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Contribution to Knowledge-based Methodology for Collaborative Process Definition: Knowledge Extraction from 6napse Platform

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Abstract. This paper presents a knowledge-based methodology dedicated to automate the specification of virtual organization collaborative processes. Our approach takes as input knowledge about collaboration coming from a collaborative platform called 6napse developed by EBM WebSourcing, and produces as output a BPMN (Business Process Modeling Notation) compliant process. The 6napse platform provides knowledge to instantiate the ontology to contribute to the collaborative process definition. The ontology is in the collaborative network domain, consisting in (i) collaboration attributes, (ii) description of participants and (iii) collaborative processes inspired from the enterprise Process Handbook (MIT).

Keywords: Ontology based methods and tools for interoperability, Tools for interoperability, Open and interoperable platforms supporting collaborative businesses

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 (e.g. location, language, information system), 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 [6] [18].

General issue of each company in collaboration is to establish connections with their partners. Partners have no idea about what their collaboration will exactly be but they know what they are waiting for from the collaboration. This means that

partners can express informally and partially their collaboration requirements (knowledge). But, how to make these requirements more formalized and completed?

In principle, partners collaborate through their information system. The concept of collaborative information system (CIS) has been evolved to deal with the interoperability issues. According to [16], 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 collaborative process model into a SOA (Service Oriented Architecture) model of the CIS. This is comparable to the Model Driven Architecture (MDA) approach [9], as discussed in [17]. The BPMN supports the Computation Independent Model (CIM) of the MDA, while the SOA-based CIS supports the Platform Independent Model (PIM) of the MDA.

Consequently, our research interest concerns the CIM model. The main focus is to formalize the informal and partial knowledge expressed from the partners in form of BPMN relevant process. But, how do we obtain the BPMN? The answer is shown as follows:



Fig. 1. Our approach for defining a BPMN collaborative process

The schema above shows our approach composing of (i) two gathering methods: interview and knowledge extraction, (ii) two repositories: collaboration characteristics (participant and collaboration) and collaborative processes, and (iii) a transformation.

The approach starts at gathering knowledge by interviewing or extracting from a platform called 6napse. This knowledge will be classified and kept in corresponding repositories. Main difference between these two gathering methods is that the interview provides knowledge about the participants (e.g., name, role, business, service) and their collaborations (e.g., relationship, common objective) for the characteristic repository, while the extraction from 6napse provides not only the same knowledge as interview, but also the collaborative process (e.g., CIS, CIS services). Both repositories allow to analyze, keep and construct knowledge in form of collaborative process.

Defining these two repositories requires implementing a knowledge-based methodology. This methodology uses ontology and reasoning to automate the specification of collaborative processes. The ontology covers the collaborative network domain which maintains the repositories of collaboration characteristics and collaborative processes, as shown in Fig. 1. The reasoning methodology

establishes the interactions between the repositories in order to fulfill the building of collaborative processes.

The paper is focused firstly on introducing 6napse platform. Secondly, the ontology describing the collaborative network domain will be presented. Finally, the knowledge extraction from the platform and an application scenario will be discussed.

2 6napse Collaborative Platform

The global evolution makes the enterprises to open themselves to their partners. The necessity of creating network depends on various elements, for example, competition, communication, complexity of products. The collaboration is set up around business tools corresponding to a collaborative process between the enterprises (e.g., group buying services, supplier-customer services).

The actual market offers many collaboration tools addressing various functionalities, for example, communication (i.e. e-mail, instance massager), sharing document (i.e. blogs), knowledge management (i.e. wiki, e-yellow pages) and project management (i.e. calendar sharing). However, one of the most required functionality from users is to be able to integrate directly their functionalities emerged from their proper activity domain to the platform as mentioned in [7].

EBM WebSourcing, an open source software provider, has been found in late 2004. Their business focuses on editing and developing the solutions dedicated to SME clusters. EBM WebSourcing is now developing a collaborative platform called “6napse”.

6Napse is a collaborative platform intended to enterprises that would like to work together. The main idea is to provide a trustable space for members to establish (or not) commercial relations among them. The platform will play the role of mediator between the information systems of the enterprises. It is different from the other actual products in the market because it is integrated the business services.

The development of this platform is on a basis of the social network paradigm. It aims at (i) creating a dynamic ecosystem of enterprises which communicate by using the services provided by the platform (i.e. send/receive documents, send mails, share documents), (ii) creating a network by viral propagation in the same way as Viadeo, LinkedIn and (iii) being the first step which drive to integrate information systems of the partners and to define more complicated collaborative processes (i.e. supply chain, group buying, co-design).

The third development aim led to the concept of CIS and the collaborative process definition by using the knowledge-based methodology (Fig. 1).

The followings are some examples of functionalities that the platform offers to their members:

- Registering the enterprise, the user.
- Login or logout of the user to the platform.
- Creating or consulting the profile of enterprise and user.
- Inviting partners to join network, creating a partnership and a collaboration.

- Searching enterprises, services via keywords (i.e. service, localization, tag)

Through these offered functionalities, the members can create their partnerships and collaborate. The user of the 6napse platform will be an individual relevant to an enterprise. It means that an enterprise is considered as a frame grouping their individuals (employees). An enterprise can be also a reference for the external individuals because normally we need to recognize the enterprise before being able to identify their belonging personnel. The collaboration occurred on the platform is established at the individual level.

3 Collaborative Network Ontology (CNO)

In Artificial Intelligence, according to [3], knowledge representation and reasoning aim at designing computer systems that reason about a machine-interpretable representation of the world, similar to human reasoning. A knowledge-based system maintains a knowledge base which stores the symbols of the computational model in form of statements about the domain, and it performs reasoning by manipulating these symbols.

Our knowledge-based methodology lies on the above approach in order to deal with the collaborative process design. Fundamentally, the methodology of collaborative process design in our case starts at analyzing the input knowledge regarding collaborative behaviors of the participants and ends at providing a related BPMN collaborative process.

The input knowledge we require for manipulating the methodology concerns the collaborative characteristics or behaviors of all involved partners of the network. This kind of knowledge is, for example, business sectors, services (competencies) and roles. This knowledge is extractable from the 6napse platform. We have already discussed about the platform in the previous section. The knowledge extraction will be presented in Section 4.

After manipulating the methodology, what we are waiting for at the output are network participants, exchanged data, business services and coordination services. These elements are essential for designing a BPMN collaborative process. Thus, to make the methodology able to produce these elements, we need (i) to define ontology and rules describing the collaborative network domain and (ii) to use an inference engine to deduce these modeling elements from the input knowledge.

According to [4], ontology is a specification of a conceptualization. It contains a set of concepts relevant in a given domain, their definitions and inter-relationships.

To define domain and scope of ontology, [8] suggested starting by answering several basic questions which concerns for example, the domain of interest, user and expected result of the ontology. Often developing ontology is akin to defining a set of data and their structure for programs to use. Problem-solving methods and domain-independent applications use ontologies and knowledge bases built from them as data.

The domain of interest for developing an ontology that we focus is on the collaborative network domain especially for designing collaborative process. The

knowledge base built from this ontology will cover the two repositories shown in Fig. 1. It will be used in some applications by the consultants of EBM WebSourcing to suggest their clients a collaborative process relevant in given collaboration behaviors.

There are three key concepts underlying the collaborative network ontology (CNO) which are (i) the participant concept, (ii) the collaboration concept and (iii) the collaborative process concept.

What we need to define in an ontology is not only the concepts, relations and properties, but we need also to define rules that reflect the notion of consequence. The followings are some examples of rules in the collaboration domain: If decision-making power is equal and duration is discontinuous then topology is peer-to-peer or if role is seller then participant provides delivering goods.

The following paragraphs describe these three concepts with their relations, properties and rules.

The participant concept, see Fig. 2, concerns the descriptions about participant, which are the characterization criteria of collaboration [13].

A participant provides several services at high level (discussed in the collaborative process concept) and resources (e.g., machine, container, technology), plays proper roles (e.g., seller, buyer, producer) and has business sectors (e.g., construction, industry, logistic).

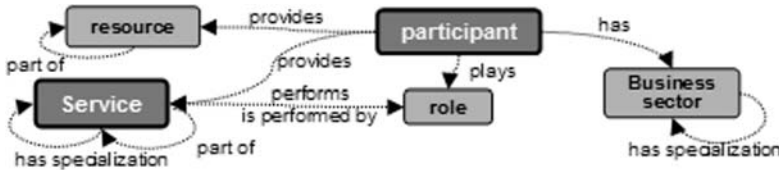


Fig. 2. RDF graph representing the participant concept

From the above figure, reasoning by deduction can be occurred for example between role and service. Role and service are not compelled to have both but at least one of them is required because they can be completed by each other by deduction. It means that related services will be derived from a given role and vice-versa. For example, if role is computer maker then its services are making screen, making keyboard...

The collaboration concept, see Fig. 3, concerns the characterization criteria of collaboration [13] and the collaborative process meta-model [17]. Common objective, resource, relationship and topology are the characterization criteria, while CIS and CIS services are a part of the collaborative process meta-model.

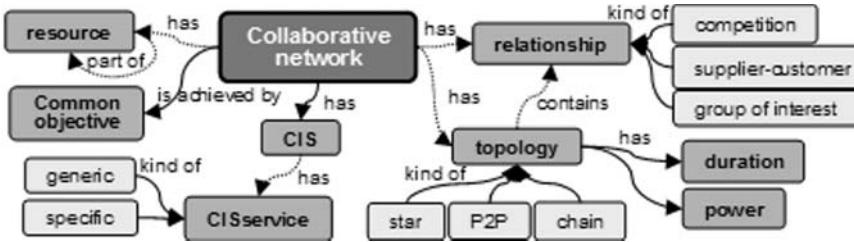


Fig. 3. RDF graph representing the collaboration attributes

A collaborative network has a common objective (e.g., group same products to buy together) and a CIS. A CIS has its own CIS services which can be generic (e.g., send documents/mails) or specific (e.g., select supplier service). A network can have several topologies which can be star, peer-to-peer, chain or combination of these three structures. Topology has duration and decision-making power characteristics. Central, equal or hierarchic power is a decision-making power. Duration can be continuous or discontinuous. A topology contains relationships which can be group of interest, supplier/customer or competition.

Reasoning topology by deduction is for example, if decision-making power is equal and duration is discontinuous then topology is peer-to-peer, if decision-making power is hierarchic for whatever duration be then topology is chain.

The collaborative process concept, see Fig.4, is an extension of the concepts developed by the MIT Process Handbook project [8] and also the value chain of [12]. The value concept provides a list of services describing competencies at very high level and generic (e.g., vehicle manufacturing, software development), while the Process Handbook provides business services (i.e. assemble components of computer) at functional level.

A service can be divided into business service and coordination service. Business service explains task at functional level. Service can derive the business services that correspond to it. For example, if service is making keyboard then business services are assembling circuit board, testing board...

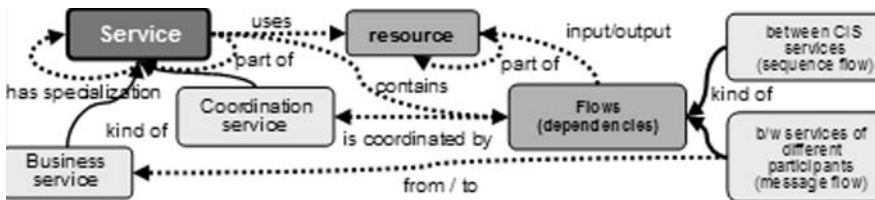


Fig. 4. RDF graph representing the service

The concept of dependencies (flows) of resources is also included. To deduce a dependency, according to [2], we consider possible combinations of services using resources. Each dependency can be associated a coordination service (i.e. manage flow of material from a business service to another). 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 is in charge of managing a dependency. For example, if the placing order service of a buyer produces a purchase order as output and the obtaining order service of a seller uses a purchase order as input then there is a dependency of resource between these two services and we can use the forwarding document coordination service to manage this dependency.

Collaborative networks usually have several participants, resources, relationships and a common objective. Common objective achieves services which use resources and are performed mostly by proper roles of the participants. A relationship gets two participants together which its type is depended on the roles of the participants (e.g. if two participants play seller and buyer roles, the relationship will be supplier/customer). The following figure shows these expressions which unite the three above concepts together:

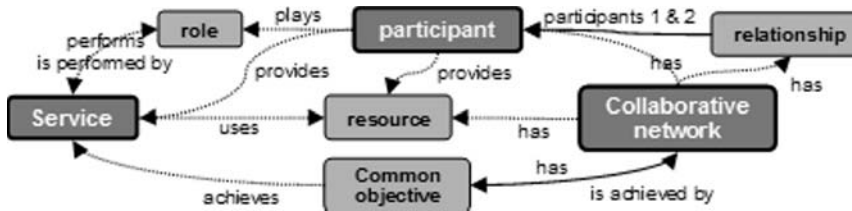


Fig. 5. Union of the participant, collaboration and collaborative process concepts.

Once the CNO has been informally defined, we need to formalize it with rigorous syntax and semantic language. OWL (Web Ontology Language), a W3C recommendation, is the most recent development in standard ontology languages. There are three OWL versions but the most appropriate one in our case is OWL-DL (Description Logics) because it adapts to automated reasoning. It guarantees the completeness of reasoning (all the inferences are calculable) and logics.

For using this language, we need an editor to create ontology’s elements (classes, relations, individuals and rules). We use the Protege which is an open-source OWL editor developed by Stanford University [11]. To reason the ontology, we use the inference engine Pellet which is an open source OWL-DL inference engine in Java, developed at the University of Maryland’s Mindswap Lab [15].

4 Knowledge Extraction from 6napse Platform

The two previous sections have been described about the CNO and the 6napse platform. This section interests in using 6napse platform with the CNO as discussed in [1]. We focus on extracting knowledge from the platform, which will be used to instantiate the CNO.

The beginning idea of using 6napse came from when partners have no perspective about what their collaboration is supposed to be or they would like to see it clearer, they can try to collaborate through 6napse.

In principle, we try to extract knowledge and to find patterns behind the collaborations occurred on the 6napse. The extracted knowledge and patterns will

be used to improve existing collaborations and to define more complicated collaborative processes.

In this section, we will discuss about the knowledge extraction from 6napse platform. Then, an application scenario will be presented by using a supplier-customer use case.

4.1 2-level Knowledge Extraction

Extracting knowledge from 6napse can be occurred at two levels corresponding to the life cycle of the enterprise on the platform: individual registration and collaboration. The first level occurs when the enterprises register on the platform. The second level is when the enterprises collaborate or start exchanging data between their partners. The second one can occur once the first one has been done.

We will detail the extractable knowledge at each level of the platform in comparison to the requirements of the ontology defined in Section 3.

The individual registration level provides knowledge about the description of the participants concerning the enterprise itself which is seen as an organization. This knowledge is available immediately since the participants have individually registered themselves on the platform and will not be varied depending on the collaboration. We can find this knowledge on the “my company” and “my profile” pages of the platform.

The table 1 compares the information that the ontology requires as input to what we can extract from the 6napse.

Table 1. Requirements of the ontology vs. Extractable knowledge from 6napse

Requirements of the ontology	Extractable knowledge from 6Napse
Name of participants	Name of the enterprise
Business sector	Activity sector
Services	List of the services
Business services	List of the business services (or function of the individual belonging to the enterprise)
Relationships	List of the partners

Following is an example of the information on the “service” tab of the “my company” page. The service tab shows the list of services which explain the competencies of the enterprise.

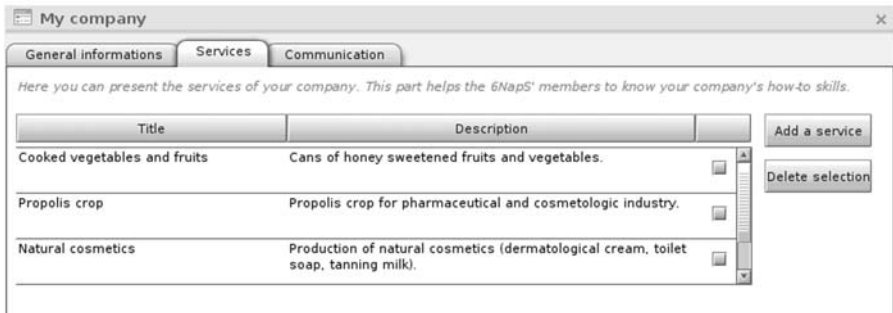


Fig. 6. Printed screen of a service tab of an enterprise

The **collaboration level** provides the source of knowledge concerning the enterprise which is considered as a member of the network. To enter the collaboration level, they need to declare their partnerships and create their collaborations (network) on the platform. This can occur once the individual registration of each enterprise has been done.

After the individual registration, the enterprises can invite other 6napse's members to be their partners in the network. Then, they can create their collaborations on the collaborative space of the platform.

During the partners are collaborating (e.g., transferring documents) via the platform, we will extract their collaboration knowledge. Through this knowledge, we can understand what is happening in the real collaboration. This knowledge is available on the collaborative space which includes the "share service".

The knowledge we expect to extract in this level are, for example, number of participants in the network, CIS services they are using and documents transferred from one to others, see the table below.

Table 2. Requirements of the ontology vs. Extractable knowledge from 6napse

Requirements of the ontology	Extractable knowledge from 6Napse
Number of participants	Number of members in a collaboration
CIS services	CIS generic services of the platform
Transferred resources	Documents shared on the platform
Business service	Shared by (individual who shares the document)
Common objective	Description of why creating the collaboration
Duration of the collaboration (continuous, discontinuous)	Measurement of the duration of the collaboration

Following is an example of the knowledge on the "share" tab of a collaboration occurred on the platform. The share tab shows the documents transferring between partners of this collaboration.



Fig. 7. Printed screen of a collaboration occurred on the 6napse platform.

The knowledge extracted in this level is, for example, an individual named Laura shares the test case documents as same as Pascal who shares the how-to text to their partners. Comments can be written for each shared documents.

However, some working environments force the users to reroute several times before finding the right information, for example, B needs to see the document shared by A before transferring to C.

We cannot study the exchange flows of documents on the platform without taking the network topology and the type of relationship into account. This is significant for improving or defining more complicated collaborative processes afterwards.

4.2 Supplier-customer Scenario

To illustrate principles of knowledge extraction in this section, we introduce a customer-supplier use case. The input knowledge is extracted from the 6napse platform. Some reasoning examples will be shortly explained. The output result will be shown at the end.

The tables 3 and 4 show the knowledge extracted from 6napse while registering and collaborating respectively.

Table 3. Description of each participant in the network

Participants	Business sector	Services	Relationships
M	Manufacturing	Making computers Sales	S, W (supplier-customer)
S	Part Manufacturing	Supplying the parts of computer	M (supplier-customer)
W	Logistics	Stocking materials and transporting to customers	M (supplier-customer)

Table 4. The extracted knowledge from 6napse while collaborating

Knowledge	Extracted knowledge
Nb of participants	3
CIS services used	Sharing documents, Mailing...
Resources transferred	Purchase order, bill, delivering detail, receipt, messages...

Business services	Identifying needs, transferring materials, paying...
Common objective	Fulfill the supply chain for manufacturing products to stock
Duration of collaboration	Continuous

The knowledge in the tables 3 and 4 is required as input of the ontology. It will be used to instantiate the ontology defined in the section 3.

Once we have the input knowledge (instances in the ontology), we can derive first of all the topology and the characteristics of the network. This network has two chain topologies because, from the deduction, the decision-making power is hierarchic and the duration is continuous.

We continue the collaboration definition by deducing the roles and business services. If there is any missing information at this level, this information will be completed by the ontology. In this case, for example, since M provides making computer and sales then M plays manufacturer role which performs identifying needs, receiving materials, paying and producing business services.

Once the business services provided by the participants have been reasoned, what we need to do next is to derive all possible dependencies between business services belonging to different participants. This dependency brings to the deduction of the coordination and the CIS services in the collaborative process.

After that, we can find if there are any services required in the collaboration that no any participant can be in charge of. If this is the case, we need to create the CIS services to perform these services. For example, the control and evaluation service cannot be done by any participant, so it will belong to the CIS.

At the end, we have to deduce once again the dependency between the CIS services and the coordination services. The result is shown in the following figure:

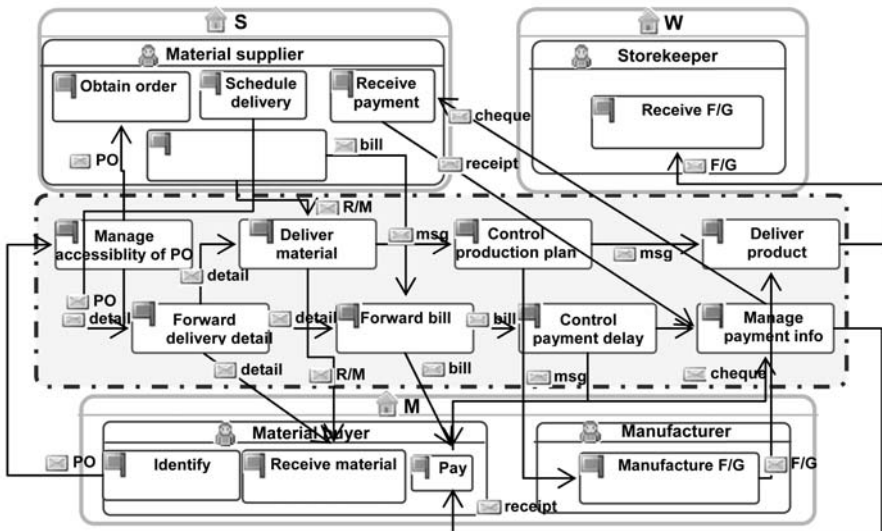


Fig. 8. A solution of collaborative process of the network.

We have to remark that the collaborative process obtained at the end is just a solution for the given use case. It is always possible to have other solutions that meet to collaborative behaviors of the participants more than the proposed one.

5 Conclusion

The 6napse collaborative platform is still on the development phase. It allows to extract knowledge before setting up collaborations. The contribution of the 6napse is dedicated to partners who have no idea about what their collaboration is supposed to be or would like to see it clearer. The partners can capitalize on their collaboration knowledge for better collaborating in the future. Also, it plays an important role for enriching the knowledge (instances) in the CNO in order to improve existing collaborations of the partners and define more complicated collaborative processes.

The collaborative process obtained from the ontology (Fig. 8) is really near the BPMN compliant process but still not complete. There are some missing elements such as gateways and events. These elements are needed to be added in actual collaborative processes because they can make process more dynamic.

Our current work is focused on firstly extracting knowledge from real collaborations occurred on the 6napse. Secondly, we address adding the dynamic aspect to the actual reasoning methodology by taking into account event and gateway elements. Also, the actual knowledge-based methodology, including its concepts, rules and reasoning steps is needed to be finalized and validated.

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