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# An Environment to Support Negotiation and Contracting in Collaborative Networks


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# 1. Introduction to the Problem

*This section introduces the context in which the research work is aimed to be developed, namely the addressed problem with its open issues and the main motivation to accomplish it.*

## 1.1. Introduction

As a result of the persistent market instability, companies and organizations have to continuously adapt their operating principles to search, face and act in response to new business or collaboration opportunities in order to survive and remain competitive in the global market.

Therefore, to promptly respond to such business or collaboration opportunities, and because companies and organizations might not be able to react by themselves, they will have to collaborate with their peers.

Moreover, in this context, when two or more companies or organizations come together for a common purpose, they must also join forces with their clients so they can stand to win. Therefore, companies and organizations should then have to restructure and make use of an infrastructure that allows them to become more agile.

Thus, the possibility of rapidly forming virtual organizations to respond to a business or collaboration opportunity gives companies an expression of agility and survival mechanisms in face of this market turbulence. That is why the topic of collaborative networks (CNs) appears significantly promising because if the enterprises or the organizations share a common interoperable infrastructure, common operating principles, common cooperation agreements, and a base of trust among them, then their ability to rapidly form a virtual organization (VO) is increased (Camarinha-Matos et al., 2008a).

Nevertheless, to form a VO, besides the important and classical task of selecting the adequate partners with the most suitable competencies to form a consortium able to respond to the requirements of the business or collaboration opportunity

(BO/CO), it is also of extreme importance to have a robust and reliable negotiation mechanism that supports the potential VO partners in achieving agreements during the VO creation process, reducing the amount of time spent in this process. These VO agreements will then be the basis for the governing principles of the VO during its operation phase.

Furthermore, depending on the different domains or on the different objectives, CNs, and specifically VOs, may appear in a variety of forms with a variety of behavioral patterns (Camarinha-Matos and Afsarmanesh, 2008a). Thus, due to this possible varieties it is also essential to take into account each context and its fundamental characteristics. This also applies to the negotiation process that will have to be *adaptable* to each specific case.

## *1.2. Main Problems in the Area*

Having introduced the context and focus of the problem, what are then the main issues that companies and organizations face when creating VOs? For example, in the industrial sector, the 'quotation request' business process is a challenging task for every company involved in subcontracting activities as potential customers have nowadays access to a very large global market. As a consequence (Oliveira et al., 2010):

- 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 thus the price calculations must be very accurate;
- The quotation must be ready in a very short time as competitors also react quickly.

In the case of Collaborative Networks the quotation process is even more difficult due to the supplementary delays induced by the participation of various partners and the need to have several negotiation rounds until an agreement is reached.

The delays induced in this process are mainly the result of having to deal with several critical issues, such as (Camarinha-Matos et al., 2008b):

- Finding / choosing the right partners;
- Coping with the lack of common templates or standard formats for basic profile information about organizations;
- Establishing trust among organizations;
- Developing and agreeing on the common principles of sharing and working together;
- Defining the agreements on the roles and responsibilities of each partner, to reflect sharing of tasks, the rights on the produced results, etc; and
- Coping with the lack of preparedness of organizations to collaborate.

Most of these problems have already found some possible solution through the concept and benefits of the virtual organizations breeding environment (VBE). Nevertheless, the issues of negotiation's time reduction and agility regarding the quotation or bidding processes are not completely supported by the current infrastructures provided by these VBEs. Furthermore, it is also important to have a negotiation environment that enables companies and organizations to conduct their negotiation processes following a simple and easy approach.

## *1.3. Motivation*

The delays described above are not too critical within a small local CN 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 widely geographically spread networks. For these cases, there is a need to improve the effectiveness of the negotiation processes in the formation of virtual organizations, particularly at the stage of the quotation or bid preparation.

One important motivation is to contextualize the VO creation process in the VO breeding environment (VBE), making use of all its infrastructures and functionalities.

Furthermore, understanding each partner's motivation and expectations when entering into a collaboration process can be of extreme importance in order to prevent unnecessary risks during that collaboration.

# 2. Research Question

*Given the introduced problem area and motivation for this work, this section introduces the main research question to be addressed, together with its corresponding hypothesis. Additionally, some detailed questions are also presented.*

## 2.1. Research Question

Whenever a business or collaboration opportunity is identified, if the interested entities are clustered into VO Breeding Environments (VBEs) (Afsarmanesh et al., 2008), the chance of acquiring the business opportunity becomes higher. Nevertheless, although the mechanisms and models provided by the VBE to its members already facilitate the VO formation, one important stage that is specific for each case is the negotiation among possible VO partners, which implies dealing with numerous differences that those partners might have, for example, cultural differences or interests. Thus, having into account this background, this work aims to find better ways to support the negotiation process that happens during the VO creation phase, which certainly has a relevant impact on the agility and reliability of the process, and can contribute to the successful execution of the VO during its operation phase.

Taking into consideration the described virtual organization breeding environment context for the creation of virtual organizations, one important question is how can this process be improved with the aid of a negotiation methodology, especially when dealing with market turbulence, low success rate, and natural delays in negotiation. These three aspects are particularly significant due to:

- **Market Turbulence**: The possibility of rapidly form virtual organizations to respond to a business or collaboration opportunity gives companies an expression of agility and survival mechanisms in face of the market turbulence.
- **Low Success Rate:** When facing the market, the consortia quotation process is very difficult. So, there is a huge number of potential consortia that fails

(in various sectors the success rate of a quotation lays around 10% (Oliveira et al., 2008)).

- **Delays in Negotiation:** The main drawback in the case of collaborative networked organizations, is the supplementary delays induced by the participation of many partners, possibly located in diverse geographical regions, and the need to negotiate till an agreement is reached.

Therefore, the main research question that emerges is:

***How can an electronic negotiation support environment increase the agility in the creation process of successful dynamic virtual organizations?***

## *2.2. Hypothesis and Approach*

As mentioned above, the main reason why it is important to have a consistent negotiation support in the formation of VOs in response to business or collaboration opportunities is essentially to improve the entire process of establishing the VO agreement that will regulate the main behavior of the consortium during the operation phase. Therefore, to achieve a consistent electronic negotiation support, it is of extreme importance to make a comprehensive analysis of the important characteristics that such support environment shall involve. Due to the heterogeneous contexts of the VO breeding environments that usually companies or organizations belong to, the problem solving and decision making processes of an electronic negotiation support shall use soft modeling techniques to support its desired characteristics, namely in terms of collaboration structure, risks, duration, trust, and potential partners expectations.

The hypothesis adopted for this work is:

**The process of creating dynamic virtual organizations can become more agile if an appropriate electronic negotiation wizard environment is established with the necessary soft modeling characteristics to structure and conduct the entire negotiation process, making it traceable, reducing the collaboration risks, and managing the participants' expectations. Moreover, the negotiation environment should be customizable according to different collaboration levels, either in terms of commitment or in terms of duration.**

The main outcome form the negotiation process will be the VO consortium agreement that will induce the governing rules and principles of the consortium during its operation phase. The agreement shall include the rights and duties of all partners involved, but can also include, for example, some sections on intellectual property rights, partners' benefits and shared risks.

For this significant topic on collaborative networks, besides establishing proper models, effective conceptual and technological support must be provided. Consequently, some detailed questions arise, such as the ones represented in Table 2.1 below:

**Table 2.1: Detailed Research Questions.**

| Questions | Some topics to be addressed in order to find answers |
|---|---|
| Which process/framework? | — Collaborative environments/networks<br>— Contract framework<br>— Electronic negotiation and institutions<br>— Different VO creation processes |
| How should the negotiation process be modeled? | — Collaborative problem solving<br>— Contract Models<br>— Electronic negotiation ontology / taxonomy<br>— Characterization of risks and failures in collaboration<br>— Creation of organizational strategies for collaborative risk reduction<br>— Definition of different levels of partnership / responsibilities<br>— Establishment of formal methodologies in collaborative consortia modeling<br>— Establishment of the desired automatic level of a negotiation environment |
| What are the main characteristics of a negotiation wizard? | — Negotiation support services<br>— Digital signatures<br>— Notary services (Auditing & certifications)<br>— Rules/suggestions for risk reduction<br>— Expectations management<br>— Customizable environment |
| What are the promising technologies to be applied in a negotiation wizard? | — Multi-agent systems<br>— Security protocols<br>— Standards (eg. LegalXML) |

Figure 2.1 illustrates the just described research scheme:

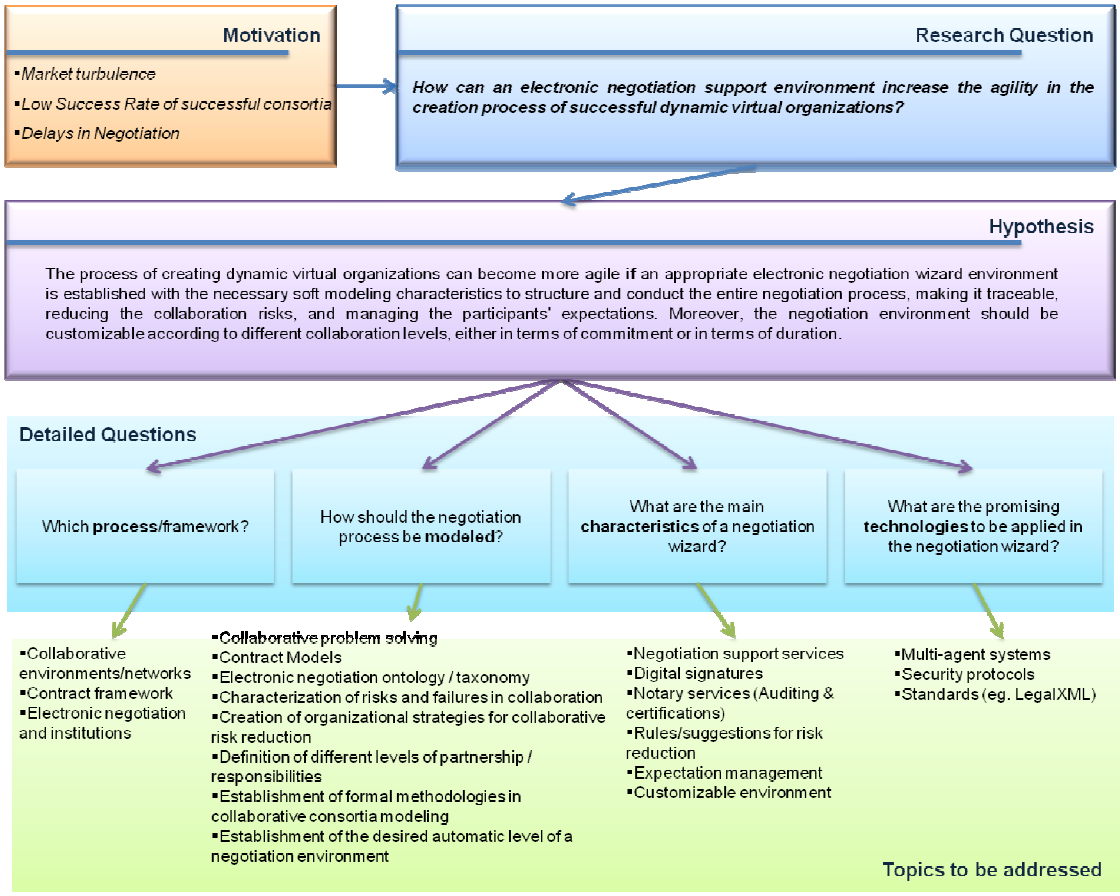


**Figure 2.1: Research Scheme.**

# 3. Literature Review

*This section introduces a brief literature review in related areas that provide the baseline for the planned research work. The most relevant area for this work is the collaborative networks discipline with special relevance for the virtual organizations (VOs) creation and their related environments, namely the VO breeding environments (VBEs). Also the electronic negotiation and contracting areas are of the most importance for this work. Some other related areas are also considered. Therefore, in the next three subsections a brief outline and discussion on these areas is presented, and a succinct review of how they are related to the main focus of this work is also included.*

## 3.1. VOs and their Related Environments

During past research on collaborative networks, the VO creation process has received considerable attention. However, most of the proposals and developments were aimed at designing a fully automated process and frequently based on a set of simplistic assumptions.

The Virtual Organization paradigm constitutes one of the first manifestations of the collaborative networks. Being the concept developed and applied in several domains and areas, many contributions for the characterization and modeling of the paradigm can be found in the literature, as exemplified by (Bititci et al., 2007; Camarinha-Matos and Afsarmanesh, 2008b; Camarinha-Matos, et al., 2008a; Parung and Bititci, 2008). The main idea behind this concept is basically of a temporary consortium of enterprises and/or organizations, geographically dispersed, that strategically join their competencies to rapidly respond to a business or collaboration opportunity.

For example, a large number of works have been published on the application of multi-agent systems and market-oriented negotiation mechanisms for the VO formation. One early example can be found in (Rocha and Oliveira, 1999), which assumes a virtual market place where enterprises, represented by agents, can meet each other and cooperate in order to achieve a common business goal. A similar

work is found in (Li et al., 2000) where a more detailed analysis of the problem of goal decomposition, leading to a hierarchy of VO goals, is done. The work described in (Shen and Norrie, 1998) identifies the need for yellow pages agents that are responsible for accepting messages for registering services. They also consider the notion of Local Area, a concept similar to the Local Spreading Center first introduced by the HOLOS system (Rabelo and Camarinha-Matos, 1994; Rabelo et al., 2000). (Reis et al., 2001) propose a model for a multi-agent cooperative scheduling system for an extended enterprise context.(Kaihara, 1999) elaborates further on the application of market-oriented principles, such as the general equilibrium in micro-economics. More recently, (Kaihara and Fujii, 2006) described a game-theoretic approach to support negotiation in VO formation.

Another line of work is the service-federation approach or implicit VO creation. According to this approach, companies (potential members of the virtual organization) are considered as "service providers", i.e. the potential collaborative behavior of each company is "materialized" by a set of services. Services are selected and composed in order to satisfy the needs of the business or collaboration opportunity and therefore the providers of those services implicitly form the VO (Camarinha-Matos et al., 2001). Early cases of such line of work is the case of the Fetish project (Afsarmanesh and Camarinha-Matos, 2000) which has introduced service-oriented approaches to VOs in the tourism sector called federated Web-based Tourism Information System (WTIS). Another example is given by the OSMOS project (Rezgui, 2007), which was focused on the construction industry and followed a service-based approach for the design and development of its ICT infrastructure. Moreover, (Kutvonen et al., 2008) introduced the Pilarcos architecture that addresses the needs of managed collaboration and interoperability of autonomous business services in an inter-organizational context. Using a federated approach, the Pilarcos B2B middleware is then designed for lowering the cost and effort of collaboration establishment and to facilitate the management and maintenance of electronic business networks.

Examples of standard technology that can be applied for service description, communication and data formats are the web services. The standards can include, for instance, WSDL (for service description), UDDI (for repository organization), SOAP (for service invocation), etc.

Other researchers put the emphasis on formulating the VO creation as an optimization problem. Several researchers present integer programming models where the objective is to minimize total costs which consist of production, operation, and transportation costs, for instance (Ip et al., 2004; Ko et al., 2001; Wu and Su, 2005). However, it has been recognized that VO creation is essentially a multi-criteria decision-making problem, including also soft factors such as corporate culture, personal preferences, mutual trust, level of preparedness, and learning ability, which are not incorporated in pure cost models. Responding to this challenge, earlier literature presents some multi-criteria models, which however seem to lack one important issue, namely explicit modeling of inter-organizational relations between partner candidates (Boon and Sierksma, 2003; Mikhailov, 2002; Sha and Che, 2005). Also, in (Johnson et al., 2009; Johnson et al., 2010) we can find a description of the nature of the complexities of large group collaboration that provides a basis for the thinking about this structural aspects of collaboration in virtual organizations from both a technical and social perspective.

Also, considering the partner selection for the virtual enterprises as a multi-criteria decision making problem, (Crispim and Sousa, 2007, 2009) propose an integrated approach to rank alternative VE configurations using fuzzy data.

Nevertheless, 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 potential partners' readiness and preparedness assumes that there is certain criteria to be considered for a group of organizations rather than for a single organization, such as the existence of a common interoperable infrastructure, common operating rules, common cooperation agreement, and a base trust level among the organizations. Therefore, an approach is to consider that dynamic VOs are mostly created in the context of a VO Breeding Environment (VBE) (Afsarmanesh and Camarinha-Matos, 2005; Camarinha-Matos, et al., 2008a; Camarinha-Matos, et al., 2008b; Romero et al., 2008).

Taking into account the mentioned considerations on VOs and their related breeding environments, below are the adopted definitions of VBE and VO:

VBE is 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 (Afsarmanesh, et al., 2008).

VO is a temporary consortium of enterprises and/or organizations, geographically dispersed, that strategically join their competences to rapidly respond to a business or collaboration opportunity. Typically VOs are supported by a computer network (Camarinha-Matos et al., 2009).

Given the above definitions, some of the main aims of the VBE include (Afsarmanesh, et al., 2008; Camarinha-Matos et al., 2007):

- 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, for example in the case of a partner failure; and
- Providing some commonality for interaction by offering:
    - Base ICT infrastructure (for collaboration), thus reducing the set up time during the VO formation;
    - Common metrics to evaluate member's trustworthiness and performance;
    - Template contracts for rapid involvement in VOs; and
    - 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 (Camarinha-Matos and Oliveira, 2007; Camarinha-Matos, et al., 2008b). As illustrated in Figure 3. 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., 2008b).

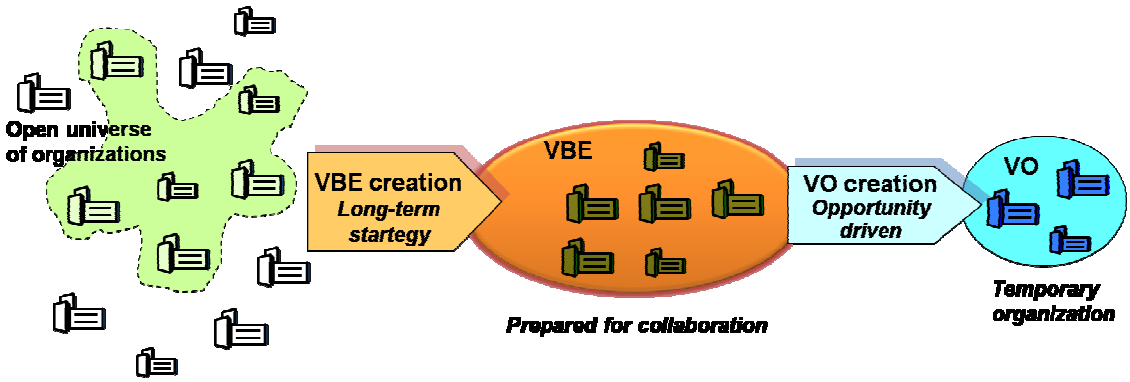


**Figure 3. 1: VO creation in a VBE context.**

As an example of the importance of the adopted models, recent works already make attempts to tailor Enterprise Architecture Modeling methodologies to the requirements of virtual organizations, as is the case of (Paszkiewicz and Picard, 2009). For that the fundamental elements being considered are also the ones adopted in this work for the VBE and VO that are inherited from the ECOLEAD project.

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 fulfill the opportunity requirements; or (ii) when it is necessary to go through a quotation process before having acquired the business opportunity (Camarinha-Matos and Afsarmanesh, 2007). Nevertheless, in both cases, the process of establishing a virtual organization can be quite complex, where several items have to be addressed. Although the most addressed topic in past works is the

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.

## *3.2. Negotiation and Contracting*

Negotiation is an iterative communication and decision-making process between two or more parties who seek a consensus decision and cannot apply unilateral actions to achieve their objectives (Strobel and Weinhardt, 2003; Turel and Yuan, 2007).

In collaborative environments, due to the heterogeneous background, context, and cultures, a negotiation processes can involve a transversal, multi- and inter-disciplinary approach. It is therefore necessary to have a holistic view of the problem, making use of multiple methodologies and paying attention to the practical details (Gimpel et al., 2006). 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 (Bartolini et al., 2005; Jennings et al., 2000), this continues to be a rather difficult issue. For example, the automation of negotiation using software agents is well suited when contextualized in well structured areas (Mancini, 2009; Weigand et al., 2003). One interesting work is the case of the V-Mart, an open market model and enabling framework for automated service negotiation and contracting in network virtualization environments based on auctions (Zaheer et al., 2010). Nevertheless, in most business settings, negotiation will still need to be performed by humans in the foreseeable future. In these cases negotiation support systems (Kersten and Lo, 2003) may have an important role to play. The main obstacle for the automation of the process is to produce a context-independent solution (Angelov and Grefen, 2002). Thus, as mentioned, only partial and very specific solutions and prototypes for negotiation are available, as it is for example the case of the eLegal project (Carter et al., 2001) where the main goal was to develop solutions to legal issues related to VOs in the area of the civil construction. Another

example in an area where there are not many solutions for negotiation is in the domain of services. In this field (Di Nitto et al., 2010) propose a Service Level Agreements negotiation architecture. Nevertheless, this solution continues to be very specific to customer-provider solutions and does not completely cover collaboration aspects.

When referring to contracts and negotiations, various proposals are related to customer-provider relationships, as the example described in (Gimpel, et al., 2006). 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. Nevertheless, is shall be noted that the application context is mainly one of simple marketing transactions and not collaboration.

In order to enable a fast contracting process an electronic representation of contracts is required (Grefen and Angelov, 2002) as standard paper contracting is often slow and requires involvement of human actors in all negotiation and contracting phases. Thus computer assisted negotiation and e-contracting is expected to provide a faster and cheaper solution than standard contracting.

Focusing on the internal consortium agreement (that is the contract or agreement being established among the VO potential partners), its relevance is to establish the necessary clauses to regulate the consortium behavior, governing rules and principles during the VO operation phase. Therefore, special attention should be put into e-contracting forms as they can capture and describe the rights and duties of all VO partners (Rocha et al., 2005), as well as specification of penalties to apply to those that do not satisfy the agreement. Furthermore, the legal and contractual issues associated to each contract/agreement concentrated on the ICT perspective can be found in (Shelbourn et al., 2005).

Computer assisted negotiation and e-contracting is expected to provide improved solutions than traditional contracting for geographically distributed consortia formation because it can be faster and cheaper. Hence, several significant characteristics of the e-contracting process can be found in (Angelov, 2006), namely the structured content that must be presented in a formal way preventing misinterpretations or contract violations.

Furthermore, an electronic contract can have both a machine readable and a human readable representation, being the existence of a human readable representation of the contract required when its creation and management involves the participation of human beings.

Moreover, the advances in the negotiation domain stem from the use of information systems and communication media to support negotiation processes and decisions. Negotiation Support Systems (NSS) are interactive, computer-based tools intended to support negotiating parties in reaching agreements. These systems provide varying levels of structured communications and decision support; and offer both dispute resolution mechanisms (i.e. dealing with infringements of existing contracts) as well as contract formation services (i.e., creating new agreements) (Turel and Yuan, 2007). Also, in the CrossFlow and E-ADOME projects, the established contracts describe the agreed activities and transitions as workflow interfaces based on WfMC's WPDL (Workflow Process Definition Language) (Chiu et al., 2001; Grefen et al., 2000). In addition, (Oliva et al., 2010) propose the SANA (Supporting Artifacts for Negotiation with Argumentation) framework that assists the negotiation participants to engage in negotiation dialogs generating and exchanging proposed deals in order to reach mutually-acceptable proposals. Nonetheless, this proposal assumes the existence of a mediator that regulates the entire negotiation process.

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 CN as a whole, and not only within the companies or organizations that are members of a CN (Oliveira, et al., 2008).

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 *Contract Models*, *Ontology*, *Contract Framework*, *Electronic Institutions*, *Digital Signature, etc.* Below, in the following subsections, some of these topics are addressed.

### *3.2.1. Contract Models*

Usually contracts 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 contract or agreement is the explicit representation of such consensus. Therefore, 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, where Bilateral negotiations are restricted to two negotiation partners (one buyer and one seller), one-sided multilateral negotiations are deemed to be the standard form of auctions and are either characterized by one seller and many buyers or vice versa, and finally double-sided multilateral negotiations are characterized by many buyers and many sellers. All these cases can happen in a VO creation. Deontic logic (Meyer and Wieringa, 1993) is used to describe contract models specifying obligations, permissions, and forbiddances for a specific business process, which works in an extremely ideal process mainly because it can facilitate the formal structure of the documents.

Accordingly, in the CN context, contract models can be characterized as templates that enable parties to specify contracts or agreements that can be monitored / enforced by a computer-supported contract framework.

About contract structure, 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.; and
- 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.

Another line of work can be found in (Barata and Camarinha-Matos, 2003) when defining a contract lifecycle to address coalitions of collaborating machines in an agile shopfloor environment. In this case, three main phases are described: formation, performance (which is the execution phase of the contract) and

termination. Also in this work, it is explicit that for a contract or agreement to become valid and robust, the formation phase of the contract is vital.

Although most of the presented models can be derived to the CN's context, they will have to be adapted due to the possible heterogeneous background of the involved organizations.

### *3.2.2. Contract Framework*

A Contract Framework comprehends a computer-supported environment in which a contract for a certain business opportunity is created / specified, executed and monitored (Xu, 2003, 2004; Xu and 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.

Although, in this research field, the main trend is to automate the contract or agreement negotiation process, in the scope of CNs there are cases where human intervention is definitely essential, especially when dealing with business processes. Another relevant aspect is the fact that there is no reference model for the negotiation process that should be applied in a generic case. So, an interesting research line is to derive a contract framework to cover the VO creation process.

### *3.2.3. Electronic Institutions*

Similarly to institutions in human societies, an electronic institution provides a structured framework for agents to regulate their interactions (Campos et al., 2009). Electronic Institutions are mainly frameworks that facilitate, 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 (Cardoso and Oliveira, 2008b; Rocha, et al., 2005).

Often electronic institutions are perceived as a formalism to define the rules in which structured agents interact, as it is the case described in (Esteva et al., 2004). In that 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, 2008a) 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. A good potential can be found in such type of work since it addresses the application into the B2B field, namely regarding the formation of virtual organizations. On a different perspective (Garcia-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 find higher-level normative languages.

Furthermore, (Aldewereld et al., 2007) propose an extension to electronic institutions to allow a flexible enforcement of norms to help overcoming the difficulties of translating nonfigurative norms.

Taking into account the mentioned works, one key aspect that has to be further considered is the case where fuzzy information exists. In this case, electronic institutions should also consider aspects of incomplete or uncertain information situations related to the negotiation process.

### 3.2.4. Digital signatures and authentication methods

Digital Signatures 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 signatures, such as DSA, RSA, blind RSA, Schnorr and ECDSA (COMMERCE, 2000; David and Jacques, 2000).

The digital signatures method is also taken into consideration in this area of work because it can ensure the legitimacy of a certain agent/participant to be part in a negotiation of a VO, and also for the formalization of the final contract agreement signature process.

### 3.2.5. Taxonomies and Ontologies

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 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. Nevertheless, in (Pereira and Soares, 2008) a method to support the collaborative construction of semantics in an inter-organizational context is proposed. There, the authors analyze the main problems and gaps in current ontology development methods regarding collaboration and negotiation in early development phases.

## 3.3. *Relation to current work*

When relating all the above different sections with the proposed research work problematic, it is noticeable that deeper research work is required in various fields specifically in what concerns mechanisms and systems to support communication, communities of organizations, ontology engineering, document management, negotiation protocols, etc.

Despite several works have already addressed some of these items, further research is however mandatory in particular regarding agreements and/or contracts establishment, because of the new requirements that are constantly challenging the current processes, specially due to the constant market evolution and technology advancement. Some of these challenges are related to communication channels, use of artificial intelligence methods, intellectual property rights, electronic institutions, etc. More specifically, if the main aim is to explore how an electronic negotiation support environment can increase the agility in the creation process of successful dynamic VOs, a complete collaborative background, where automation is not the focus and information for the agreement establishment is sometimes not clear, has to be considered. Thus, an environment that comprehends most of the described areas with the needed adaptations to support the aimed negotiation support of dynamic VOs with "smart" characteristics, such as: collaboration risks reduction, management of participants' expectations, traceability, etc., is then foreseen.

Below, Figure 3. 2 illustrates a temporal synthesis of some of SoA that is related to the proposed research work and has been mentioned in the previous subsections.

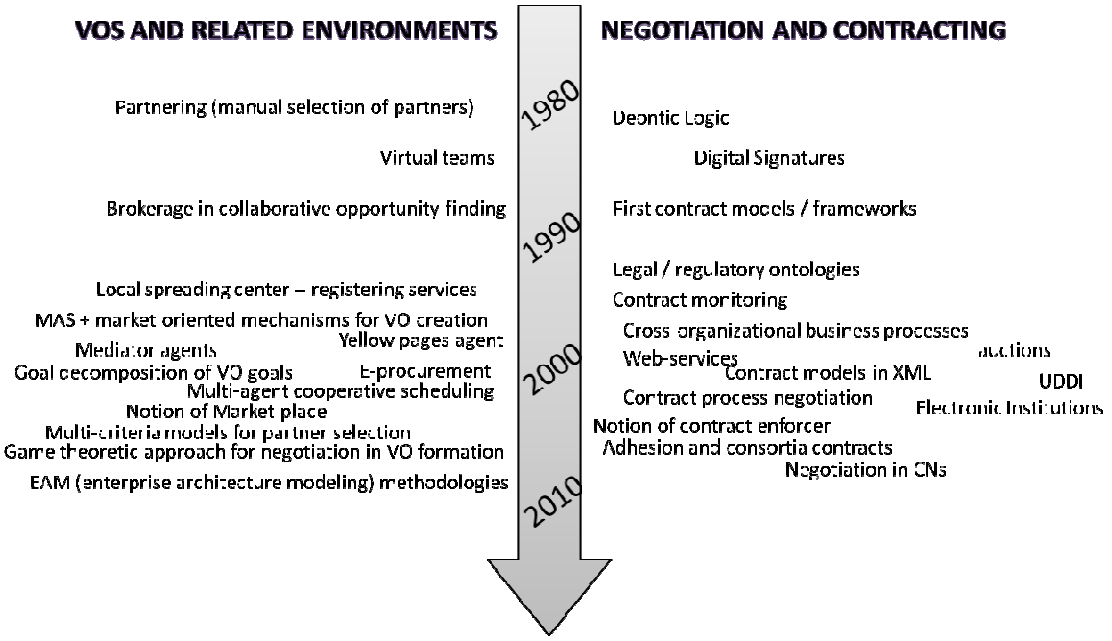


**Figure 3. 2: Temporal synthesis of related SoA.**

Hence, all the addressed topics are of major importance to what concerns a negotiation environment to increase the agility in the creation process of successful dynamic virtual organizations.

# 4. Research Methodology

*In this section the aimed contribution of this work is presented, together with some preliminary developments that have already been done and related publications. Also, a detailed work plan and scheduling is proposed for the rest of the activities along with its validation methodology and dissemination plan. Moreover, in the end of this section there is a list of research activities that contextualize and establish the planned research work.*

## 4.1. Aimed Contribution

The proposed negotiation environment aims to contribute in the domain of the creation of dynamic virtual organizations making the process more agile in the virtual organizations breeding environment context. For that, the development of conceptual models is foreseen, as well as prototypical tools to make proof of the support concepts.

The negotiation environment is then intended to provide computer-assisted support to the process of negotiation and reaching agreements during consortia creation enhancing the efficiency and effectiveness of both the process and the outcome, together with the flexibility of human intervention in decisions.

Such environment shall also focus its attention on indentifying how concerns on conflict-related risks avoidance can be supported. The dynamics of the negotiation process and the necessary support functionalities will then be influenced by factors such as the character of the involved organizations, their expectations regarding the collaboration opportunity, affective aspects, the adopted governance principles, as well as the historic traces of past collaborations.

Towards achieving the aimed contribution as a final result of this work, it is relevant to briefly mention some preliminary work that has already been performed, namely:

- Characterization of the dynamic virtual organization creation process,

- Identification of the main requirements of a negotiation wizard and proper mechanisms for negotiation depending on different contexts, and
- Implementation of a first negotiation wizard prototype.

### *4.1.1. Dynamic virtual organizations creation process*

In order to promptly respond to a business or collaboration opportunity, the virtual organization creation process has to be well defined (Camarinha-Matos et al., 2005). 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 fulfill the opportunity requirements; or (ii) when it is necessary to go through a quotation process before having acquired the business opportunity (Camarinha-Matos, et al., 2009).

Being the VO creation process triggered by a business or collaboration opportunity identified during the operation phase of a VO breeding environment (VBE), then contrary to the VBE, the VO is supposed to be a short-term organization, meaning that it will only have its lifecycle for the necessary period of time that corresponds to its creation, execution of the planned project, and dissolution (Romero et al., 2010).

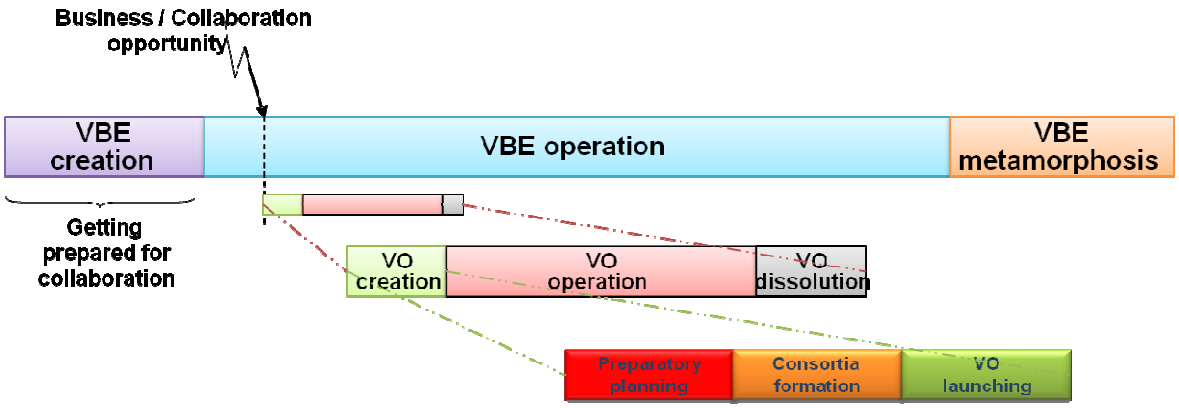


**Figure 4. 1: VO creation in a VBE context.**

Inside the VBE it is then necessary to find the adequate competences to fulfill the BO/CO. Nevertheless, although the VO partners are primarily selected from the VBE members, there might be the case of lack of skills or capacity inside the VBE, so other organizations can be recruited from outside the VBE boundaries (Camarinha-Matos, et al., 2008b). Being this the case, it shall be necessary to ensure that the new organizations are rapidly integrated in the new environment. Nevertheless, in terms of negotiation, supplementary difficulties in functionalities for conflict-related risk avoidance support are foreseen.

As illustrated in Figure 4. 1, the VO creation process can be characterized with three main phases that are (Oliveira and Camarinha-Matos, 2008):

- Preparatory planning: that involves the identification and characterization of a new business or collaboration opportunity that will trigger the new VO. The BO/CO can be external, originated by a customer and detected by a VBE members that acts as a broker. Nevertheless some BO/CO might be generated internally. After the identification and characterization of the BO/CO, it is necessary to determine the structure of the potential VO, identifying the required competences and capacities, structure of the project to be performed, as well as the organizational form of the VO and its needed actors/roles.
- Consortia formation: departs from the previous characterization and planning. At this stage the potential partners to compose the VO are assessed and selected and a negotiation round follows as an iterative process in order to reach agreements and align needs with offers. Then, according to the appropriated organizational form and structure the assignment of roles to the VBE members is made.
- VO launching: after the partners are selected to form the VO and the collaboration agreements are reached, the plan of the VO as well as its governance principles are refined. In sequence, the contracting phase involves the final formulation and modeling of contracts and agreements simultaneously with the contract signing process. Finally the VO is put into operation with the corresponding ICT infrastructure configuration and instantiation of the collaboration spaces.

All these three phases illustrated in Figure 4. 1 and described above for the VO creation process are summarized in Table 4. 1 that briefly specifies the simplified process for the VO creation for the three distinct phases (preparatory planning, consortia formation, and VO launching) when there is already an acquired business / collaboration opportunity.

**Table 4. 1: VO creation phases.**

| ***VO Creation Phase*** | | ***Main Focus*** |
|---|---|---|
| Preparatory planning | BO/CO identification and characterization | Who? Where and how? Which patterns of collaboration? How to structure the VO? Any initial template model? |
| | Rough VO planning | |
| Consortia formation | Partners search and suggestion | Who? Where? Which criteria? Which base information? Profiles? Decision support? |
| | | Who? Negotiation process? Contract, rules, templates? Agreements? |
| | Detailed VO planning | |
| VO Launching | Contracting | Common infrastructure? Governing principles? Detailed plans? |
| | VO setting up | |

With regards to the specific topic of the creation of virtual organizations, the aimed innovation relies on having an integrated approach/system environment where the manager can be assisted along the whole process, starting at the reception of the BO/CO till the VO configuration and launching.

### *4.1.2. Main requirements of a negotiation environment*

An important process that runs across and is embedded in the three steps of the VO creation process shown in Figure 4. 1 is the negotiation and

agreement/contract establishment of the new VO. Similarly to the traditional business relationships, the virtual organization also relies on the notion of contract and collaboration agreement among its members.

As a hypothesis, and based on previous works, it is agreed that standard paper contracting is often slow and requires the involvement of many human actors in all negotiation phases of a VO. Therefore, in order to enable a fast contracting process, an electronic representation of contracts and agreements is fundamental because it can provide a faster and cheaper solution than standard contracting.

Through interaction with various end-users networks, i.e. VO breeding environments (VBEs) involved in the ECOLEAD project, various critical negotiation activities were identified (Oliveira and Camarinha-Matos, 2008):

- Reaching agreements concerning coordination aspects: for instance, who will be responsible for the VO;
- Reaching agreement concerning the sharing of risks among the involved partners. It also relates to the amount of impact that a problem in a task performed by one partner can cause in the whole VO. Moreover, agreement about the amount of budget retained to cope with possible problems is needed;
- The contract should follow a basic set of standard templates: It is important to depart from common templates, selected for each kind of BO/CO, and extend the selected template to cope with the detailed agreement specifications using "add-on" clauses;
- Reaching agreements on the detailed activities and scheduling;
- Information exchange agreement: i.e. how should information be exchanged among partners, and also which kind of information should be exchanged. These agreements have also a close relationship with the detailed scheduling of activities; detailed costs agreement, i.e. discuss and agree with each partner the value of the part that it will produce or the service it will perform;
- Support for privacy of proposals, where only the involved partners have access to the information being negotiated; and
- Provide a mechanism for tracing the history of the negotiation.

Having into account this list, it is evident that these types of agreements require fundamentally decision making by human actors rather than fully-automated decision-making. Therefore, in this case, what is addressed is not a complex e-contracting process where the system is capable of automatically generate, interpret, execute, and manage a contract or agreement, but to a certain extent, a system that is capable of storing and receiving inputs into an electronic source for later interpretation and user guidance through the process.

Therefore, at a macroscopic level three important stages of the negotiation steps lead to different negotiation "focus":

- The negotiation with the potential customer;
- The negotiation towards the selection of partners to compose the VO; and
- The negotiation to reach agreements on the details of the VO (negotiation topics) among the selected partners once the consortium is defined.

Nevertheless it is expected that at an abstract level the negotiation support mechanisms will be basically the same.

Figure 4. 2 illustrates the central actors and basic support modules that a negotiation environment should then have, such as:

- Interaction with other systems: a robust negotiation process will have to directly interact with the VBE information management system to have access mainly to the VBE members profile and competencies as well as access to collaboration history;
- Negotiation support modules: the ones identified (so far, more will appear during the accomplishment of this research work) are the following:
  - Editor that will enable: agreement templates generation; agreements templates instantiation; agreement configuration to current situation/context;
  - Negotiation rooms that are (online) virtual spaces where each participant will be able to negotiate and/or discuss certain clauses of the agreement; and
  - Notary support services to guarantee on one hand the authenticity and validity of the agreements, and on the other hand to provide a safe deposit for documentation.

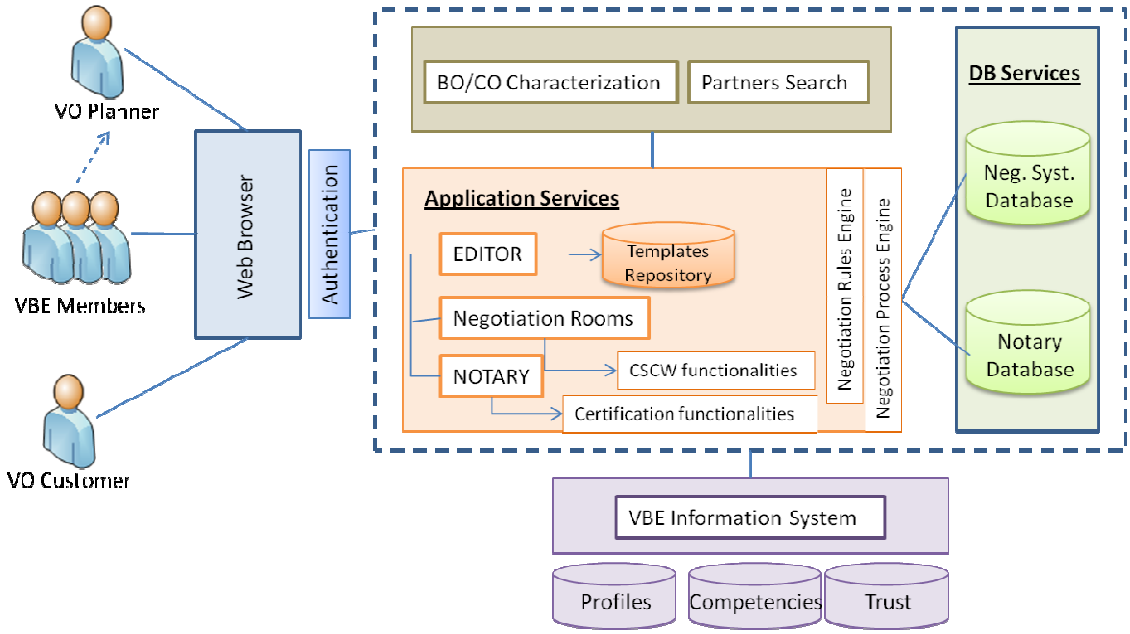


**Figure 4. 2: Basic architecture of the negotiation environment.**

Moreover, depending on the different contexts and on the BO/CO, the proper mechanisms for negotiation must be instantiated. Examples of such mechanisms are for instance (Oliveira and Camarinha-Matos, 2010):

- Identifying network members whose agreement is necessary;
- Identifying the scope and (legal) jurisdiction of the network;
- Negotiating the ground rules;
- Discussing administration and allocation of responsibilities;
- Negotiating the decision rules for closure of an issue;
- Identifying a system for resolving impasses; and
- Identifying a decision process for ending the network.

Other important mechanisms and characteristics based on the hypothesis of the current research work are:

- Traceability of the negotiation process;
- Management of participants' expectations regarding the collaboration; and
- Management of the different levels of participation in collaboration, either in terms of participants' commitments or in terms of collaboration duration.

Having into consideration the main requirements of the negotiation environment as well as the identified mechanisms, the simplified negotiation process in VO creation (for an acquired collaboration opportunity) can then be represented as illustrated in Figure 4. 3.

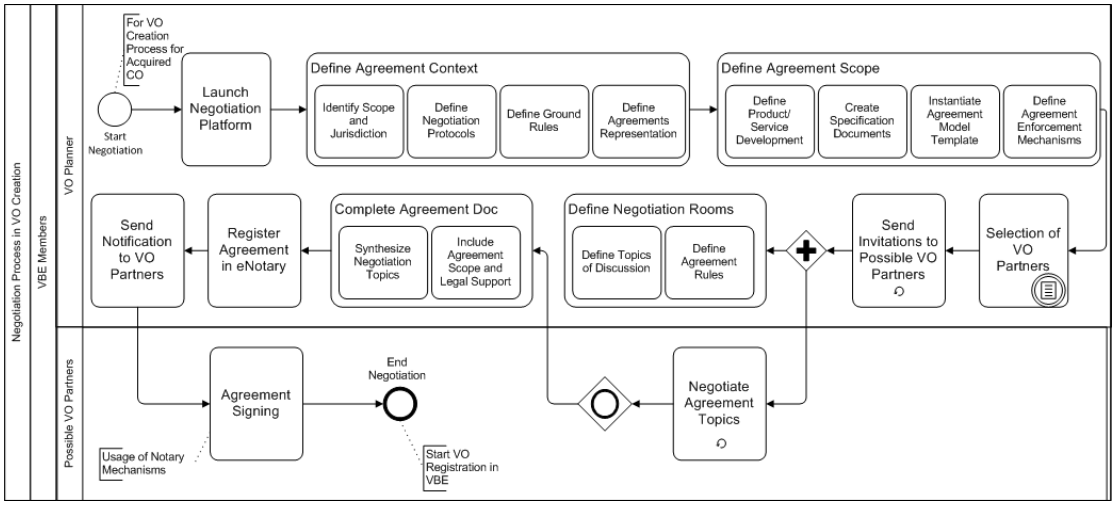


**Figure 4. 3: Simplified negotiation process in VO creation.**

### *4.1.3. Negotiation wizard*

In the previous subsection, the process of the VO creation was briefly described. As mentioned, one important process that runs in parallel with some other steps of the VO creation process is the negotiation and contract establishment. Thus, a first sketch tool to support this process was developed. The purpose was not to fully automate the process, but rather to assist the human actors during the negotiation process towards the VO establishment. At this point there are two different situations where negotiation might be required: (i) to select the right partners to compose the VO, and (ii) to reach agreements on the details of the VO. The proposed negotiation wizard (WizAN) is intended to provide facilities for both situations. At a later stage, negotiation with client/customer shall also be supported.

Currently, the main outcome of WizAN is a contract or agreement summarizing the results of the negotiations / discussions that were performed during the VO

creation process. 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 produced by the WizAN tool both negotiation types are supported, depending on what is being negotiated (every issue that is subject of negotiation is called *negotiation topic*).

The full negotiation process is guided by a 'contract or agreement template' composed of a number of sections. When a negotiation topic is created it is associated to a specific section of the agreement where a link to the topic can be kept (Figure 4. 4). Once all negotiation topics are agreed, the final agreement can be produced representing a kind of "compilation" or integration of the agreements on all these topics.

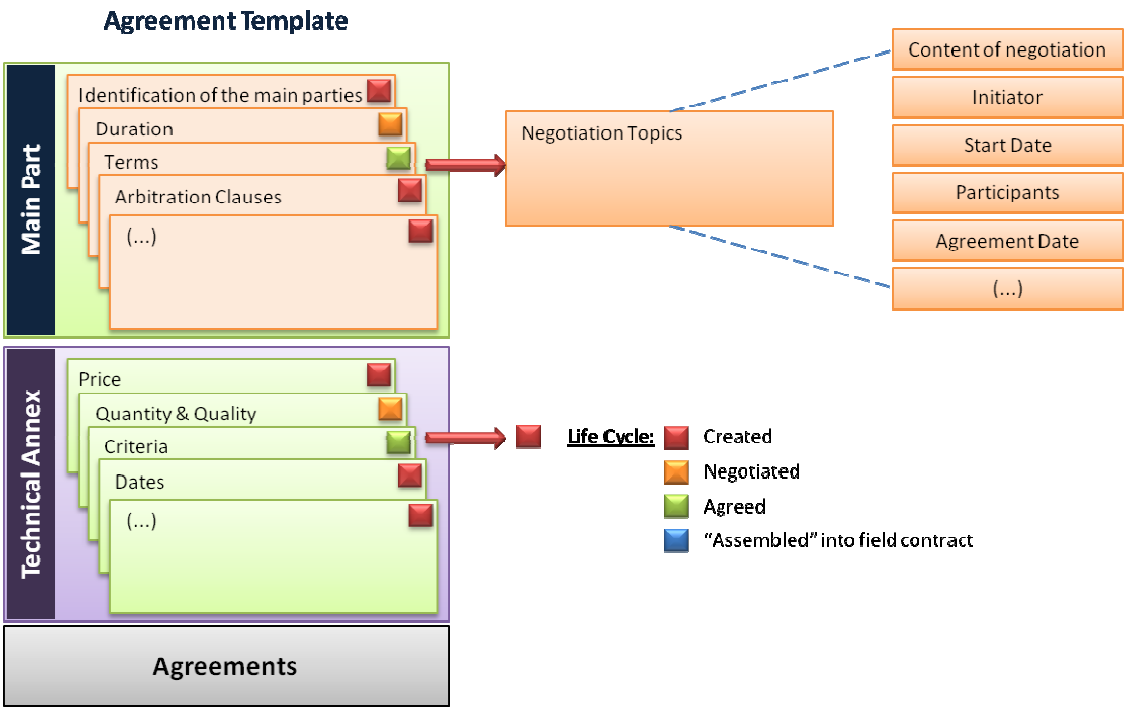


**Figure 4. 4: Agreement template and negotiation topics.**

The negotiation processes is quite hard to structure in terms of defined workflows / protocols as several flows depend on decisions made by the human negotiators and also their individual timing (mostly asynchronous regarding each other). Thus four main modules were developed to assist the human actors in reaching agreements:

- Assisted Contract Elaboration (ACE). This module provides a collection of contract templates and negotiation topic templates to support the VO creation. In the contract construction process it is possible to build or edit the contract skeleton or template.
- Contract Editor (CE). The contract editor in WizAN is the main point of interaction with the user. Here it is possible for the VO planner to initiate, conduct, and monitor the entire negotiation process in the VO creation. For this, the VO planner has some specific functionality available, such as: add partners to the VO; add, read or edit documents that refer to the general part of the VO; create new virtual negotiation rooms (VNRs); and produce the final document that reflects all the agreements established during the negotiation process. If the user is not the planner and is a potential partner of the VO, there are some restrictions in terms of functionalities, namely in terms of management of the new VO. Nevertheless, there are also other functionalities available, namely: accept to participate in the VO; see the general conditions that were specified by the VO planner; know who are the other partners involved; read or add documents to the general part of the VO; have access to the VNRs where this partner was invited to participate; and sign the final agreement. Furthermore, it is important to mention that in this editor a list of all the VNRs that were created along with the discussions carried out and exchanged documents are also stored. Here privacy and security are both supported once only authorized potential VO partners can access that information.
- Virtual Negotiation Room (VNR). It is the virtual space where the potential partners of the VO are invited to join in order to discuss the necessary topics that need agreement. When the VO planner wants to discuss a specific topic with certain members, a virtual sub-space is created inside the VO space, i.e. a new virtual negotiation room (Figure 4. 5). Each VNR is divided into two distinct parts: one for edition of the negotiation topic characteristics and associated documents, and another for enabling discussion among partners involved in the negotiation topic by means of chatting (enabling synchronous communication between participants) and/or specific forums that only the members of a that VNR can have access to.

- Support for Agreement Establishment (SAE). The e-Notary is a module that allows clients to exchange information with warranty of authenticity and validity as well as providing a safe repository for saving and requesting documentation (through digital signatures and encryption techniques). This module was developed as a web service allowing its clients to use the following facilities: user registry; documents requesting; document signing; document certification; document repository; and document authentication.

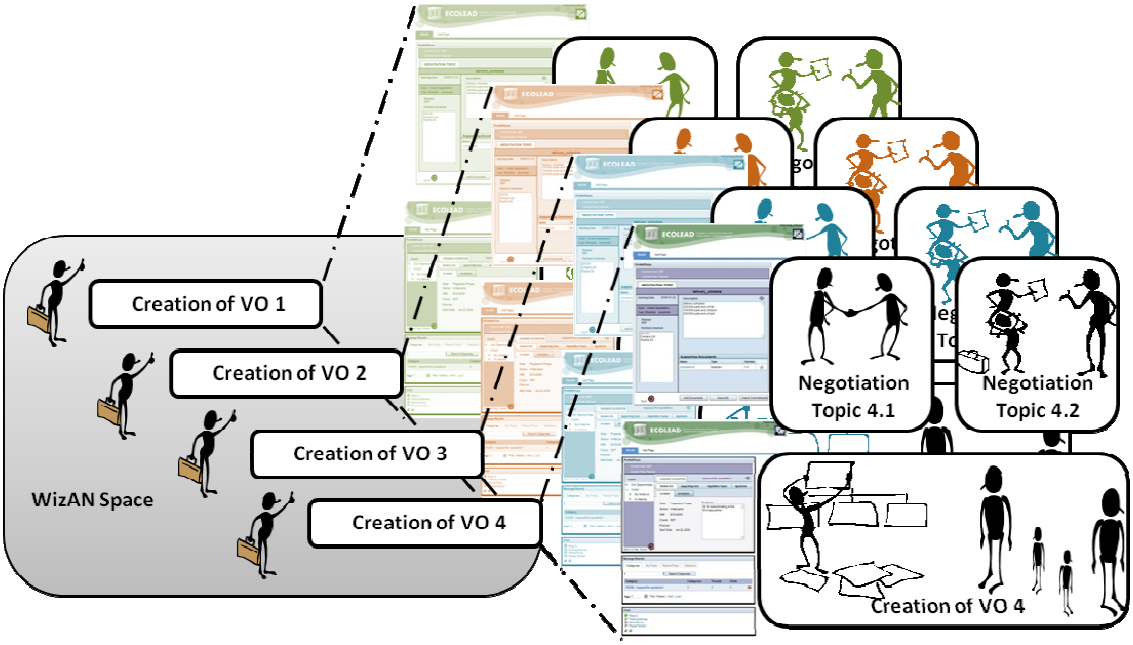


**Figure 4. 5: Virtual spaces (Virtual Negotiation Rooms) in WizAN.**

Table 4. 2 summarizes the just described WizAN functionalities.

**Table 4. 2: Summary of current WizAN functionalities.**

| *Functionality* | *Description* |
|---|---|
| Contract Editor (CE) | Users can find the base information regarding the agreements being established among the VO partners. Through CE 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. |

| | |
|---|---|
| Virtual Negotiation Room (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 one VNR is created. |
| Support for Agreement Establishment (SAE) | 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. |
| Assisted Contract Elaboration System | Collection of contract and negotiation topic templates to support the contracts creation, as well as dedicated template editors. |

The current prototype was developed in JAVA as a web application and its portlets are supposed to be deployed in the *Liferay* portal (http://www.liferay.com).

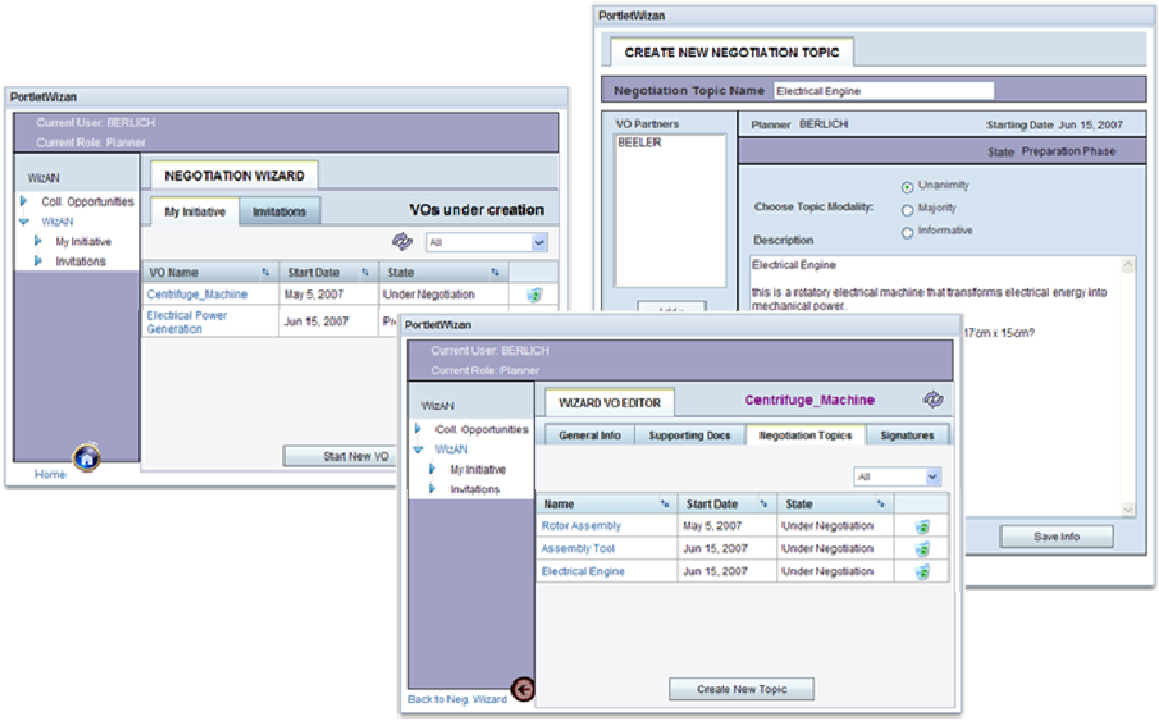


**Figure 4. 6: Example of WizAN user interfaces as portlets.**

### *4.1.4. Discussion of aimed contributions*

The time and amount of resources consumed during the VO creation process whenever a business or collaboration opportunity is acquired, give a good indication of the level of agility of a collaborative network. To achieve that agility, it is essential that some requirements that were presented along this document are provided, namely in terms of common infrastructures to its members. For that, as mentioned before, the existence of a VO breeding environment context, enables a partially fulfillment of those requirements. Also, a negotiation environment that enables organizations to conduct their negotiation processes with the necessary soft modeling characteristics can be a high-quality indicator for the aimed agility of the VO creation process.

Hence, the ECOLEAD project provided the fundamental test bed for:

- The evaluation of the main requirements for a negotiation framework to enable the creation of successful dynamic VO;
- Design and development of a basic agreement negotiation wizard (WizAN) to achieve important results (focused negotiation, authenticity, eNotary services, etc.).

Nevertheless, other important topics / requirements to consider in such an aimed negotiation model are certainly the problematic of:

- Collaboration risks reduction and risks sharing among the involved partners in order to reach agreements. This also relates to the impact that a problem in a task performed by one partner can cause in the whole VO;
- Participants' expectation management that deals with the motivation of the organizations in collaborating, and the consequences that some disappointments might have;
- Different levels of participation in collaboration, either in terms of individual participant commitment in the collaboration, and/or in terms of individual participant collaboration duration (i.e. individual participation commitment vs. temporal participation), which certainly has different forms of treatment in terms of negotiation; and
- Past collaboration between organizations with 'levels' of success;

- Available technologies with the required characteristics for the negotiation wizard environment.

Subsequently, an improved prototype including more characteristics with new models is foreseen.

### *4.1.5. List of publications*

As a result of the described work of the previous subsections, some publications are already available, namely:

- Oliveira, A. I. and Camarinha-Matos, L. M. (2010). ***Negotiation and Contracting in Collaborative Networks***. In L.M. Camarinha-Matos, P. Pereira, L. Ribeiro (Eds.), *Emerging Trends in Technological Innovation* (pp. 83-92), Springer.
- Romero, D., Oliveira, A. I., Camarinha-Matos, L. M., and Molina, A. (2010). ***The Virtual Enterprise from a Governance Perspective***. In L.M. Camarinha-Matos, P. Pereira, L. Ribeiro (Eds.), *Emerging Trends in Technological Innovation* (pp. 73-82), Springer.
- Oliveira, A. I. , Camarinha-Matos, L. M., and Pouly, M. (2010) **Agreement negotiation support in virtual organisation creation - an illustrative case.**, Production Planning & Control, 21: 2, pp. 160 — 180.
- Camarinha-Matos, L. M., Oliveira, A. I., Sesana, M., Galeano, N., Demsar, D., Baldo, F., and Jarimo, T. (2009). **A framework for computer-assisted creation of dynamic virtual organizations**. *International Journal of Production Research,* 47:17, pp.4661-4690.
- Oliveira, A. I., Camarinha-Matos, L. M., and Pouly, M. (2008) ***Agreement Negotiation Support in VO Creation***. In IFIP International Federation for Information Processing, volume 283; Pervasive Collaborative Networks, Luis M. Camarinha-Matos, Willy Picard (Eds.), pp. 107-118, Springer.
- Oliveira, A. I., & Camarinha-Matos, L. M. (2008). **Agreement Negotiation Wizard**. In L. M. Camarinha-Matos & H. Afsarmanesh & M. Ollus (Eds.), *Methods and Tools for Collaborative Networked Organizations* (pp. 191-218): Springer.

- Camarinha-Matos, L. M., Oliveira, A. I., Demsar, D., Sesana, M., Molina, A., Baldo, F., & Jarimo, T. (2008). **VO Creation Assistance Services**. In L. M. Camarinha-Matos & H. Afsarmanesh & M. Ollus (Eds.), *Methods and Tools for Collaborative Networked Organizations* (pp. 155-190): Springer.
- Camarinha-Matos, L., Oliveira, A. I., Ratti, R., Demsar, D., Baldo, F., Jarimo, T., (2007). **A Computer-Assisted VO Creation Framework**, in IFIP International Federation for Information Processing, Volume 243, Establishing the Foundation of Collaborative Networks; eds. Camarinha-Matos, L., Afsarmanesh, H., Novais, P., Analide, C.; (Boston: Springer), pp.165-178.
- Camarinha-Matos, L.M.; Oliveira, A. I. (2007) **Contract negotiation wizard for VO creation**, in Digital enterprise technology – Perspectives and challenges, P. Cunha, P. Maropoulos, (Eds.), pp 333-342, Springer.
- Camarinha-Matos, L. M., Silveri, I., Afsarmanesh, H., Oliveira, A.I. (2005). **Towards a Framework for Creation of Dynamic Virtual Organizations**. In L. M. Camarinha-Matos, H. Afsarmanesh and A. Ortiz (Eds.), Collaborative Networks and their Breeding Environments, pp. 69-80, Springer.

## *4.2. Detailed Work Plan and Scheduling*

The proposed work plan follows the traditional / classical research method that consists into seven main phases: (i)Research question / problem; (ii) Background / observation; (iii) Formulate hypothesis; (iv) Design experiment; (v) Test hypothesis / collect data; (vi) Interpret / analyze results; and (vii) Publish findings. These phases are illustrated in Figure 4. 7.

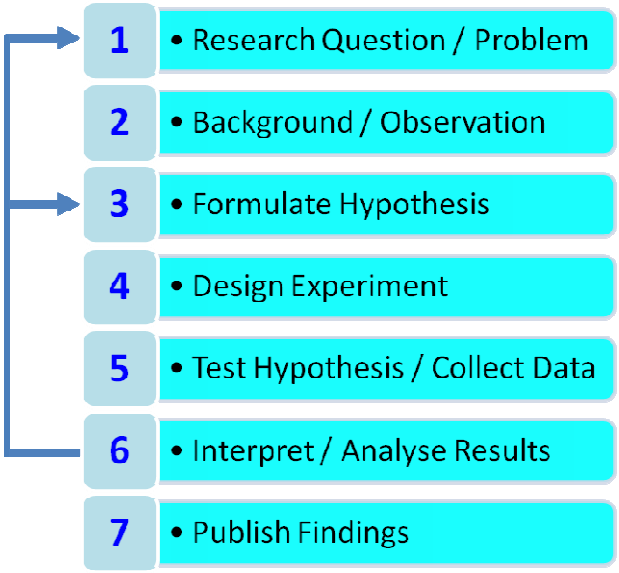


**Figure 4. 7: Classical research method[1].**

According to this method, the current work is then planned and scheduled for the seven main phases:

- **Phase 1**: Research Question / Problem formulation [December 2008 – February 2010]
  - Having into account the correct identification of the working context and motivation, the proper problem can be identified and the research question is formulated.
- **Phase 2**: Background / Observation [February 2009 / September 2012]
  - This phase is based on the related SoA and existing requirements and is split into two sub phases:
    - [February 2009 / August 2010] observation of the current background as a starting point for the current research work; and

[1] From the handouts of SRMT (Scientific Research Methodologies and Techniques) class of the Doctoral Program of Electrical and Computer Engineering of Universidade Nova de Lisboa, by Professor Luis Camarinha-Matos.

        - [September 2010 / September 2012] for the continuous observation of the developments in the area of research.
    - In this study, some main topics are addressed, namely:
        - Related SoA and existing requirements in collaborative networks specifically VOs and its related environments;
        - Formalisms for consortia creation
        - Business to business contracting
        - Contracts & Agreements for collaborative networks
        - Applicable ICT and frameworks.

- **Phase 3**: Formulate Hypothesis [December 2008 / August 2010]
    - According to some preliminary analysis of the main problem and the current state of the art, the hypothesis is then formulated.
- **Phase 4**: Design experiment [2008 / December 2011]
    - This phase is divided into two sub phases:
        - [2008 / October 2009] Development of a first negotiation tool that supports the creation phase of dynamic VOs (WizAN - described in the previous sub-section 4.1.3); and
        - [December 2010 / December 2011] Development of a restructured negotiation tool considering the results of the previous WizAN and new characteristics based on the developments on framework architecture, system architecture and validation scenario. These three aspects are described below:
            - Framework Architecture for inter-community negotiation in Collaborative Networks. Including the development of conceptual framework for different negotiation processes considering: the different actors, roles and objectives of different collaborative environments, namely business vs. social context. For that the following activities are planned:
                - Identification and characterization of different collaborative environments
                - Identification and characterization of the different actors, Roles and objectives
                - Definition of Inter-community negotiation
                - Specification of models & functionalities

- System Architecture that envisages inter-community negotiation, i.e. different levels of negotiation between one or more consortia. Specification of models and functionalities for online notary certification, authentication and contracting are also considered.
- Validation scenario with the characterization of the basic scenarios to validate the developed concepts. Important variables to be used in the experiment shall be identified.

- **Phase 5**: Test hypothesis / collect data [December 2010 / January 2012]
  - Prototype implementation and validation for the concepts and technologies. The system prototype will follow the design experiment and will be applied in a validation scenario. Subsequently, the results are collected.
- **Phase 6**: Interpret / analyze results [March 2011 / May 2012]
  - Analysis and evaluation of the model, methodology and proposed tools in context of collaborative networks.
- **Phase 7**: Publish findings [2008 / September 2012]
  - The continuing findings of the work are to be published in recognized conferences and journals.
  - At the end of the work, the thesis document is written, combining all the findings that were published and the final conclusions.

At the current stage of work, the effort is focused on phases 2 to 4 where the current document already introduces a preliminary state of the art and some existing developments, but it is necessary to conclude the study of the implication of the SoA so that new models and an improved prototype development can be achieved.

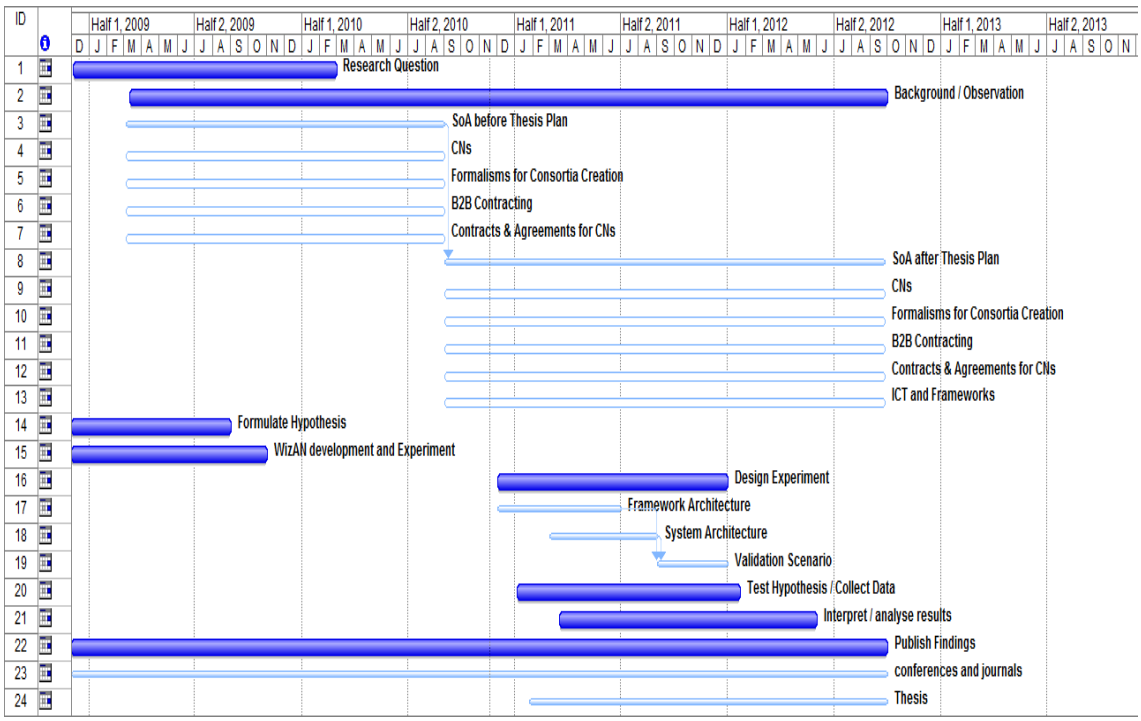


**Figure 4. 8: Gant chart with the main PhD activities and milestone.**

## *4.3. Validation Methodology*

One important goal of each research work is its validation. In the case of the planned work the question that arises at this point is how to validate the expected results.

For that, the validation process shall consist on the identification of a set of indicators that are necessarily part of the process, for example:

- if the negotiation process is well understood by the involved actors;
- if the time reduction in the VO creation process is significant and leads to the aimed agility;
- What is the major opinion of the involved actors in the process;
- etc.

Apart from the identification of the correct indicators to validate the process, the following forms of work validation are also being considered:

- Peer validation:
  - Through interaction with existing networks that have interest in such a process, namely the SOCOLNET/PRO-VE community;
  - During the simulation and formulation of case studies;
  - In the course of questionnaires to collect experts opinions;
- EU projects: the integration of this research work on European research projects, can suggest the work validity;
- International conferences and workshops; and
- Journals indexed to the web of Science (in the next section - Dissemination plan - some relevant conferences and journals in the area are identified, as well as the foreseen number of publications).

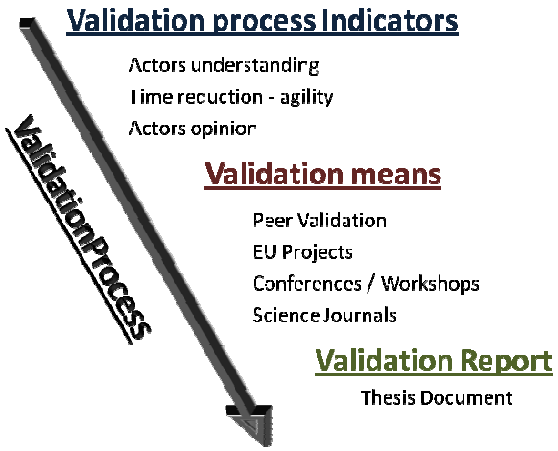


**Figure 4. 9: Main validation Channels.**

## *4.4. Dissemination Plan*

It is important to properly select the dissemination channels for a research work. Besides important conferences and workshops in the area, the publication of three major articles in journals that are related to the research area and are indexed in

the Web of Science is envisioned. Figure 4. 10 illustrates some examples of a selection of conferences and journals in the area.

While in conferences this research work can be submitted annually, the foreseen journal publications are planned to be submitted 18 and 9 months before the conclusion of this research work, and another one at the end.

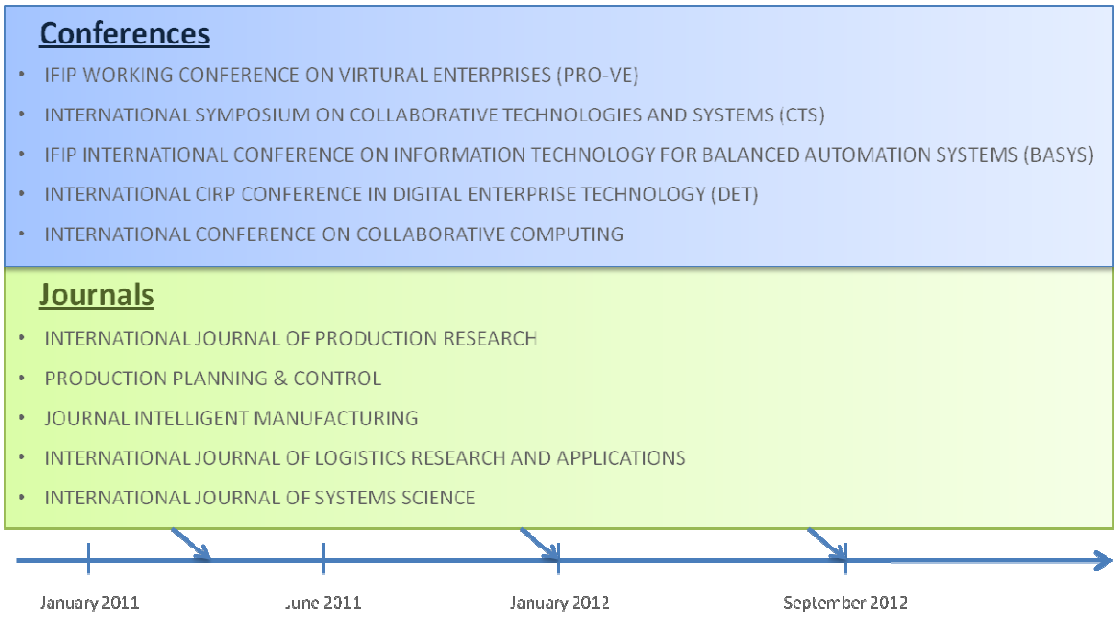


**Figure 4. 10: Selection of conferences and journals in the research area.**

## *4.5. Integration with Other Research Activities*

The current work is being developed in the CoDIS group (Collaborative networks and Distributed Industrial Systems group) of CTS, Uninova. It is foreseen that the work is to be continuously integrated in research projects. For that it is important to mention some projects that have already provided support for this work, specifically:

- ECOLEAD: European Collaborative Networked Organizations LEADership initiative (http://www.ecolead.org ), 6º FP (IP 506958) [2004/2008];
- ePAL: extending Professional Active Life (http://www.epal.eu.com ), 7º FP (ICT – 2007.7.1, GA n. 215289) [2008/2010]; and
- BRAID: Bridging Research in Ageing and ICT Development (http://www.braidproject.eu/), 7º FP. (ICT-2009-7.1 2484852) [2010/2012].

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