7. Rajsiri V, Lorré JP, Bénaben F and Pingaud H. (2007). Cartography based methodology for collaborative process definition, Establishing the Foundation of Collaborative Networks, 2007.
8. Rajsiri V, Lorré JP, Bénaben F and Pingaud H. (2008). Contribution to the knowledge-based methodology for collaborative process definition: Knowledge extraction from 6napse platform, accepted paper for I-ESA 2008, March 2008, Berlin, Germany.
9. Touzi J, Lorré JP, Bénaben F and Pingaud H. (2006). Interoperability through model based generation: the case of the Collaborative IS. Enterprise Interoperability.
10. Touzi J, Bénaben F, Lorré JP and Pingaud H. (2007). A Service Oriented Architecture approach for collaborative information system design, IESM'07, Beijing China.
11. Vernadat FB. (2006). Interoperable enterprise systems: architectures and methods, INCOM'06 Conference, St-Etienne, France.
12. Young RIM, Gunendran AG, Cutting-Decelle AF, Gruninger M (2007). Manufacturing knowledge sharing in PLM: a progression towards the use of heavyweight ontologies. International Journal of Production Research Vol 45 No7, ISSN 0020-7543.

[i] http://www.ifi.unizh.ch/ddis/ph-owl.html