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Agreement negotiation support in VO creation – an illustrative case

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In the actual market conditions, where it is essential to rapidly respond to business opportunities that might emerge, the concept of virtual organization appears particularly well-suited. The possibility of rapidly forming a virtual organization to respond to a business or collaboration opportunity gives companies an expression of agility and survival mechanisms in face of the market turbulence. Nevertheless, in the process of virtual organization creation, the negotiation among partners is essential. It is of extreme importance to have an environment where all potential partners can come together and negotiate the necessary topics towards an agreement to regulate the consortium behaviour. Through this environment it should be possible to conduct and manage the VO negotiation process, reach agreements and commitments among partners, enclose necessary documentation, specify partners' right and duties, etc. To accomplish such environment, a negotiation wizard is proposed. An illustrative scenario of an agreement negotiation in a multicultural context is presented showing the applicability of the wizard.

Keywords: virtual organization, virtual organization breeding environment, collaborative network, virtual organizations creation, agreement, negotiation

1. Introduction

The 'quotation request' business process is a challenging task for every industrial company involved in subcontracting activities as potential customers have nowadays access to a very large global market. As a consequence:

- The success rate of a quotation (transformation into an order) lays around 10%. In other words, it means that 9 out of 10 quotation preparations are only a waste of time and money;
- The profit margins are reduced and the price calculations must be very accurate;
- The quotation must be ready in a very short time as competitors also react quickly.

The quotation process is even more difficult in the case of Collaborative Networked Organizations (CNOs). The main drawback here is the supplementary delays induced by the participation of many partners and the need to negotiate till an agreement is reached. Trying to face this problem, a number of solutions have been proposed to shorten these delays; for instance, using a kind of workflow tool would

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enable to follow up the state and the progress of the bid preparation business process. These delays are not too critical within a small local CNO where the members share the same language and business background and could probably solve all problems by using traditional communication methods like e-mails and phone calls. The situation is however completely different for multicultural and geographical widely spread networks. Consequently, there is a need to improve the effectiveness of the negotiation processes in the formation of virtual organizations (VOs), particularly at the stage of bid preparation.

This article, which is an extended version of a paper presented at the 9th IFIP Working Conference on Virtual Enterprises (PRO-VE'08) (Oliveira et al., 2008), describes the usage of a negotiation wizard tool developed in the scope of the ECOLEAD project which can facilitate and better document the negotiation process during a VO creation, thus allowing potential time-saving. Hence, the subsequent sections of the article present in section 2 a brief discussion of related work, followed by section 3 that contextualizes the VO creation process. Section 4 describes the proposed agreement negotiation wizard with all its modules and functionalities and section 5 illustrates an example case scenario. Finally in section 6, conclusions and directions for future work are presented.

2. Related work

The process of establishing a virtual organization (VO) can be quite complex, where several items have to be addressed. Although the most addressed topic in past works is partners' selection, it is also of great importance to consider the commitments and agreements that have to be established among partners so that a VO can be properly created. In this context, negotiations and agreement or contract establishment appear as a major issue for virtual organizations namely during their creation and their potential evolution phases.

From this perspective, research work is required in various fields specifically in what concerns mechanisms and systems to support communication, communities organization, ontology engineering, document management, negotiation protocols, etc. Several works have already addressed some of these items. However and in particular regarding agreements and/or contracts establishment, further research is mandatory due to the evolution on technology and new requirement that are constantly challenging the current processes. Some of these challenges are related to communication channels, use of artificial intelligence methods, intellectual property rights, electronic institutions, etc.

As negotiation processes involve a transversal, multi- and inter-disciplinary approach, it is necessary to have a holistic view of the problem, making use of multiple methodologies and paying attention to the practical details (Gimpel et al., 2007). A negotiation process can rely on several mechanisms such as: auctions, game theory, intelligent agent mechanisms, etc. (Rocha and Oliveira, 1999). Nevertheless, such process if often conducted by human actors that in the last instance are the ones responsible for decision-making. Although some works try to insert some automation into the negotiation process (Jennings et al., 2000), this continues to be a rather difficult issue. The main obstacle is to produce a context-independent solution (Angelov and Grefen, 2002), and thus only partial and very specific solutions and prototypes are available.

When referring to contracts and negotiations, various proposals are related to customer-provider relationships, as the example described in (Gimpel et al., 2007).

This work aimed at: (1) designing and constructing places where goods and services can be bought and sold; and (2) providing services associated with buying and selling. For that, the authors make use of legal frameworks, economic mechanisms, management science models, and information and communication technologies.

On the other hand, the main aim of the work being presented in this article is not related to customer-provider contracts and negotiations but rather focused on the contract or agreement being established among the partners that will form a virtual organization, that is, the internal consortium agreement. As such agreement will regulate the consortium behaviour during the virtual organization operation, special attention should be put into e-contracting forms as they can capture and describe the rights and duties of all virtual organization partners(Rocha et al., 2005), as well as specification of penalties to apply to those that do not satisfy the agreement.

Computer assisted negotiation and e-contracting is expected to provide a faster and cheaper solution than traditional contracting for geographically distributed consortia formation. Several significant characteristics of the e-contracting process can be found in (Angelov, 2006). Moreover, an electronic contract can have both a machine readable and human readable representation. The existence of a human readable representation of the contract is required when its creation and management involves the participation of human beings.

Progress in this area during the last years has highlighted a number of important topics that need to be considered when developing processes and methodologies for negotiation and e-contracting, including:

a) Contract Models: templates that enable parties to specify contracts or agreements that can be monitored / enforced by a computer-supported contract framework.
   - According to (Strobel and Weinhardt, 2003), a negotiation is an iterative communication and decision making process between two or more sides (parties) represented by two or more agents who cannot achieve their objectives through unilateral actions and who search for a consensus decision. The agreement is the explicit representation of such consensus.
   - One of the common criteria to classify a negotiation (Buttner, 2006) may be the number of negotiating partners: Bilateral, one-sided multilateral and double-sided multilateral negotiations. All these cases can happen in a VO creation.
   - Grefen and Angelov (2002) divide the contract content into three general parts:
     — The first part describes the participating parties and mediators;
     — The second part provides the rights and obligations of the parties. This part contains the service (payment) description, its delivery process, legal and technical provisions, etc.;
     — The third part gives the required definitions for the contract enactment. These definitions can range from the business context of the contract to different terms and formulae used in the contract. The definitions aim at establishing an identical understanding about the contract among all participating parties.

     A similar work can be found in (Barata and Camarinha-Matos, 2003) when addressing coalitions of collaborating machines in an agile shopfloor environment.

b) Ontology: one important aspect of electronic negotiations, particularly in multi-cultural contexts, is the employed vocabulary. One interesting work developed by (Strobel and Weinhardt, 2003) proposes a taxonomy which allows the characterization and comparison of a broad variety of electronic negotiation mechanisms and systems, ranging from auctions to bilateral bargaining tables. Their focus is however on negotiation processes in electronic markets for the exchange of goods and services based on bargaining, bidding, or dispute resolution, and do not take into account non-commercial domains (politics, legal disputes) or other forms of negotiation such as group decision-making or voting. So in this case the taxonomy cannot by itself be directly applied to collaborative networks, but it can certainly be adapted.

c) Contract Framework: comprehends the environment within which a contract for a certain business opportunity is created / specified, executed and monitored (Xu, 2003, 2004; Xu & Vrieze, 2007).
A relevant work in this area has been developed by (Strecker et al., 2006) that includes a prototype that contributes to the bilateral negotiation effectiveness with the central emphasis on two key components: the negotiation process model, and the negotiation protocol. Here the main scope comprises the phases of pre-negotiation analysis, conducting negotiation, and post-settlement analysis. Although the authors claim that the used methodology has been supported by negotiation experts, they also admit that usually unstructured negotiations via email, phone or face-to-face are still preferred.
Another relevant work is presented by (Picard, 2004) proposing a model for electronic non-monolithic collaborative document edition, the document-group-message model. This model is mainly focused upon the production of a contract document on a collaborative edition basis with versioning control. It specifies the negotiation group dynamics model, as well as the message exchange model.

d) Electronic Institutions: a framework that facilitates, through a communication network, automatic transactions between parties, according to sets of explicit institutional norms and rules. Thereby, the electronic institutions ensure the trust and confidence needed in any electronic transaction (Rocha et al., 2005).
Often electronic institutions are perceived as a formalism to define the rules in which structured agents interact, as is the case described in (Esteva et al., 2004). In this work a set of tools that support the specification, analysis and execution of institutions, as well as the implementation of agents are presented. (Cardoso and Oliveira, 2008), describe an approach towards the development of an electronic institution providing an enforceable normative environment. Within this environment, institutional services are provided and assist agents in forming cooperative structures whose commitments are made explicit through contracts. This work has a good potential since it addresses the application into the B2B field, namely regarding the formation of Virtual Organizations. On a different perspective (García-Camino et al., 2006) propose a means to specify and control the normative dynamics of societies of software agents. They introduce a language with which one can explicitly manage the normative positions of agents. This language is conceived as a machine processable language to facilitate norm-oriented programming and to found higher-level normative languages.

e) Digital Signature: are methods to authenticate digital information using cryptographic techniques. They can be used to authenticate the identity of the sender of a message or the signer of a document, and possibly to ensure that the original content of the message or document that has been sent is unchanged. These mechanisms also involve a notion of non repudiation since the signatory cannot, at a later time, repudiate the signature. Several cryptography-based algorithms exist for implementation of digital signature, such as DSA, RSA and ECDSA (U.S. DEPARTMENT OF COMMERCE, 2000).

Procedures for e-contracting and negotiation are also important in relation to the ISO 9000 certification as they can ensure clearly defined and repeatable procedures within the CNO as a whole and not only within the companies that are members of a collaborative networked organization (CNO).

Considering the above rich conceptual inheritance but also practical requirements elicited through our interaction with existing enterprises networks, in this article we present an agreement negotiation wizard that allows members of a collaborative network to conduct their negotiation towards the internal consortium agreement for a virtual organization. In this context the involved actors are not seen as potential adversaries, but rather as negotiating partners with the aim of creating value and meeting the interests of all parties.

3. VO creation context

In face of a new business opportunity, when the window of opportunity is short and in order to support the rapid formation of a virtual organization (VO) it is necessary that enough information is available about potential partners and that they are ready and prepared to participate in such collaboration. This readiness includes the existence of common interoperable infrastructure, common operating rules, common cooperation agreement, and a base trust level among the organizations. Therefore, our approach considers that dynamic VOs are mostly created in the context a VO Breeding Environment (VBE). A VBE (Afsarmanesh and Camarinha-Matos, 2005; Camarinha-Matos et al., 2008 a), b)) can be defined as: an association of organizations and their related supporting institutions, adhering to a base-long term cooperation agreement, and adopting common operating principles and infrastructures, with the main goal of increasing both their chances and their preparedness towards collaboration in potential Virtual Organizations. Some of the main aims of the VBE thus include:

- Establishing the base trust for organizations to collaborate in VOs;
- Reducing the cost/time when finding suitable partners for configuration of the VOs;
- Assisting with the creation, reaching agreements, and contract negotiation for the establishment of VOs;
- Assisting with the dynamic reconfiguration of the VOs, thus reducing the risk of losses due to some organizational failures; and
- Providing some commonality for interaction by offering: (i) Base ICT infrastructure (for collaboration), thus reducing the set up times during the VO formation; (ii) Cooperative business rules and common metrics to evaluate member's credibility and performance; (iii) Template contracts for rapid involvement in VOs; (iv) Base ontology for the sector targeted by the VBE.

The organizations that compose the VBE are thus assumed to be prepared and ready to collaborate and so can rapidly respond to a collaboration opportunity through the rapid formation of well-fitted virtual organizations (VOs) (Camarinha-Matos and Oliveira, 2007, Camarinha-Matos et al., 2008 b)). As illustrated in figure 1, the VO creation process is triggered by a business opportunity identified during the operation phase of the VBE. Whereas, the VBE is created as a long-term 'controlled border' association where its members are recruited from the 'open universe' of organizations, the VO is supposed to be a short-term organization where its partners are primarily selected from the VBE members. Nevertheless in case there is lack of skills or capacity inside the VBE other organizations can be recruited from outside the VBE boundaries (Camarinha-Matos et al., 2008 b)).

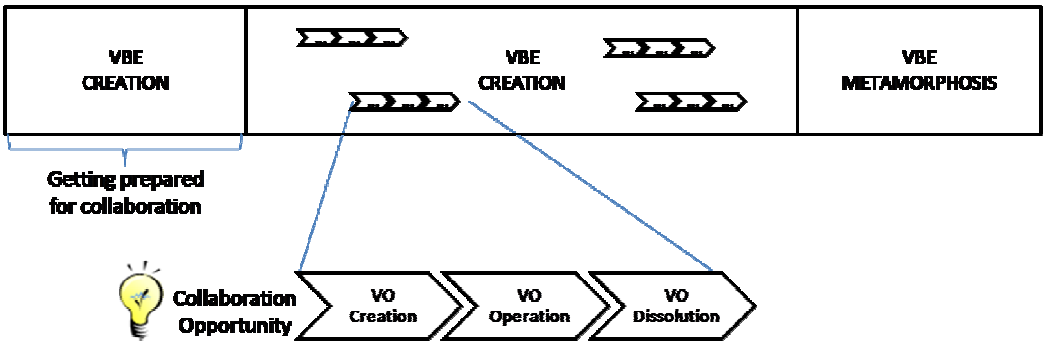

Figure 1 - VO creation in a VBE context

In order to promptly respond to a business / collaboration opportunity, the VO creation process has to be well defined. However, given different market situations, this process has to be set to provide solutions for two distinct cases: (i) when there is already an acquired business opportunity and the objective is to guarantee a consortium to fulfil the opportunity requirements; or (ii) when it is necessary to go through a quotation process before having acquired the business opportunity.

Figure 2 shows the simplified process for the VO creation when there is already an acquired business / collaboration opportunity. In this case, the process can be split into three distinct phases: preparatory planning, consortia formation, and VO launching.

The **preparatory planning** phase includes two main steps that are the collaboration opportunity (CO) identification and characterization and the rough VO planning. Thus, this phase involves the identification and characterization of a new CO that will trigger the formation of a new VO. A collaboration opportunity might be external, i.e. originated by a customer and detected by a VBE member acting as a broker. But some opportunities might also be generated internally, as part of the development strategy of the VBE. The rough planning of the VO is based on the determination of a rough structure of the potential VO, identifying the required competencies as well as the organizational form of the VO and corresponding roles. At this stage it is important to define the partnership form which is typically regulated by contracts and collaboration agreements.

The **consortia formation** phase departs from the previous characterization and rough planning and mainly includes the partners' search and suggestion step (that is perhaps one of the most addressed topics in past research) which is devoted to the identification of potential partners, their assessment, and selection. Complementary, an iterative process to reach agreements and align needs with offers is initiated and runs in parallel with the selection process. This negotiation process is also important because it is a mean to accomplish the VO composition in which the organizational structure and assignment of roles to VO members is achieved.

Once partners have been selected and collaboration agreements are reached, the **VO launching** phase starts and the refinement of the VO plan and its governance principles are addressed. Subsequently, there is the conclusion of the negotiation process that involves the final formulation and modelling of contracts and agreements as well as the contract signing process itself, before the VO can effectively be launched. The last phase of the VO creation process is the VO set up, i.e. putting the VO into operation. This last stage is responsible for tasks such as configuration of the ICT infrastructure, instantiation and orchestration of the collaboration spaces, selection of relevant performance indicators to be used, setting up of the VO governance principles, assignment and set up of resources / activation of services, notification of the involved members, and manifestation of the new VO into the VBE.

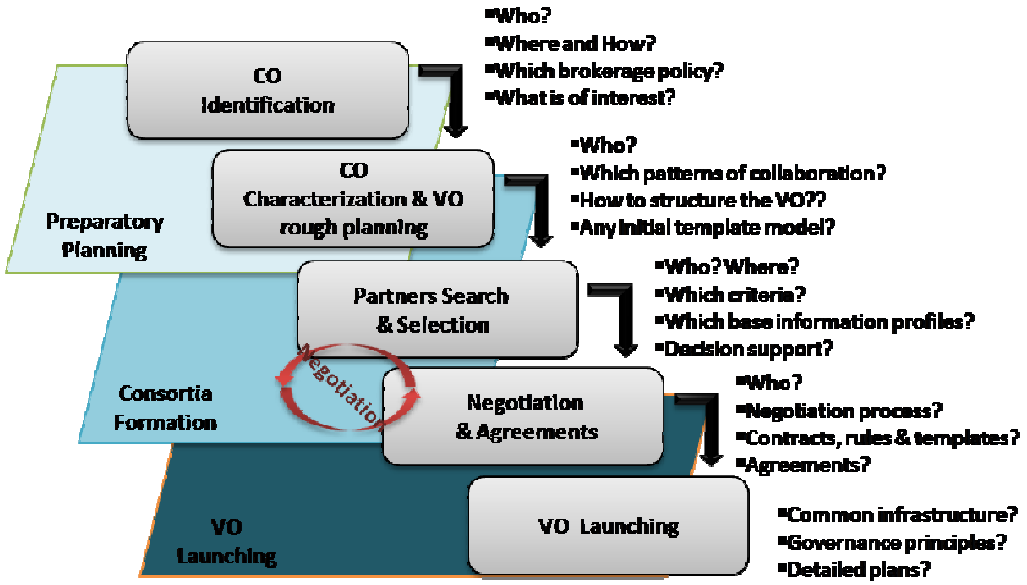

Figure 2 – VO creation process for a given collaboration opportunity

Nevertheless, in many cases before starting planning the VO, it might be necessary to go through a quotation / bidding process for a selected CO. This is the case illustrated in figure 3 that is divided into two distinct phases, the quotation and the final VO creation. In the **quotation / bidding** process, if an interesting CO is identified, then a bid / quotation to be submitted to the potential customer can be prepared. For the preparation of this bid, it is necessary to make a rough plan of the foreseen VO and also to select the core partners. If the bid is unsuccessful, the core consortium dissolves; otherwise the process continues to the next phase: the **final VO creation**. In this case, the VO's rough plan needs to be revised, based on the specific conditions of the contract with the customer, new additional partners might be necessary, and the VO is finally detailed and launched.

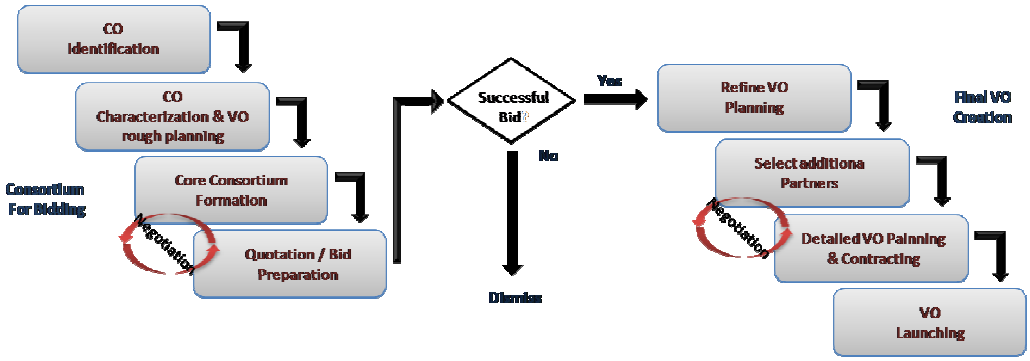

Figure 3 – VO creation for CO performance

According to these ideas, several tools were developed in ECOLEAD to cover the core phases of the VO creation process (Camarinha-Matos et al., 2008 a); Oliveira and Camarinha-Matos, 2008), namely tools for CO identification (COFinder), and CO characterization and VO rough planning (COC-Plan), partners search and suggestion (PSS), and agreement negotiation wizard (WizAN). These tools interact with the VBE Management System which provides relevant information such as profiles of potential partners, records of previous collaborations (e.g. past performance), etc.

The main roles of actors involved in this process are the Opportunity Broker and the VO Planner in the initial phases; potential partners participate in the last phase of the process. The first role is the one that is responsible for finding the collaboration opportunity whereas the second one is responsible for setting up the VO, i.e. is the one that is responsible for the characterization and planning of the CO, finding suitable partners and coordinating the process of reaching the final agreements between all parties involved. Figure 4 illustrates the main interactions among the four tools of the VO creation framework, the VBE management system and the involved actors.

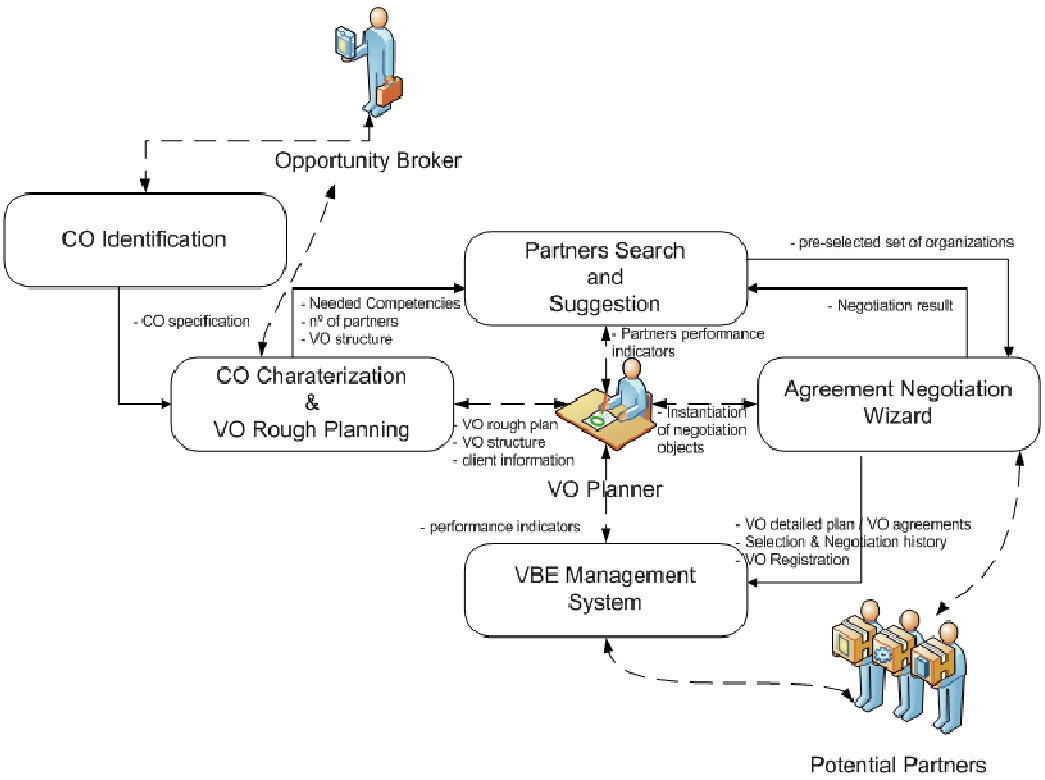

Figure 4 – Main interactions among tools and actors of the VO creation framework

As a general approach, the developed framework is aimed at assisting the human users in their decision making. Therefore, the various tools are designed as computer-assisted functionalities and not as a fully automated system.

The following sections are specifically focused on the use of the negotiation wizard.

4. Agreement negotiation wizard

In the previous section, the VO creation process was briefly described. As illustrated in figure 2 and figure 3, one important activity that runs in parallel with some other steps of the VO creation process is the negotiation. Thus, a tool to support this activity and assist contract/agreement establishment was designed and developed. The purpose of the tool is not to fully automate the process, but rather to assist the human actors during the negotiation steps towards the VO establishment. In the process of VO creation there are two main situations where negotiation might be required: (i) to select the appropriate partners to compose the VO, and (ii) to reach agreements on the details of the VO. The proposed negotiation wizard (WizAN) is intended to be suitable for both situations.

Usually contracts and/or agreements are used to regulate the exchange of values (e.g. money, knowledge), and mainly their provisions are for protection of parties in case that something does not go according to what was planned, and to describe what was agreed in the case that any party forgets it. The main result of WizAN is an internal consortium contract or agreement summarizing the results of the negotiations / discussions that were performed during the VO creation process. We could also

consider negotiations with the customer during the acquisition of a collaboration opportunity but this is out of the scope of this work.

In collaborative business relationships a negotiation might be performed either between two single parties or among several parties (multi-party negotiation). In the case of the contract / agreement envisioned by the WizAN tool both negotiation types are supported.

The full negotiation process is guided by a 'contract or agreement template' composed of a number of sections. Each section refers to a specific topic to be addressed in the negotiation. Therefore, every issue that is subject of negotiation is called *negotiation topic*. When a negotiation topic is created in the system it is associated to a specific section of the agreement where a link to the topic is kept (figure 5).

Depending on the nature of the negotiation topics, they can be closed according to different conditions: (i) by unanimity, meaning that all participants involved must agree upon the topic; (ii) by majority, where only the majority of the involved participants need to agree on the topic; and (iii) informative, that happens when the VO planner decides to launch some subjects that do not need the participants approval. For each negotiation topic a virtual sub-space, where the topic is discussed / negotiated among the involved participants, is created - a *virtual negotiation room* (similar to what other authors call *virtual negotiation table*).

Once all negotiation topics that need to be negotiated are agreed, the composite agreement can be assembled into a document that represents a 'compilation' or integration of the agreements reached on all negotiation topics.

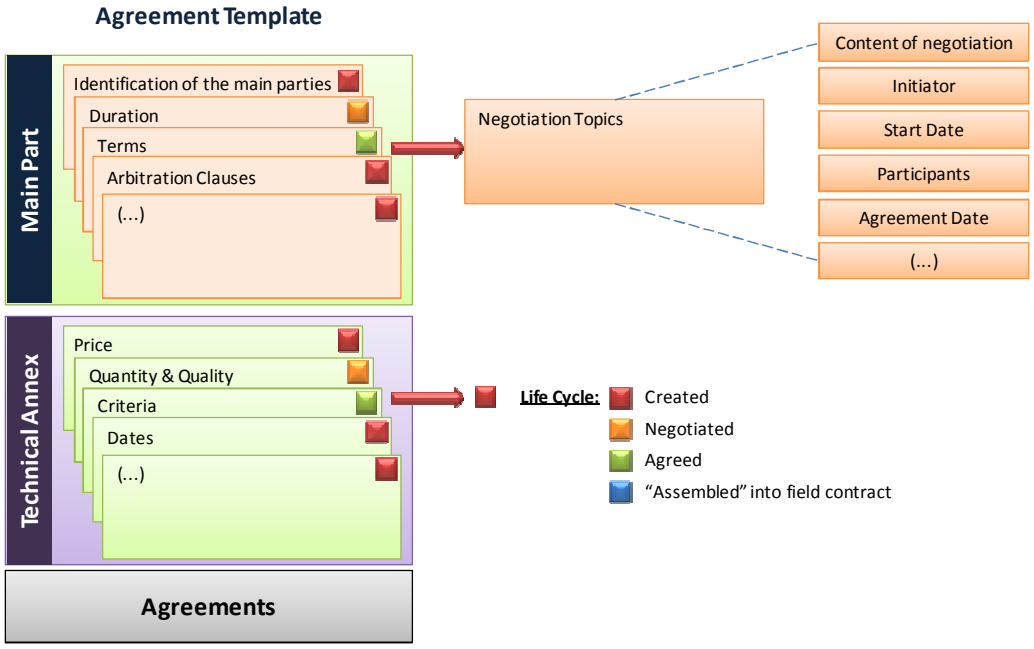

Figure 5 – Agreement template and negotiation topics

In terms of workflows and protocols, the negotiation process is quite difficult to structure since several flows depend of decisions made by the human negotiators (Buttner, 2006) and also their individual timing (mostly asynchronous regarding each other). Therefore WizAN was designed to allow considerable flexibility regarding this process.

To assist the human actors in the negotiation process WizAN includes four main modules, namely: Contract Editor (CE), Virtual Negotiation Room (VNR), Support for Agreement Establishment (eNotary), and Assisted Contract Elaboration System (ACE).

4.1. Contract editor (CE)

The WizAN Editor is the main interface to the WizAN tool. In the contract editor (CE), users can find the base information regarding the agreements being established among the VO partners. Through the editor the VO planner is able to initiate, conduct, and monitor the VO creation; as it deals with the general part of the agreement that is being established.

For presenting such information, the CE provides four distinct levels of entities: *General Information; Supporting Documents*; *Negotiation Topics*; and *Signing of the final agreement*. Figure 6 shows an example of the CE GUI for a VO that is being negotiated. The editor provides different functionalities to its users according to their role, since different roles might have different permissions / visibility access to the VO/VBE information. If the user is playing the role of VO planner, then the available functionalities are:

- *Add partners to the VO:* according to the CO characteristics add partners to the consortium under construction from the set of VBE members taking into account the preferences of the planner. For this activity the VO planner might accept the suggestion of the PSS tool or make a manual suggestion;
- *Add / read / edit documents that refer to the general part of the VO:* the planner is able to edit the documents that are attached to the general part of the agreement of the VO. Each time a document is modified, the system keeps a record with document versioning control. Only the VO planner can delete/remove these attached documents;
- *Create new Virtual Negotiation Room (VNR):* the planner is the only member that is allowed to create a new VNR whenever a new topic requires discussion among some or all partners;
- *Produce the final agreement document:* when all negotiations are closed and there is no need for further discussion, the VO planner can generate the document that represents a synthesis of the VO reached agreements.

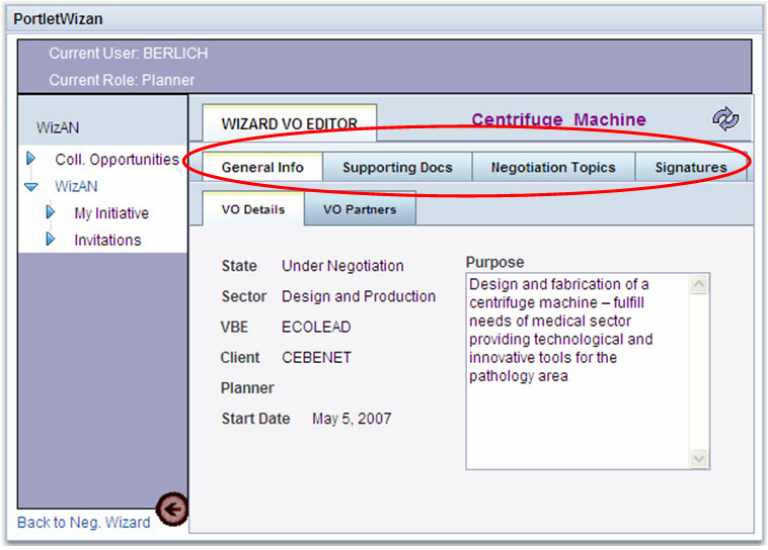

Figure 6 – Example of WizAN contract editor GUI

If the user is playing the role of potential partner, the available functionalities are:

- *Participation acceptance:* whenever a VBE member receives an invitation to participate in a VO, it can accept or reject the invitation through the editor;
- *See general conditions of the VO:* through this editor, the potential VO partner can access to the general conditions of the VO being created;
- *See involved partners in the VO:* it is also possible to have access to the information regarding the other participants of the VO being created;
- *Read / add documents to the general part of the VO:* playing the role of partner, the user can read all documents that are related to the general agreement of the VO, but can only edit the ones that were created by himself/herself. When adding a new version of the document, a history track is kept;
- *Have access to the VNRs:* the partner will have access to a list of all VNRs to which it has been invited to participate in (potential partners will not be able to visualize VNRs where they have no participation);
- *Signing functionality:* when all the discussions are already closed and the VO planner has already generated the composite VO agreement, each partner has to accept and sign it, with the help of the eNotary module.

4.2. Virtual negotiation rooms (VNR)

When the VO planner wishes to discuss any specific topic with certain members, he / she creates a virtual sub-space inside the VO negotiation space, i.e. a new virtual negotiation room. Therefore, the VNR is a virtual 'place' where the negotiation takes place. Through the VNRs each participant can access the various negotiation topics and discuss with the other involved participants in order to reach agreements. For each negotiation topic there will be one corresponding VNR. In figure 7, the instantiation of the negotiation objects for evaluation and discussion by the invited potential VO partners is illustrated. Each VNR can be divided into two distinct parts: one for edition of the negotiation topic characteristics and associated documents, and another for enabling discussion among the partners involved in the negotiation topics.

The **edition** part of the VNR provides functionalities for the VO planner such as:

- *Add partners to the room (negotiation topic):* choose from the partners already invited to the VO, the ones that are directly involved in the discussion of a certain topic**;**
- *Choose the topic agreement modality:* each topic might have a different agreement modality depending on what it concerns. The topics might be agreed by: unanimity (when all partners must agree), majority (when only the majority of partners have to agree), or informative (when there is no need for partners to agree);
- *Add / read / edit documents that refer to the VNR:* manage the associated documents;
- *Open discussion area:* with the functionalities of chat and forum. In the case of the forum, partners will only have access to the topics on which they have a direct participation;
- *Close VNR:* manage partners' commitments.

On the other hand, partners involved in the negotiation have some restrictions regarding the use of these functionalities, namely in what concerns:

- Adding partners to the VNR;
- Editing associated documents;
- General management.

Moreover, the **discussion** functionality of the forum enables the involved members to discuss subjects related to the negotiation topic that they are dealing with. Each time a user enters the room, he/she has access to the discussions around the topics he/she is involved in. As a way to provide some confidentially, the partners are not allowed to view discussions about subjects they are not involved in. In addition to the forum of the specific negotiation topics, there are also the typical functionalities of chat.

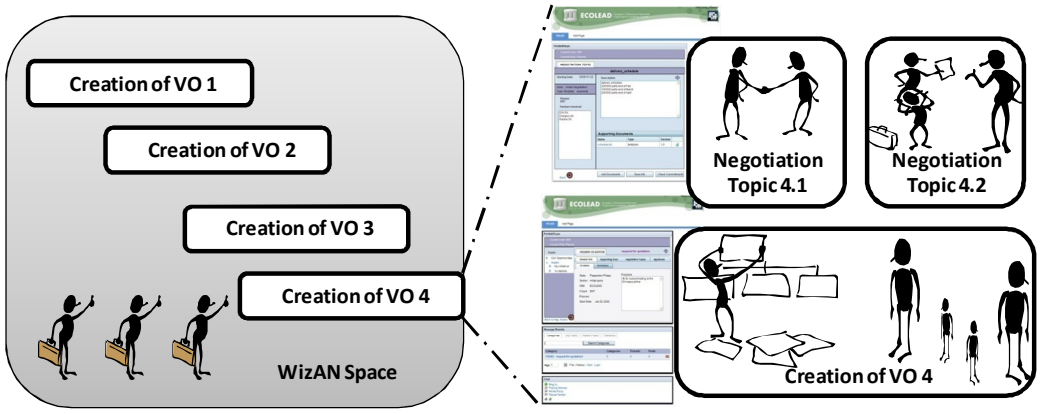

Figure 7 – Virtual spaces (virtual negotiation rooms) in WiZAN

Furthermore, whenever a potential partner requires a new negotiation topic, he/she can propose it to the VO planner through the discussion functionality. If the VO planner agrees with the proposal, he/she will initiate the new topic based on the requirements of the potential partner.

4.3. Support for agreement establishment – eNotary

The e-Notary is a module that allows clients to exchange information with a warranty of authenticity and validity as well as providing them with a safe repository to save and request documentation. Furthermore it provides the functionality for partners to (digitally) sign agreements.

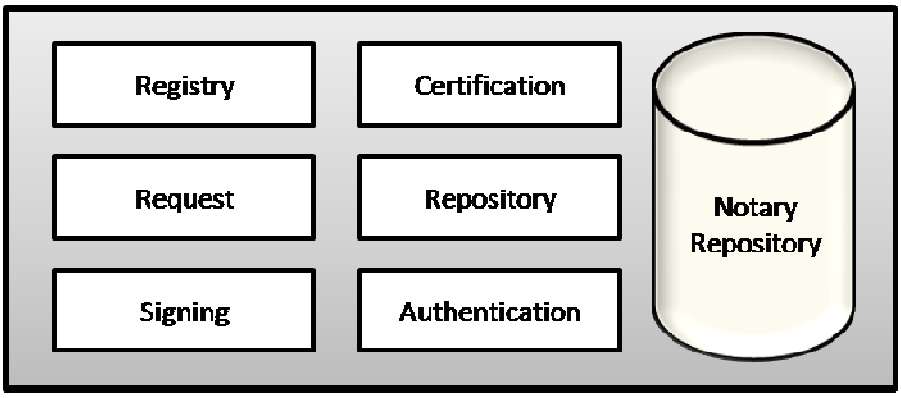

Figure 8 – Main eNotary functionalities in WiZAN

This module is developed as a web service allowing its clients to use the following functionalities (figure 8):

- *Registry:* any user who wants to use this service will be required to previously register in the notary. As the service works based on asymmetric key cryptography this is the moment in which the service and the user exchange keys. If the user doesn't have a key yet, one can be assigned;
- *Request documents:* any registered user can request documents that are available for him/her to sign or just for consultation. When a user requests the available documents, the service will return a list of documents and the actions associated with them;
- *Signing:* the notary is the entity responsible for validating each user's signature for each document. This functionality allows the user to digitally sign a document;
- *Certification:* a user can submit a document to the notary to be certified. The certification of a document ensures that the document is valid and is indeed signed by the people/entities it claims to be signed by;
- *Repository:* every document that is in any way submitted to the notary's appreciation will be saved both for future consultation and to provide means of certification;
- *Authentication:* provides ways for a user to guarantee its identity before any other entity.

4.4. Assisted contract elaboration system – ACE

This component provides participants in the VO creation process with the ability to write and sign digital contracts/agreements based on rules, clauses and categories. This is accomplished in a simple way and taking advantage of reusable components. To fulfil these requests the module includes editors to build the contract's structure and template and to instantiate the variable components of the contract ('variables') with the results from negotiation. The contract's correctness is validated by a number of checkers that act based on user defined rules. Thus, virtually anyone is able to write

a contract and submit it for negotiation and signature by other members, with a guarantee that it is structurally correct.

The contract's construction process can be divided into four phases:

1) Building/editing the contract's skeleton;
2) Building/editing the contract's template;
3) Instantiating the contract's variables with the negotiated topics; and
4) Submitting the contract to the eNotary to be signed and saved for consultation.

Along this pathway eight different components are involved:

- *editor of rules, categories and collaboration types:* to provide means to create or edit a new rule, category or collaboration type (depending on the type of consortium for which the contract will apply, e.g. explicit consortium (Camarinha-Matos et al., 2008 a))) and all other associated properties;
- *editor clauses:* allowing the user to create new clauses, inserting text, variables and rules associated to corresponding clauses;
- *editor of the contract's skeleton:* to allow a user to create areas in a new document that will be placeholders for clauses;
- *repository of the contract's skeleton:* to provide facilities for contract skeletons list viewing, associated properties viewing, saving and loading of a contract skeleton;
- *editor of the contract's template:* to provide lists of available clauses for each placeholder based on the type of placeholder and, if sufficient information exists, suggests some for each area;
- *repository of the contract's template:* to provide a list of contract templates viewing and all its associated properties, saving and loading of a contract template;
- *editor of the contract's variables:* to provide the user with the ability to replace the variables in a contract with concrete values;
- *information repository:* where the contracts and other information are stored.

Table 1 presents a summary of the functionalities of the four modules described above as well as the outputs of each one of them and the involved actors.

Table 1 – WizAN's main functionalities

Functionality	Description	Outputs	Actors
Contract Editor (CE)	Uses the CRT repository and agreed negotiation objects to add clauses to contracts	Contracts	VO Planner
Virtual negotiation room (VNR)	Virtual 'place' where the negotiation participants can access the various negotiation objects and can 'discuss' in order to reach agreements	Agreed negotiation objects	VO Planner and all possible partners
Support for agreement establishment (eNotary)	Set up facilities for contract signing and notification to relevant parties, and repository/archive for its storage	Repository with signed contracts	VO Planner and all partners involved
Assisted Contract Elaboration System (ACE)	Collection of contract templates and negotiation object templates to support the contract creation	'Skeletons' of contracts	VO Planner

To summarize, the main objective of the designed and developed agreement negotiation wizard is to offer in the same environment functionalities for conducting and managing the VO creation phase with special relevance to the negotiation phase.

In the developed environment it is possible to: ensure the potential partners commitments; enclose required documentation; create and manage virtual negotiation spaces where the actual negotiation on the negotiation topics (also known by clauses) are discussed and agreed; generate a document that represents a summary of all the established agreements, with its supporting documents and rights and duties of participants; and digitally sign the generated contract /agreement document through means of an electronic notary. All this is enhanced by discussion functionalities such as messages board and chat.

In the following section an example of how the WizAN tool can be used in a real case scenario is illustrated.

5. Illustrative scenario

The following example scenario is based on a case study of the DecoCHina Swiss-Chinese multicultural VBE.

5.1. Collaborative context

Basically, the DecoCHina collaborative network consists of two interacting VBEs, the Swiss Microtech regional network (SMT) and a Chinese network located in the Guangdong province, which have their own activities and collaborate on specific orders when it brings a competitive advantage for their customers (Pouly et al., 2008). Swiss Microtech (SMT) is a network of seven independent SMEs active in the small parts machining industry. They produce parts for the watch making, automotive, medical, space and telecommunication sectors and export 90% of their production (figure 9).

Figure 9 – Examples of parts manufactured by SMT

Swiss Microtech has defined as a strategy to be proactive and prepared to address the current market needs by adding further production capacities in a fully flexible way and outsourcing parts that can no longer be produced in Switzerland in order to survive in a very fierce competition. SMT also aimed to be able to 'follow' important customers in China through local production and to address the Chinese market which is considered by the financial analysts' community as one of the main future global players.

As parts produced by Swiss Microtech often require the collaboration of different partners contributing with specific technologies and know-how and considering the market analysis made by the network in Switzerland, the association to a partner network in China (figure 10) looked a very promising solution with real win-win prospects:

- SMT could outsource the parts which cannot be produced in Switzerland for price or capacity reasons to the Chinese network which would get new orders and profit from the worldwide sales organization of SMT.
- SMT could 'redirect' an important customer to China with the partner network acting as a local proxy. In this case, most parts would be produced in China, some others in Switzerland, but all parts would be delivered by the DecoCHina network.
- Swiss Microtech would be able to produce in China without having to invest all the necessary resources to plan, install, start and operate an own local factory, resources which are beyond the possibilities of small SMEs like the SMT members.
- The actual and future Chinese markets will be addressed by the local Chinese network that would sell its own parts but also some special parts that it is not (yet) able to produce locally and that can be made by SMT.

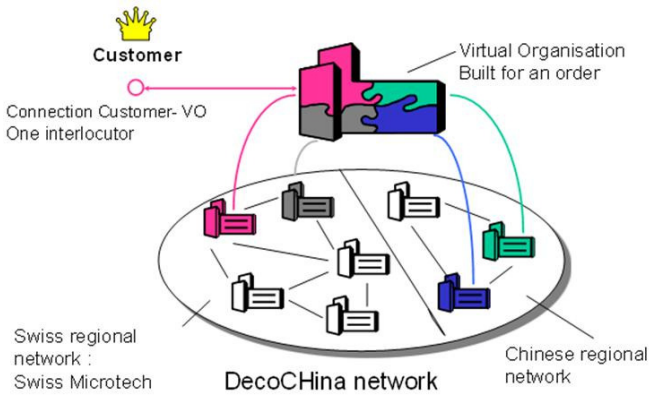

Figure 10 – The DecoCHina CNO

5.2. Negotiation example

Before starting commercial operations, the following business processes between the two networks have been defined: request for quotation (1), order management (2), and delivery (3).

The *request for quotation process* will be here analyzed in more details to show how a negotiation support tool like WizAN can help reducing the delays which are far too long when only traditional communication methods are used. As shown in figure 11, the first activity of this business process is the *request for quotation (1.1)* addressed by SMT to the Chinese partner network. This request contains the drawings (dimensions, tolerances, surface quality, and material), the quantities and the corresponding delivery schedules. The second activity (1.2) is *the selection of the potential partners* within the Chinese network which could participate in a possible order (candidates to constitute a virtual organization) and which must first give their prices and delivery schedules. The third activity is the *technical clarification* (1.3) of the quotation based mainly on the information included in the drawings of the parts and the preparation of a *quotation* (1.4). The last activity is the *commercial negotiation* (1.5) on prices and schedules.

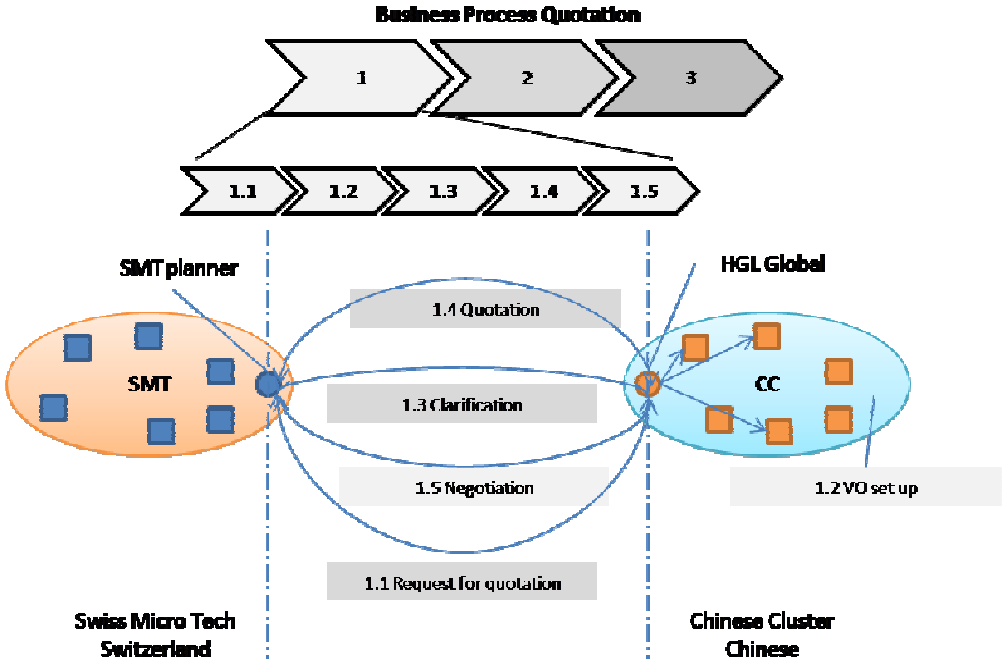

Figure 11 – Interactions of the business process 'request for a quotation'

The agreement negotiation wizard (WizAN), developed by UNINOVA within the ECOLEAD project, is used by the broker or VO planner in charge of the preparation of a quotation including members of the two networks and allowing him to cover the activities highlighted in 1.1, 1.2, 1.3, 1.4 and 1.5 with the support of the following functionalities:

- Specify the main characteristics of the product or service being developed;
- Append the necessary documents, as drawings, technical specifications, etc.;
- Create and edit the main part of a future agreement;
- Add partners for the agreement preparation;
- Create Virtual Negotiation Rooms according to the requested topics to be discussed and agreed upon and invite all or some partners to enter the corresponding room;
- Keep track of the partner's commitments and agreements (e-signatures);
- Produce the final agreement.

In the following sub sections, the process to complete the quotation business process is illustrated.

5.2.1. Step 1 – VO preparation: creation of VO details

The broker (from the SMT side) defines a new possible VO in WizAN (VO characterization - figure 12) with the corresponding documents, such as drawings including dimensions, tolerances, surface quality, material, the quantities and the

corresponding delivery schedules, which are annexed in the 'supporting documents' part of the wizard (second tab 'supporting Docs' illustrated in figure 13).

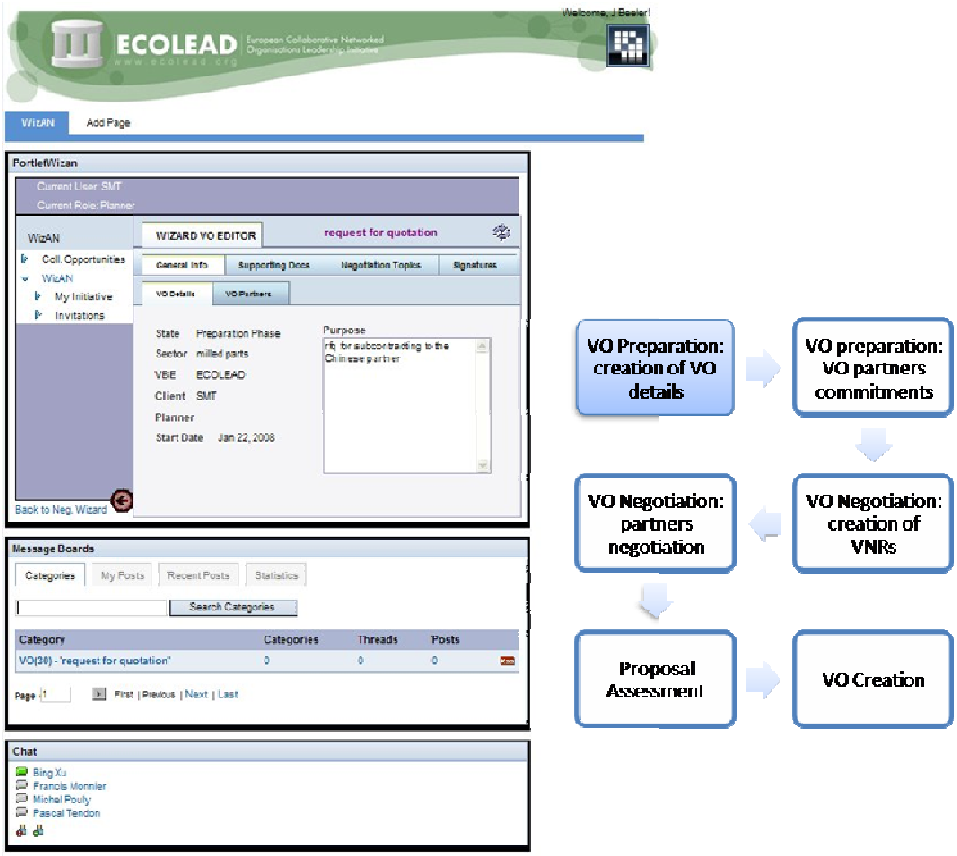

Figure 12 – WizAN user interface for the agreement editor – VO characteristics

Then, together with the list of suitable members from the SMT network, the VO planner invites the appropriate members from the Chinese network to join the newly created VO to respond to the business opportunity.

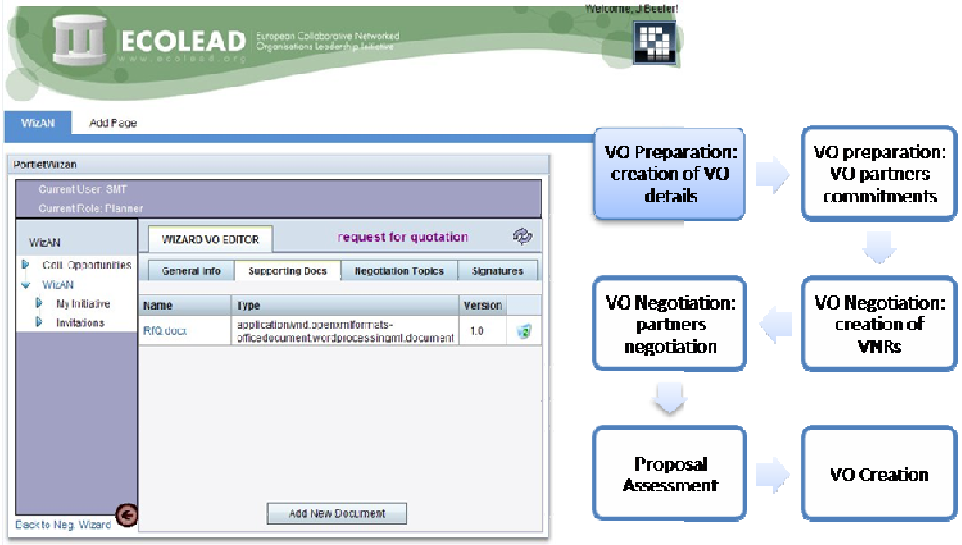

Figure 13 – WizAN user interface for the agreement editor – VO documents

5.2.2. Step 2 – VO preparation: VO partners commitments

After sending the invitation to the suitable possible partners of both networks (Swiss and Chinese), the VO planner is able to track the commitments of each of the invited companies. To accept the invitation, on the invited partners side, they can also access the annexed documents and general properties of the newly proposed VO.

In figure 14, the list of invited partners and their invitation status can be seen. In the illustrated case, all partners have already accepted to participate in the VO that is being created. If any of the invited companies does not want to accept the invitation, they must decline it. The SMT broker will call any on them in case no change in the VO partner acceptation status is recorded after max. 1-2 days (meaning that they did not accept nor reject the invitation).

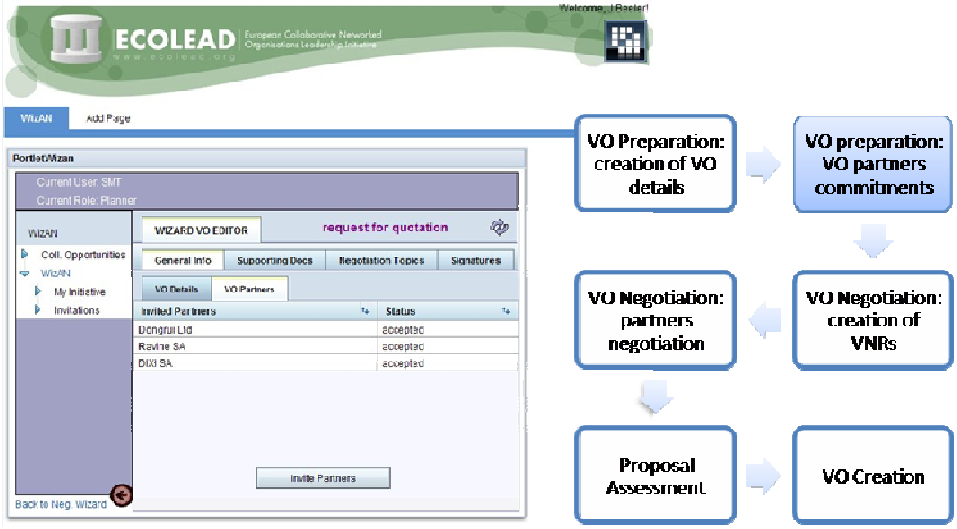

Figure 14 – WizAN user interface for the agreement editor – VO invited partners

Through this functionality, the VO planner will have a register of the commitments of all invited partners. From this point on, the potential partners are committed to the negotiations that follow.

5.2.3. Step 3 – VO negotiation: creation of VNRs

To start new negotiation topics, the involved partners are supposed to have previously accepted to participate in the VO. Otherwise it will not be possible to create a new negotiation topic. To create new topics (on the VO planner side) there is the 'Negotiation Topics' option on the 'Wizard VO Editor' where the necessary data shall be introduced. When the planner decides to create the first negotiation topic, the VO phase changes to 'VO Under Negotiation'.

In this example, the VO planner from SMT creates three negotiation topics:

1) Technical issues (raw material definition, tolerances, applicable norms etc.);
2) Delivery schedules (example in figure 15);
3) Price and commercial conditions.

Each negotiation topic is discussed in its own negotiation room (example of delivery schedule in figure 15). Note that for specific VNR, the VO planner only invites the necessary partners to participate. In that case, only these partners will have

access to the negotiation. This way, privacy of negotiation and participants' data is ensured. All launched topics shall be discussed and agreed by the corresponding partners involved in each topic.

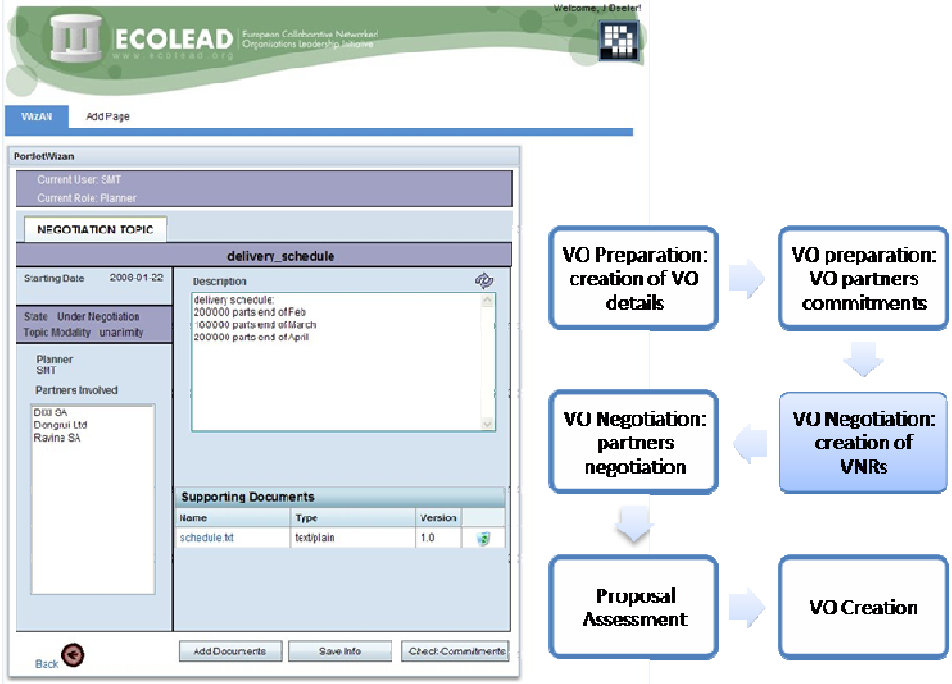

Figure 15 – WizAN user interface for VNR – negotiation topic for delivery schedule

5.2.4. Step 4 – VO negotiation: partners negotiation

The Sales department of the contact company of the Chinese cluster forwards the request to its Quotation Engineering department. The quotation engineering department together with the collaborators responsible for raw material purchasing and subcontracting will perform a feasibility analysis and cost calculation. Possible discussions on the negotiation topics will then take place.

For the e-discussions between China and Switzerland during the quotation negotiation phase, users can use the discussion functionalities, such as chatting and forum provided by the WizAN tool.

A functionality that is of great importance is that all documents that are uploaded into the VNRs are stored with versioning control allowing users to keep track of the changes that the documents might have suffered.

After completion of all technical and commercial negotiation topics, the VO planner will want to close the negotiation. Nevertheless, and if the topic must be agreed by unanimity, he can only do it if all partners involved in agree on the topic being negotiated. To ensure that, the VO planner can check from time to time if all the partners have already agreed through the 'check Commitments' button of the interface illustrated in figure 15. If all partners have already agreed on the topic, then the VO planner will close the negotiation as illustrated in figure 16 (this functionality only becomes available, when all partners agree on the specific topic). Through this functionality, a consensual agreement is guaranteed.

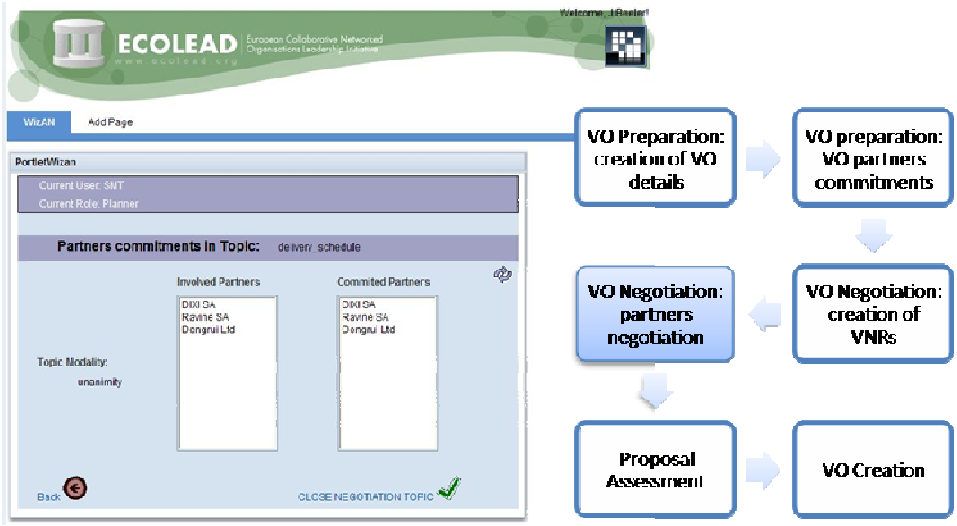

Figure 16 – WizAN user interface for VNR – partners commitment

After all negotiation topics are closed, the VO planner can create the composite agreement. From this point, the status of the VO changes to 'Proposal assessment', which will last until the agreement document is signed by all involved partners in order to become valid. At that stage, it will no longer be possible to add new partners nor create new VNRs.

5.2.5. Step 5 – Proposal assessment

The VO planner (from the SMT side) can create the final agreement, which must be signed by all VO partners before completing the VO negotiation process. In order to digitally sign the agreement, each participant has its own digital public/private keys that were assigned to them when they first used the WizAN editor.

The entire process of eNotary to register and sign the agreement document is completely hidden from the users (figure 17). What happens is that the planner sends the document that represents the agreement to the eNotary, generating a hash code of the document that can also be understood as a digest signature or stamp. Subsequent to this action, the generated hash code is sent to all partners involved in the negotiation. Only with the correct hash code of the document, partners will be able to request the exact document from the eNotary and through their private key digitally sign it.

As the VO planner is the one that conducts all the VO creation process, in particular the negotiations that take place, he/she automatically commits to the negotiated and agreed topics, meaning that he/she automatically signs the agreement document when he/she creates it.

Figure 17 – WizAN interface for agreement signing / example of agreement document

This process guarantees a complete authenticity of the agreement document and annexed documents. Another important perspective of this process is the considerably time reduction as partners only have to briefly interact with the tool at this stage, saving them a considerable bureaucratic work.

5.2.6. Discussion of results

As mentioned above, the main focus of the agreement negotiation wizard (WizAN) is to facilitate reaching an internal consortium agreement that summarizes the results of negotiations and discussions that are performed during the VO creation process. The negotiation process for the VO creation essentially occurs in two distinct situations: (i) to select the potential VO partners to compose the VO; and (2) to reach agreements on the details of the VO.

From the experience acquired with this case study some conclusions may be drawn in what concerns:

- Focused negotiation

  During a VO creation a large number of topics typically need to be discussed and agreed with different partners. This results in a diversity of 'negotiation focus' that can lead to loosing focus if the whole process is not properly organized.

  To conduct the necessary negotiations for the VO creation, it is necessary to create and edit the main part of the future agreement, specifying the main characteristics of the product or service being developed, and annexed the necessary documents to support the corresponding technical specifications. Afterwards, the necessary partners may be invited to participate so that the agreement is prepared. When partners accept the invitation, they became committed to the negotiation that follows. Subsequently and according to the topics that require negotiation, it is then possible to create virtual negotiation rooms to discuss and agreed upon the topics.

  As WizAN supports both bilateral and multi-party negotiations and keeps the negotiation flows organized according to the various VNRs, the focus of each negotiation is more easily kept. On the other hand, as the VO planner is able to choose the modality in which each negotiation topic is created (unanimity, majority, and informative), also no rigidness is imposed to the topics. Furthermore, when a virtual negotiation room is closed, no further changes can occur. Nevertheless, in order to ensure a consensual agreement, the system does not allow the VO planner to close any negotiation without all partners agree and commit to it.

- Preventing misunderstandings

  As all negotiations and agreements reached during the negotiation phase are recorded and represented in the VO agreement, the risk of misunderstandings is reduced. The main supporting mechanisms are the possibility to keep track of the achieved commitments and agreements and their validation through means of public/private keys and digital signatures. Moreover, making available a versioning control of documents that are uploaded either related to the general part of the VO being created, or to its specific virtual negotiation rooms, allows users to keep track of changes that a document might have suffered along the negotiation process thus avoiding misinterpretations.

  As WizAN operates in interaction with the VBE Management System also developed in the ECOLEAD project, its users have access to the common VBE ontology that defines the main domain terminology used in this sector and thus facilitates mutual understanding. One of the practical consequences is the reduction of the number of iterations in the preparation of technical documents associated to the agreement.
- Authenticity

  The existence of an eNotary service is a means to provide the exchange of information with a warranty of authenticity and validity as well as to provide the system with a safe repository of information, guaranteeing the authenticity of the agreement document and its annexed files.
- Privacy

  The system ensures privacy in terms of negotiation topics. Although all potential VO partners have access to the general information and documentation of the VO that is being created, only the ones that are directly related to the negotiation topics are invited to participate in their discussions. As a way to provide some confidentiality, partners are not allowed to view discussions about subjects they are not involved in. Thus, the exchange of information and documentation of each virtual negotiation room is private to its participants and their personal data is ensured. This is an important mechanism to allow discussions on sensitive matters.
- Time reduction

  By using traditional communication methods and tools to conduct a negotiation process, sometimes the delays are significantly long. With the usage of the proposed wizard, the delays may be reduced. The main reason is due to its structured outline that allows the VO planner to keep track of the chronology in which the negotiation is conducted. Thus, the VO planner can be alerted and proceed with other communication mechanisms and reminders if necessary.

  This could also be done via email, but with additional administration effort. A practical advantage of using WiZAN is the automatic organization of the negotiation steps. This is particularly relevant in a context as the exemplified one.

  As negotiation may occur several times in the VO creation process (either between partners or to detail the consortium agreement specifications), WizAN makes the entire process of VO creation considerably more agile and efficient.
- Integration

  The system may be of great use in a VBE context where the VO planner will also have access to other functionalities such as the VBE members' profiles and records of past performance. With the first one, the VO planner is able to select the potential VO partners based on their competencies, while with the

second one he/she can have access to indicators of past performance of some potential partners and thus better select the appropriate partners to compose the VO being created.

Although the main objectives were achieved with this prototype, much work is still required. One of the possible directions is to revise and adapt the used methodologies and protocols so that the proposed wizard can fit a negotiation with customers.

6. Conclusions and future work

The time and amount of resources consumed during the VO creation process whenever a business/collaboration opportunity is acquired, give a good indication of the level of agility of a collaborative network. The effectiveness of this process mainly depends on the availability of adequate information about potential partners and their level of preparedness for VO involvement. The existence of a VO breeding environment facilitates the fulfilment of these requirements as it provides common infrastructures to its members.

The main contribution of this article is the introduction of a negotiation support system in the collaborative networks context with an example of use. What makes the case of collaborative networks different is its complex environment. In this case, not only bilateral negotiations have to be considered, but also multi-lateral negotiations in a multi-cultural context.

Being contextualized in a virtual organization breeding environment makes the entire process of VO creation considerably more agile and efficient (Camarinha-Matos et al., 2008 b)). But even in the context of a VBE it is necessary to improve the negotiation processes that must take place during a VO consortium formation. The Agreement Negotiation wizard (WizAN) was designed to facilitate this process. By using the proposed wizard, users are able to compose an agreement document that represents a synthesis of all VO partners' commitments that are reached during the negotiation phase, which significantly decreases the risk of misunderstandings and consequent contestations. Moreover, the environment allows the usage of collaboration tools, for instance discussion forum, associated to each specific topic of negotiation and only for the involved partners. As such, it is possible to guarantee confidentiality. Also for ensuring authenticity, an eNotary was introduced so that the agreement documents remain authentic and can be digitally signed by all partners. The WizAN tool also contributes to make the quotation process in a collaborative network compliant with the ISO 9000 certification that requires repeatable and traceable processes.

Nevertheless, there are some areas where some research challenges remain. As an interesting topic for research is how to improve and better adapt the negotiation wizard to multidisciplinary and multicultural environments that are used by people and organizations with different business practices, languages, objectives and terminologies. Thus, although several works already mention the negotiation phases and taxonomy, a research challenge is the definition and formalization of more specific negotiation protocols for collaborative networks. Furthermore, though the aim is not to achieve a level of automation where humans are no longer required in the negotiation process, one issue that might also be subject of consideration in future works is the definition of the negotiation process as an exchange of negotiation objects followed by a phase of agreement formation, supporting a certain level of automation for some functionalities of the negotiation process, making it more efficient and agile.

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