1. ECOLEAD AND CNO BASE CONCEPTS

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Collaborative networked organizations represent an important paradigm to help organizations cope with the challenges of market turbulence. Under this scope, the ECOLEAD integrated project was launched with the aim of creating the necessary foundations and mechanisms for establishing an advanced network-based industry society. The main underlying concepts, research roadmap and achieved results of this initiative are briefly summarized.

1. INTRODUCTION

Participation in networks has nowadays become very important for any organization that strives to achieve a differentiated competitive advantage, especially if the company is small or medium sized. Collaboration is a key issue in addressing market demands, particularly in the manufacturing sector, through sharing competencies and resources. A new competitive environment for both manufacturing and service industries has been developing during the last few years, and this trend is forcing a change in the way these industries are managed. In order to be successful in a very competitive and rapidly changing environment, companies need significantly improved competencies in terms of dealing with new business models, strategies, organizational and governance principles, processes and technological capabilities. Thus companies are increasingly restructuring their internal operating and information systems and re-engineering production processes to both eliminate waste and lower the costs. Furthermore, they are changing the nature of their modus operandi by partnering with other companies in complex value chains and business ecosystems, which now extend globally (Myers, 2006).

In today's industry, collaborative networks manifest in a large variety of forms. Moving from the classical supply chain format, characterized by relatively stable networks with well defined roles and requiring only minimal coordination and information exchange, more dynamic structures are emerging in industry. Some of these organizational forms are goal-oriented, i.e. focused on a single project or business opportunity, such as in the case of virtual enterprises (VE). The same concept can be applied to other contexts, e.g. government and service sectors, leading to a more general term, the virtual organization (VO). A VE/VO is often a temporary organization that "gathers" its potential from the possibility of (rapidly) forming consortia well suited (in terms of competencies and resources) to each

business opportunity. Other emerging collaborative networks are formed by human professionals who may collaborate in virtual communities and form virtual teams to address specific problems, such as collaborative concurrent engineering or development of a consultancy project.

Another case of collaborative network is the collaborative virtual laboratory (VL). Here a virtual experimental environment is provided for scientists and engineers to perform their experiments, enabling a group of researchers located in different geographical regions to work together, sharing resources, (such as expensive lab equipment), and results. In this case, and in addition to the network of involved organizations (e.g. research centers or research units of enterprises), there is an overlapping network of people. In a research activity most collaborative acts are in fact conducted by researchers that have a high degree of autonomy. Therefore, in this example, the necessity for tools to support human collaboration – advanced groupware tools, becomes evident. A typical VL involves scientific equipment connected to a network, large-scale simulations, visualization, data reduction and data summarization capabilities, application-specific databases, collaboration tools, e.g. teleconferencing, federated data exchange, chat, shared electronic-whiteboard, notepad, etc., application-dependent software tools and interfaces, safe communications, and large network bandwidth. A similar situation can happen in a virtual enterprise when engineering teams formed by engineers of different enterprises (virtual teams) collaborate on some engineering problem.

Many more examples can be found in different sectors. For instance, we can think of networks of insurance companies, networks of governmental institutions, networks of academic institutions forming virtual institutes for joint delivery of advanced courses, networks of entities involved in disaster rescuing, networks of care centers, healthcare institutions, and family relatives involved in elderly care, etc.

With the development of new collaborative tools supported by Internet and mobile computing and a better understanding of the mechanisms of collaborative networks, new organizational forms are naturally emerging. And yet all these cases have a number of characteristics in common (Camarinha-Matos, Afsarmanesh, 2006):

- Networks composed of a variety of entities - organizations and people – which are largely autonomous, geographically distributed, and heterogeneous in terms of their operating environment, culture, social capital and goals.
- Participants collaborate to (better) achieve common or compatible goals.
- The interactions among participants are supported by computer networks.

Therefore, the notion of collaborative network was established as a generic term to represent all these particular cases (Camarinha-Matos, Afsarmanesh, 2005):

> A **collaborative network** (CN) is a network consisting of a variety of entities (e.g. organizations, people, machines) that are largely autonomous, geographically distributed, and heterogeneous in terms of their operating environment, culture, social capital and goals, but that collaborate to better achieve common or compatible goals, thus jointly generating value, and whose interactions are supported by computer networks.

Most forms of collaborative networks imply some kind of *organization* over the activities of their constituents, identifying roles for the participants, and some

governance rules, and therefore, can be called manifestations of **collaborative networked organizations (CNOs)**. Other more spontaneous forms of collaboration in networks can also be foreseen. For instance, various **ad-hoc collaboration processes** can take place in virtual communities, namely those that are not business oriented – e.g. individual citizens contributions in case of a natural disaster, or simple gathering of individuals for a social cause (Camarinha-Matos, Afsarmanesh, 2008). These are cases where people or organizations may volunteer to collaborate hoping to improve a general aim, with no pre-plan and/or structure on participants' roles and how their activities should proceed.

Reinforcing the effectiveness of collaborative networks and creating the necessary conditions for making them an endogenous reality in the European industrial landscape, mostly based on small and medium enterprises (SMEs), is a key survival factor. If properly established and managed, collaborative networks can provide a basis for competitiveness, world-excellence, and agility in turbulent market conditions, they can support SMEs in identifying and exploiting new business potential, boost innovation, and increase their knowledge. The networking of SMEs with large-scale enterprises also contributes to the success of big companies in the global market.

Continued dedicated efforts on virtual organizations (e.g. through the Esprit, IST, and IMS initiatives), although fragmented, have led to a European critical mass and a culture of collaboration, giving early and systematic entry into the area. This "movement" is consistent with the process of European integration, which represents a push towards the "cooperation culture", while preserving the desire to leverage regional values and assets. In a time of very rapid technological evolution and socio-economic transformation, but also when other geographical regions (e.g. USA, Latin America, Australia, Japan, and China) are focusing their research strategies on this area, it is necessary to break with the tradition of fragmented incremental research, and aim at a sustainable breakthrough with large beneficial impacts on the society.

2. BASE ORGANIZATIONAL FORMS

Early projects and proposals, too much technology-driven, underestimated the difficulties of the Virtual Organization / Virtual Enterprise (VO) creation process and suggested very dynamic scenarios. However, the agility and dynamism required for VOs are limited by the difficult process of establishing common operational basis and building trust. Even if flexible support infrastructures become widely available, the aspects of trust building and the required reorganization at the enterprise level are hard to cope with in collaborative business processes. "Trusting your partner" is a gradual and long process. The definition of "collaborative business rules", contracts for VO or even common ontologies are challenging, especially when different business cultures are involved. In this sense, very dynamic organizations formed by enterprises without previous experience of collaboration might be limited to scenarios of simple commerce transactions (e.g. buy-sell).

The creation of long term clusters of industry or service enterprises represents an approach to overcoming these obstacles and can support the rapid formation of

VO inspired by business opportunities. The concept of cluster of enterprises, which should not be confused with a VO, represents an association or pool of enterprises and related supporting institutions that have both the potential and the will to cooperate with each other through the establishment of a long-term cooperation agreement. Buyer-supplier relationships, common tools and technologies, common markets or distribution channels, common resources, or even common labor pools are elements that traditionally bind the cluster together. In some cases they are formed around a special technology or product type, sometimes to support an OEM (original equipment manufacturer).

A more frequent situation is the case in which the cluster is formed by organizations located in a common region, although geography is not a major facet when collaboration is supported by computer networks. Nevertheless, the geographical closeness has some advantages for collaboration, as it may facilitate better adaptation to the local (cultural) needs and an easier creation of a "sense of community". But with the development of more effective communication infrastructures, such long-term associations are not necessarily motivated by geographical closeness. Cultural ties, even particular human relationships are also motivating factors in forming such associations which in fact represent VO **Breeding Environments** (VBE) for the dynamic formation of VOs. For each business opportunity found by one of the VBE members, acting as a **broker**, a subset of the VBE enterprises may be chosen to form a VO for that specific business opportunity. Thus:

> A ***VO Breeding Environment*** (VBE) represents an association of organizations and their related supporting institutions, adhering to a base long term cooperation agreement, and adoption of common operating principles and infrastructures, with the main goal of increasing their preparedness towards rapid configuration of temporary alliances for collaboration in potential Virtual Organizations. Namely, when a business opportunity is identified by one member (acting as a broker), a subset of VBE organizations can be selected to form a VE/VO (Afsarmanesh, Camarinha-Matos, 2005).

From a regional perspective, a well-managed VBE may offer the opportunity to combine the necessities of both "old" and "new" economies, and form a sustainable environment (local business ecosystem) while leveraging and preserving the regional assets and culture. The VO breeding environment can support the exploitation of local competencies and resources by an agile and fast configuration of the most adequate set of partners for each business opportunity. Furthermore, the local VBEs can gather and empower a unique set of competencies tailored to regional culture and local customers' preferences, allowing a concerted offer of cooperation to global companies. As a result, members of the local industry cluster for instance can play an important role in the customization and final assembly of products to local markets even though the basic components may be produced elsewhere. Therefore, in times of tough competition and market turbulence, the organization and effective management of the local industry or service enterprises, VBEs focused on the characteristics of SMEs, provide a promising approach for regional sustainability. In addition to the mentioned benefits of cooperation within dynamic VOs, there is also the opportunity to share experiences and costs in the

learning process of introducing new ICT for instance, within an industry cluster, and to reduce the risk of big losses and failure.

Some researchers with a more theoretical perspective, often focused on very limited scenarios, advocating that it is better to consider VOs in a totally "open universe" context and thus consider VBEs as a too constrained approach. However, reality is proving the correctness of the approach as a large number of related initiatives and real world implementations have emerged during the past decade, namely in Europe (Afsarmanesh et al., 2004), (Flores et al., 2007), Japan (Kaihara, 2004), Brazil (Vargas, Wolf, 2006), Mexico (Flores, Molina, 2000), and USA (Goranson, 2004). Virtuelle Fabrik (Plüss, Huber, 2005) in Switzerland and south Germany is a well-known case of breeding environment with more than 70 active organization members. But the advances in information and communication technologies now bring new opportunities to leverage the potential of this concept, namely by providing the adequate environment for the rapid formation of agile virtual organizations.

Furthermore, current trends in mass customization have highlighted the need to take into account the preferences, specificities, and constraints as well as the assets of the target market regions. The current challenge is to enable *collaborative innovation* involving a network of SMEs (manufacturers, designers, etc.), interfacing different entities and customers. Therefore, VBEs are evolving to address the much more challenging scope of customer involved networked collaboration and co-innovation, as shown in Fig. 1 (Camarinha-Matos, 2007).

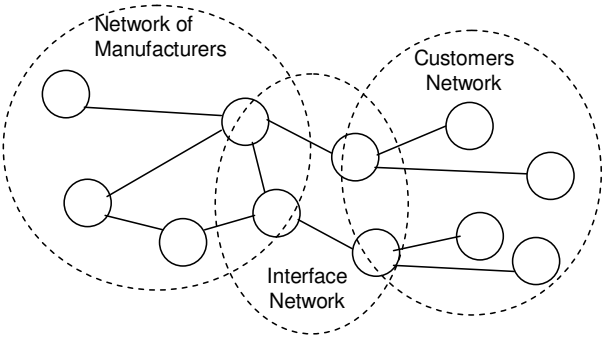

Fig. 1: Customers' involvement in a CN

The concept of **virtual enterprise** (VE), understood as a *temporary* consortium of enterprises that strategically join skills and resources, supported by computer *networks*, to better respond to a business opportunity, has emerged during the 1990s (Davidow, Malone, 1992), (Nagel, Dove, 1995).

Facing business globalization around the world, companies need to co-operate efficiently despite of their different infrastructures, business cultures, organizational forms, languages, and legal and fiscal systems. As a reaction to the highly dynamic market challenges, and taking advantage of the facilities offered by the advances in information and communication technologies, enterprises are increasingly operating in cooperative networked environments. Moreover, the business networks themselves are dynamic and constantly changing. In this setting the benefits from collaborative networking are usually considered to come from e.g. the following features:

- Business partners can quickly and easily come together to benefit from a business opportunity, fulfill the need and then disclose the collaboration.
- Increasing applications in early stages of product life cycle, speeding up and giving more efficiency to engineering and design.
- Increased customer collaboration and logistics enhance market understanding and reduce delivery times and times to market.
- Customer collaboration in after delivery networks enables new form of support activities over the life-cycle of the delivered product or service.
- Efficiency relies on capability for companies to co-operate despite different infrastructures, business cultures, organizational forms, and languages, legal or fiscal systems.
- Business networks themselves continuously change.

A virtual organization represents an extension of the VE concept by considering other possible kinds of members in addition to enterprises (Camarinha-Matos, Afsarmanesh, Ollus, 2005):

> A ***virtual organization*** (VO) is considered to be a set of collaborating (legally) independent organizations, which to the outside world provide a set of services and functionality as if they were one organization, supported by computer networks.

This definition, like many others, assumes that a virtual organization behaves and can be managed in some way like single enterprise. However, the features of a VO create new challenges to its management compared to the management of a single organization.

Virtual or online communities are important social structures emerging from an Internet-enabled society. These communities bring together people of similar interests in order to communicate, to share and exchange information, to have fun or just to fulfil the need for social belonging and empathy. Typical examples include communities involving emotional support, sports, science, professions, etc. Virtual communities are enabled and empowered by an increasing amount of internet technologies, such as e.g. bulletin boards, list servers, newsgroups, chat rooms, work spaces, document repositories. Such communities invent new social-relationships, resulting in new behavioural patterns and new ways of sharing and creating knowledge, which creates specific value from their activities. On the other hand, Communities of Practice (CoP) have been around for many years and are described as "*groups of people informally bound together by shared expertise and passion for joint enterprise (that) share their experiences and knowledge in free-flowing, creative ways that foster new approaches to knowledge*" (Wenger, Snyder, 2000). Leavitt et al. (2001) point out that CoPs have become more prominent and formalized in recent years because they develop critical organizational knowledge assets. Most communities are "boundary-spanning units in organizations, responsible for finding and sharing best practices, stewarding knowledge, and helping members work better".

When communities of practice adopt computer networks and most of the practices and tools of virtual communities, they become **Professional Virtual Communities** (PVC):

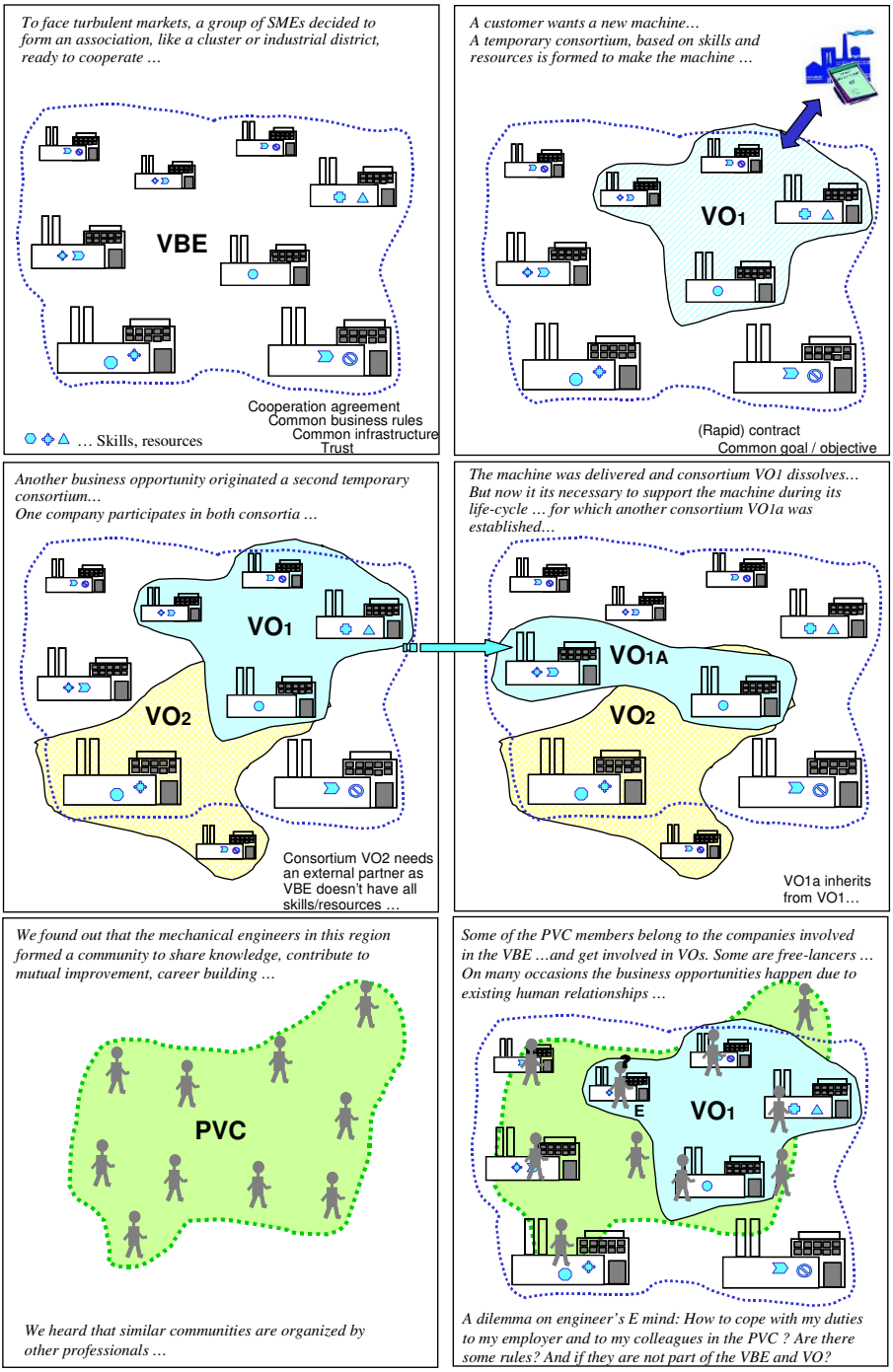

Figure 2 – Illustration of CNO-related concepts

> A ***Professional virtual community*** is an alliance of professional individuals that aim at being prepared for collaboration under a business perspective, and provide an environment to facilitate the agile and fluid formation of **Virtual Teams** (VTs) to respond to business opportunities, similar to what VBE aims to provide for the VOs.

Virtual Communities and Communities of Practice are not new concepts but they acquire specific characteristics and increased importance when considered in the context of the collaborative networks of organizations. These communities, spontaneously created, promoted by companies, or induced by the work relationships, are bound to certain social rules resulting from the commitment (social bounds) of their members to the underlying organizations (new concept of *social-bound PVCs*).

This is the case, for instance, in *concurrent* or *collaborative engineering* where teams of engineers, possibly located in different enterprises, collaborate in a joint project such as the co-design of a new product or performing a consultancy job. The trend is followed by other communities of professionals (e.g. consultants) that share the body of knowledge of their professions such as similar working cultures, problem perceptions, problem-solving techniques, professional values, and patterns of behavior.

Figure 2 presents a scenario illustrating the base concepts introduced above. Figure 3 shows a more comprehensive taxonomy of collaborative networks (Camarinha-Matos, Afsarmanesh, 2007, 2008a).

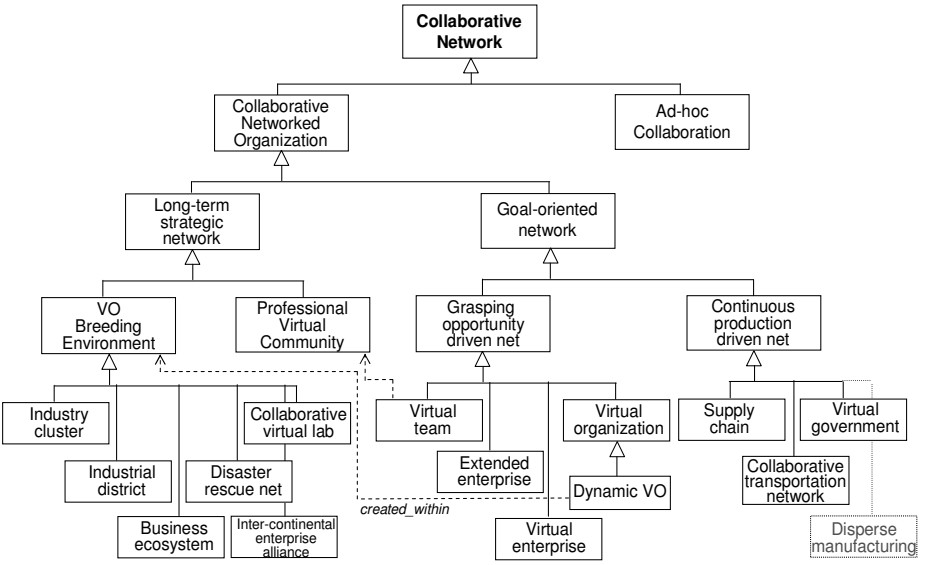

Figure 3 – A taxonomy of collaborative networks

3. A HOLISTIC APPROACH

During the last 10-15 years, and in parallel with the development and spread of Internet technologies, traditional collaborative networks have found new supporting tools and new collaborative business forms have emerged. In terms of research, there has been significant activity during the last decade especially in Europe in the area of Virtual Organisations. From the European Commission's funded activities a large number of projects can be identified, which are complemented by a large number of national initiatives. However, as verified by the VOSTER cluster network (Camarinha-Matos et al, 2005) and the VOmap roadmap projects (Camarinha-Matos et al., 2004), these initiatives corresponded to *fragmented* research and in most cases, due to the funding and assessment criteria, targeted very short-term objectives, focused on solving a specific problem, and were too biased by "fashionable" short-life technologies. Furthermore, there has been little cross-fertilization among these initiatives. This implies that a large number of developments were repeated over and over again in each project. This is particularly evident in terms of the development of horizontal infrastructures in these initiatives. In summary, the situation regarding these past initiatives could be characterized as follows:

- Research on VOs has created a critical mass and a European-wide *intuitive* understanding of the area.
- Required basic supporting infrastructures and relevant technologies are well identified, but the developments are often focused on particular needs and are based on ad-hoc experiments, hardly re-usable.
- Generic functions or harmonization of achievements are addressed only in few projects.
- To a large extent efforts on general plug-and-play architecture and interoperability are missing. Consequently, no generally accepted reference model or interoperability base is available.
- Although several disciplines are concerned, the main focus has been on the ICT infrastructure. Research on social/organizational aspects, including management, is mainly focused on best practice. Integration with technological development and impacts on organizational structures are not covered. In addition little research is focused on the social and organizational issues created by VOs.

Nevertheless there is a growing awareness that the CNO developments should be based on contributions of a multidisciplinary nature, namely from the information and communication technologies, socio-economic, operations research, organizational, business management, legal, social security, and ethical areas, among others.

In this context, the ECOLEAD project was launched with the aim to create the necessary strong foundations and mechanisms for establishing an advanced collaborative and network-based industry society. The guiding vision was that:

"*In ten years from now most enterprises will be part of some sustainable collaborative networks that will act as breeding environments for the formation of dynamic virtual organizations in response to fast changing market conditions*.**"**

ECOLEAD was a 51-month initiative, running from Mar 2004 till Jun 2008, and involved 28 partners from industry and academia, from 14 countries (12 in Europe and 2 in Latin America), namely:

- Academic and research organizations:
  - VTT (Finland), project management
  - UNINOVA (Portugal), scientific direction
  - University of Amsterdam (Netherlands)
  - Federal University of Santa Catarina (Brazil)
  - Institute of Technology of Monterrey, ITESM / IECOS (Mexico)
  - BIBA / University of Bremen (Germany)
  - Jozef Stefan Institute (Slovenia)
  - Czech Technical University (Czech Republic)
- Industrial partners and other organizations:
  - TeS Teleinformatica e Sistemi (Italy)
  - Virtuelle Fabrik (Switzerland)
  - Grupo Formula (Italy)
  - Software AG (Spain)
  - TXT e-Solutions (Italy)
  - Enicma (Germany)
  - Certicon (Czech Republic)
  - Logica CMG (Netherlands)
  - France Telecom (France)
  - Siemens (Austria)
  - Comarch (Poland)
  - AIESEC (Netherlands)
  - ISOIN - Ingeniería y soluciones Informáticas S.L (Spain)
  - CeBeNetwork GmbH (Germany)
  - Swiss Microtech (Switzerland)
  - Supply Network Shannon Ltd. (Ireland)
  - ORONA EIC S. Coop. (Spain)
  - Joensuu Science Park (Finland)
  - Edinform SpA (Italy)
  - HSPI, Italy.

It should be mentioned that a number of these organizations (Virtuelle Fabrik, ISOIN, Supply Network Shannon, Joensu Science Park, Edinform, AIESEC, CebeNetwork, ITESM / IECOS), represented in fact end-user networks (VBEs and PVCs), providing real-world scenarios and validation cases for the project results.

The underlying rational of ECOLEAD was that efficient launching and operation of VOs requires preparedness, both in the VO environment and regarding the involved individuals. Thus the planned core research addressed three main focus areas (ECOLEAD pillars): **VO Breeding Environments (VBE)**, **Virtual Organizations**,

and **Professional Virtual Communities (PVC)**, as well as their inter-relationships. These areas were complemented by research on **horizontal ICT** support **infrastructures** and **theoretical foundation** for CNOs (Fig. 4).

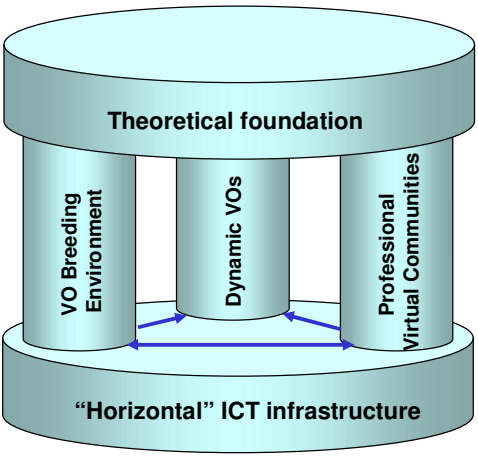

Figure 4 – The ECOLEAD focus areas

Long standing relationships - regional clustering being an example – when driven by the willingness to cooperate and anchored on common business practices, supporting *institutions*, and common infrastructures and ontology, form a business ecosystem where trust is incrementally built and where dynamic virtual organizations can be created whenever business opportunities arise. The need for such long-term sustainable networks is now widely recognized as the basis or breeding environment that can support the realistic emergence of true collaborative virtual organizations. The temporary nature of VOs, the inter-organizational processes needed, and the potentially diverging objectives of the participating partners require the development of a VO management system, which is based on the preparedness created in the VBE. The VO breeding environment is also the boosting element for the emergence of new *institutions* and mechanisms for accreditation and "life maintenance" in a turbulent business environment, where sustainability must build on both new approaches to cope with the partly contradicting individual calls for stability and the agility required by business needs.

The human collaborative relationships, namely based on common professional interests, approaches, and motivations, constitute the third area. Unlike some (not so successful) traditional virtual communities that have populated the web during last years, professional virtual communities have distinctive elements and are mobilized to face specific challenges. Their distinctive facets are not only due to the professional needs (e.g. infrastructures, tools, protocols). They cannot either be dissociated from the underlying business ecosystem of the society, due to their contractual links (social-bounds) with all the consequences at the intellectual property and life maintenance levels. Complementarily, PVCs are seen as one of the

most relevant elements for keeping the business ecosystem "alive" and for launching and operating dynamic VOs in the future.

Ad-hoc approaches and poor understanding of the behavior of the collaborative structures and processes mainly characterize past developments in the area of collaborative networks. There is not even a commonly agreed definition of the virtual organization concept. Therefore ECOLEAD also included research on the establishment of a theoretical foundation as a pre-condition for the sound development of next generation collaborative networks.

Finally the implantation of any form of collaborative network depends on the existence of an ICT infrastructure. The lack of common reference architectures and generic interoperable infrastructures, together with the rapid evolution of the underlying technologies, represents a major obstacle to the practical evolution of the area. The rapid proliferation of Internet-related technologies, although creating the opportunity for developing new experiments in terms of collaborative processes, has also created the illusion that the infrastructure problems were solved. Nevertheless, most of these technologies and concepts are in their infancy, have a very short life-cycle, and require considerable effort to implement and configure comprehensive VO support infrastructures and operational methods. Even the most advanced infrastructures coming out of leading R&D projects require complex configuration and customization processes, hardly manageable by non ICT-oriented SMEs. The interoperability problem, although an old issue in systems integration, still remains in the agenda. The fact that most teams involved in VO projects lack strong software engineering expertise (e.g. various projects are dominated by experts in the application domain but with limited background in computer science) justifies the fact that almost all VO projects are mainly "followers" of the mainstream (new fashion) in ICT, rather than breakthrough contributors.

The fundamental assumption in ECOLEAD is that a substantial impact in materializing networked collaborative business ecosystems requires a **comprehensive holistic approach**. Given the complexity of the area and the multiple inter-dependencies among the involved business entities, social actors, and technologic approaches, substantial progress cannot be achieved with the incremental innovation in isolated areas.

4. RESEARCH ROADMAP

The implementation of a comprehensive research initiative such as ECOLEAD needs to be based on a focused strategic roadmap identifying the vision and major research actions for advanced collaborative, networked organizations. ECOLEAD adopted, as a starting basis, the results of a number of major European roadmap initiatives: VOmap (Camarinha-Matos et al., 2004), COMPANION, CE-NET, and ROADCON. Fig. 5 shows, in darker color, the components of the VOmap roadmap that were adopted in and addressed by ECOLEAD.

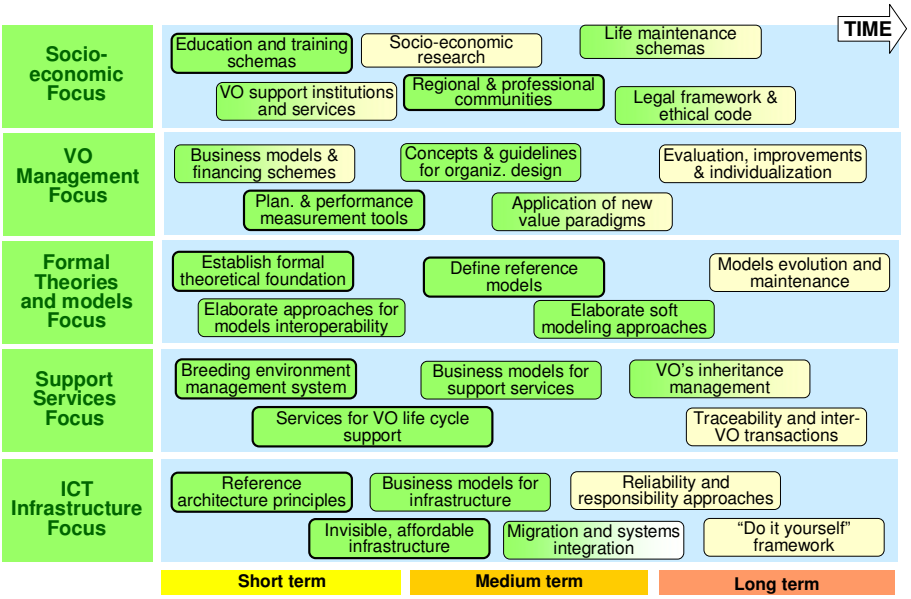

Figure 5 – VOmap roadmap, basis for ECOLEAD

Furthermore ECOLEAD approaches roadmapping as an important instrument for fine tuning of a research program, and as such, a continuously evolving activity. Therefore, ECOLEAD periodically updated its strategic roadmap and applied its findings and evolution into the project focus areas as a horizontal activity.

The following sections describe in detail different aspects of the ECOLEAD research roadmap.

4.1 VO Breeding Environment

The main aims of this focus area were to achieve substantial contribution on VBEs such that: the operating principles of VO breeding environments are understood and formalized, the infrastructures and services to support the full life cycle of these business ecosystems with a diversity of emerging behaviors are developed in a generic way, while also coping with regional and sector-based specificities and SME needs. For this purpose the following specific strategic research actions were planned for the VO breeding environments:

Action **BE1**: ***Develop generic VBE models and mechanisms***
This action aims at addressing the challenges and providing the models and base mechanisms for breeding environments. It includes:

- Characterization of VBE establishment elements and features as well as VBE typology.
- Definition of working and sharing principles (responsibility, liability, as well as benefits), ethical code, and base general agreements; schema of incentives.
- Elaboration of common ontologies and ontology evolution support.

- Partners profiling and registry; skills and competency management (individual, enterprise, environment); developing a knowledge map on partners competencies, expertise, skills and tools.
- Value system definition and its interaction with VO management.
- Business perspective / business models for VBE - cost benefit analysis example cases; multi-objective network analysis methods; branding and marketing strategies support (models, structures, training needs).
- Mechanisms to create and build the base trust among the VBE members; Mechanisms for management and measurement of trustworthiness in VBEs.
- Mechanisms for instantiation to different application domains (principle of replicability) and support SMEs joining a VBE.

Aimed innovation: Full characterization of VBE models and working mechanisms. Semi-automatic construction of ontology for heterogeneous domains. Definition of members' competency; and mechanisms to measure trustworthiness and to build/maintain the base trust among the VBE members.

Action **BE2**: ***Develop VBE management system***

This action aims at providing needed mechanisms and tools supporting the daily operation and evolution of VBEs. It includes:

- Characterization of VBE management elements and features.
- Mechanisms for competency management (members' competencies, VO competencies, and VBE competencies).
- Mechanisms for trust management.
- Mechanisms for structuring VBE members.
- Management of VBE Bag of Assets.
- Mechanisms to manage the VO configuration information, and its inheritance.
- Management of VBE ontology.
- Decision support mechanisms in VBEs.
- Mechanisms for VBE instantiation to different application domains (replicability).
- Performance catalogue and performance history management.

Aimed innovation: Competencies management at organization, VO, and VBE levels, trust management support, and dynamic VBE ontology creation and management.

Action **BE3**: ***Develop VO creation framework***

This action aims at supporting the creation of the VOs within the VBE. It includes:

- Support and provision of practical guidelines for configuration and launching of VO.
- Identification of collaboration opportunity, brokerage and planning of VO.
- Provision of simple mechanisms for partners search and selection, based on their profiles, competencies, trust worthiness and past performance.
- Agreement negotiation and contract establishment support.
- Definition of operational rules and infrastructure parameterization, clarifying the transition between VO creation and VO management.

Aimed innovation: Simple and realistic matchmaking algorithms and negotiation support for VO creation in the context of a breeding environment.

4.2 Dynamic VO Management

The challenges on VO management come from the features of a virtual organization:

- Dynamic environment
  - Temporary nature of the VO and a need of fast reaction to changes on turbulent markets.
  - Management set-ups and structures can be VO-specific and dynamic.
- The organizations collaborating in the VO can have varying
  - Internal processes;
  - Organizational and business cultures;
  - Commitment and objectives.

In this environment, the VO management means differ from those ones in a single enterprise. Especially, the management has less management power and has also to rely on incomplete information.

The goal in this focus area was to develop business models to allow VO management under the described circumstances, namely to act in regards to planning, control, organization and leadership, taking into account the importance of social mechanisms in multi-interest collaboration networks, as well as the transitional nature of VO. For this purpose, the following strategic research actions were followed for the dynamic VO management:

Action **VO1**: ***Definition of VO performance measurement approach and assessment mechanisms***

A common understanding of intra-VO shared benefits and costs (i.e. values) is elaborated to enable fair cooperation and common goal achievement. To get the needed understanding, a performance metrics with related measurement systems were developed. The metrics had to take into account multiple views and objectives, including:

- Definition of VO specific metrics based on process and type dependent key performance indicators, and development of a tool prototype.
- Development of rules and assessment procedures to measure performance and allocate values to processes and VO partners.
- Determination of individual (incremental) added-value and corresponding rewards.
- Interaction with VBE, PVC / Virtual Teams, and Theoretical Foundation in order to define a consistent framework.

Aimed innovation: Formal structure and systematic support for fair allocation of values in VO, enabling real competitiveness and increasing chances for SMEs.

Action **VO2**: ***VO management, coordination, and supervision***

This action addresses the consolidation and necessary progress on VO management, and supervision. Management has to rely on comprehensive models of the VO processes. Issues addressed in this action are:

- Distributed business processes (DBP) modeling methodologies and tools (which come from multiple disciplines), including simulation models, management structures and interdependencies.

- Models and control methods for adaptive and pro-active management. Unlike past approaches, this perspective needs more emphasis that the distributed business processes topic alone.
- VO supervision including enactment, monitoring (including pre-warning and alarms), diagnosis and error recovery, based on key performance indicators.
- Identification, prevention, and handling of conflicts in VO.
- Multi-level, multi-modal access and visibility of information.

Aimed innovation: VO management methods for different VO categories, taking into account multi-objective and multi-cultural environments.

Action **VO3**: ***VO inheritance management***

The outcome of the VO operation (generated knowledge, devised practices, developed products and processes, etc.), as well as liabilities, need to be handled after the VO dissolves. This "inheritance" relates to each VO partner and to further VOs that will continue the "processes" started by the VO being dissolved. It includes:

- Governing principles for joint knowledge management and ownership
- VO dissolution management, including procedure handbook, guidelines, legal contracts, in close interaction with VBE management.
- Collection and management of experiences, actions, etc. from the lifecycle of VO: Practices, Partners performances, Performance indicators.
- Collection and management of outputs and results created by the VO: Joint knowledge, intellectual property ownership, liabilities and enforcement mechanisms.

The VO inheritance is aimed to increase the "bag of assets" of the VBE by:

- Improving the preparedness of the VBE members and thus supporting a faster creation of VOs.
- Making the VOs more effective and reliable both in time and costs, and improving or ensuring the quality.
- Decreasing VO management efforts through increased trust and strengthened relationships.
- Supporting decision-making and tracking of VO problems or deviations.
- Increasing the value of the VBE for the members, e.g. by increasing their knowledge and market position.
- Supporting winning in competitive bidding, because of customer knowledge and closer customer relationships.
- Supporting the marketing of the VBE services to new customers by offering reference information.

Aimed innovation: Structured knowledge on VO inheritance, covering the dissolution and post-dissolution phases of the VO, collection of best practices and gathering of lessons learned.

Action **VO4**: ***Develop generic business support e-services***

VO innovative services were developed to allow support of VOs. The services are based on a performance measurement based, real-time approach, allowing the VO management to have continuous access to the status of the VO through a dashboard. They include:

- VO specific definition of Key Performance Indicators and their measurement.

- A qualitative measurement approach, complementing the key performance indicators based measurement.
- Common dashboard for access to the performance of the VO and its partners
- Intelligent alerts on deviations and emerging problems.
- Simulation based decision support for evaluation of potential management actions before their implementation. The simulation is VO-oriented, i.e. local and global, simulation. Using the local approach, single VO partners can test and validate the impact of local changes within given boundaries. Global simulation covers the complete VO.

Aimed innovation: Toolbox of key generic services suited for different VO structures and application domains.

4.3 Professional Virtual Communities

The following strategic research actions were adopted to leverage the human centered management and exploitation of knowledge and value creation by Professional Virtual Communities (PVC), while ensuring member's motivation, commitment and welfare:

Action **VC1**: ***Elaborate collaboration models and social forms***
Establishment of a conceptual framework for Professional Virtual Communities; identification of open legal and social issues; evaluation of viable approaches to the integration of PVCs into the market: workplace opportunities and direct interaction with market; identification of roadmap to best exploitation of PVC potential. It includes:

- Characterization and assessment of collaborative practices; Collaboration cultures.
- Governance principles of PVC – social, ethical, economic, and technological facets.
- Dynamic knowledge aggregation and intellectual property.
- Relationships to VO and VBE.
- Legal provisions and legal entities.
- Interfaces to existing professional bodies.
- Relationships to employers and unions.
- Roadmap for PVC exploitation.

Aimed innovation: Conceptual framework for professional virtual communities in interaction with VBE and VOs.

Action **VC2**: ***Develop advanced collaboration space platform***
Analysis of mechanisms for collaboration among members with homogeneous and heterogeneous skills. Integrating methods to accommodate the constitution and deployment of virtual teams in support to specific projects, taking into account participation in VOs. It includes:

- Generic and integrated collaborative support services (e-collaboration spaces), including multi-modal interfaces.
- Identification of operational issues in PVC operation, with a specific emphasis on social, business, and knowledge capital evaluations.

- Community management and coordination services; member knowledge [expertise] profiling.
- Methods for knowledge elicitation and seeking.
- Secure identification and profiling; proof of delivery.
- Rapid method deployment systems (for VC members' collaborative working).

Aimed innovation: New ICT supported functionalities specific for individuals aimed at managing social, business, and knowledge capital.

Action **VC3**: ***Business models for PVC exploitation***
Establishment of the business view for the exploitation of PVCs; development of methods for valuing knowledge, business, and social capital and associated capacity; analysis of the business infrastructure to support the PVC potential; development of methods and principles for interfacing PVCs to industry/service market. It includes:

- Analysis of exploitation scenarios in different domains: collaborative engineering, consulting, social service, scientific collaboration, etc.
- Identification, characterization, and support emerging value systems.
- Design and support "life maintenance" institutions in coordination with VBE and VOs.
- Knowledge capitalization and exploitation methods.
- IPR protection principles in PVCs.
- Harmonization of PVC membership with employment duties.
- Valuing Contribution to knowledge, social, and business capital.

Aimed innovation: Business view for exploitation of the PVC paradigm, characterization of exploitation scenarios, and model for life maintenance institutions.

Action **VC4**: ***Develop collaborative problem solving methods***
Design and development of support tools for brainstorming, collaborative planning and for agreeing joint approaches to problem solving. It includes:

- Develop collaborative decision support methodology
- Brainstorming principles and tools
- Develop decision support models for particular decision making problems
- Collaboration measurement, certification and rewarding.

Aimed innovation: New generation of distributed, collaborative problem solving models and some support tools.

4.4 Theoretical Foundation

The following research actions are proposed for the theoretical foundation which aims to contribute to the establishment of Collaborative Networks as a recognized scientific discipline:

Action **TF1**: ***Establish a formal modeling foundation***
As a starting point, promising theories, approaches, and models developed in other disciplines are collected and assessed regarding their applicability to, and modeling requirements of, the CNO. This action includes:

- Hands-on assessment of promising modeling approaches: formal languages, graph theory, multi-agent models, game theory, modal logics, etc.

- Identification and characterization of the necessary modeling *purposes.*
- Establish a map between needed modeling purposes and promising modeling tools ("shopping list").
- Perform modeling experiments applying promising theories to existing empirical knowledge based on selected representative cases.
- Promote education and increasing awareness for the need of a theoretical foundation.

Aimed innovation: Assessed shopping list of modeling approaches and illustrative example set.

Action **TF2**: ***Elaborate reference models for collaborative networks***
The concept of "reference model" itself needs to be well established and the main business entities (breeding environment, virtual organization, and professional virtual community) need to be covered. This action thus includes:

- Consolidation of results from various focus areas of CNOs and their abstraction in terms of a general reference model (semi-formal and easily understandable by humans).
- Development of a modeling framework and engineering methodology for application to reference modeling.
- Dissemination and involvement of relevant actors in the CNO community seeking the endorsement of the reference model.

Aimed innovation: A comprehensive modeling framework and semi-formal reference models of key entities in collaborative networks.

Action **TF3**: ***Develop soft models for collaborative organizations***
This action addresses the soft modeling needs in collaborative networks and elaborates on potential approaches to cover these needs. It includes:

- Combination of soft engineering models and social theories.
- Combination of causal networks, qualitative models and social networks.
- Development of soft reasoning models and decision-making support.
- Understanding of leadership, actors' roles, and social bodies roles.

Aimed innovation: More rigorous models of social actors and their integration into networked organizations.

Action **TF4**: ***Define basis for combination of models***
As there is no single formal modelling tool / approach that adequately covers all modelling perspectives in CNOs (no "universal language" for all problems), interoperability of different modeling tools and approaches is needed. This action includes:

- Characterization of multi-level modeling perspectives.
- Devise approaches for models combination and integration, in order to enrich the reference models for CNOs.

Aimed innovation: Multi-perspective models for selected challenging problems in collaborative networks.

4.5 ICT Horizontal Infrastructure for collaboration

The following strategic research actions were proposed for the ICT infrastructure as

a contribution to the development of an invisible, easy to use, and affordable enabler of collaborative behaviors in networked organizations:

Action **HI1**: ***Elaborate infrastructure reference architecture principles for networked organizations***
Provides guidelines, principles, and ICT reference architecture to support organizations in developing applications and ICT infrastructures suitable for networked organizations. The results are described in conceptual and functional terms rather than specific technology prescriptions. It includes:

- Platform and technology independent ICT reference architecture for collaborative networks.
- ICT infrastructure reference framework for CNOs based on the Software-as-Service and Interoperability Service Utility paradigms, to be used as general guide for particular infrastructures derivations.
- Interoperability principles foundation, considering architectures and standards to solve different interoperability scenarios within the CNO scope.
- Baseline for the organization and management of on-demand and pay-per-use services via the concept of Services Federation.
- Approaches for enterprise applications integration, both at business level and intra-enterprise level.

Aimed innovation: Principles, guidelines, reference architecture and services federation structure regarding the ICT infrastructure applicable to CNOs.

Action **HI2**: ***Devise new business models for the horizontal infrastructure***
Services-based infrastructures are a relatively new approach for CNOs. The comprehensive identification of the required business models to support services development, discovery, billing, availability, maintenance, and operation is an important need for sustainable and evolving ICT business infrastructures that relies on Software-as-Service and Interoperability Service Utility paradigms. It includes:

- Elaboration of suitable business models and characterization of stake holders in the “CNO infrastructure” business.
- Foundations for pay-per-use services and for the diversity of operation models, both of client applications and services providers.
- Assessment of models and methods based on CNO scenarios.
- Relationship of infrastructure business models to application services business models.

Aimed innovation: Approaches and assessed business models for services-based horizontal ICT infrastructures deployment, maintenance and operation.

Action **HI3**: ***Develop generic security framework***
Lack of confidence due to insufficient security provisions is a major inhibitor for organizations to collaborate with each other. This action drives the development of a security framework for networked organizations. It includes:

- Configurable, multi-level security architecture and AAA (authentication, authorization and accounting) mechanisms.
- Infrastructure monitoring facilities.
- Dynamic security for allocation and revoking of access rights.
- Quality of protection.

Aimed innovation: Flexible and easily configurable multi-level security framework for distributed collaborative environments.

Action **HI4**: ***Transparent inter-enterprise plug-and-play infrastructure***
Networked organizations need to be able to quickly define and set-up relations with other organizations, which requires a plug-&-play-&-do-business infrastructure. This being an area addressed by many activities and technology developments, supported by heavy resources, duplication of work needs to be avoided. Therefore this action focuses on the specific needs of CNOs, takes advantage of available / foreseeable results, and includes:

- Service-oriented framework for an ICT infrastructure for collaborative networks, which is platform independent.
- Standard-based support for interoperability among services deployed in heterogeneous SOA frameworks.
- Elaboration of inter-enterprise plug-&-play concept in line with current infrastructure trends.
- Assessment of emerging technologies (including technology watching) – e.g. SOA, MAS, GRID, semantic web, mobile computing - and related infrastructure developments.
- Federated information and resources management support.
- Web multi-channel accessibility.
- Support for legacy systems and corporate databases integration.

Aimed innovation: A contribution on concepts and technologies to configure applications and infrastructures for networked organizations as well as an extended collaboration model where services from CNO members can be shared.

5. KEY RESULTS

Aiming to address the application of the described research roadmap, ECOLEAD had to face a difficult exercise of combining (by contractual obligation) the need to reach innovative results and the extremely time-consuming requirement of implementing and assessing these results on real-world networks and comply with their actual requirements. As a consequence, the achieved level of innovation in some areas is perhaps lower that what would be desirable for a research project. However, the fact that these results were generated in interaction with and assessed by a large base of end-users represents a valuable achievement in itself. Nevertheless, in spite of the difficulties of the mentioned context, the project has achieved the following key results:

5.1 Main achievements

In the VBE area:

- VBE reference framework - Conceptual description and analysis of the VBE along its life cycle, including: a) Specification of the VBE concepts and their definitions, the VBE actors and roles, the base operations and processes along the VBE life cycle, and the working and sharing principles, b) Modeling and classification of VBE profiles and competency, c) Development of a generic VBE ontology.

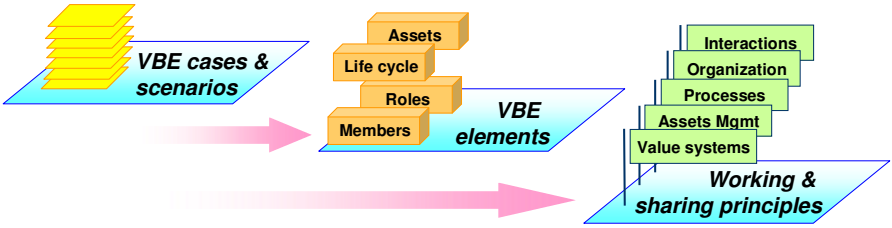

Figure 6 – Towards a VBE conceptual framework

- Value system elements and characteristics, including a set of metrics and elements characterizing past performance of collaboration processes, approaches and guidelines for VBE marketing and branding, characterization of the base for an ethical code and system of incentives.
- Guidelines for creating a trust culture, including measurement and management principles for organizations' trustworthiness.
- VBE Management System – software prototype including the following services: a) Management of VBE members' profiles, competencies, and trustworthiness levels and relationships, b) VBE structure and membership management, c) Management of VO configuration and inheritance information, d) Management of VBE's decision support system, and e) Management of VBE's Bag of Assets.
- VO Creation Framework, including identification of relevant processes and the following support functionalities: a) Collaboration opportunities (CO) identification, b) CO characterization and VO rough planning, and c) Partners search and suggestion.
- Agreement negotiation wizard, including support for multiple virtual negotiation spaces and contract modeling.

In the VO management area:

- VO operational governance models, a framework defining the basis for the management of distributed collaborative organizations, including: a) Set of concepts and definitions, b) Performance management approach, supporting VO management partly configurable from a set of predefined indicators, c) Inclusion of qualitative performance measurement of the VO, d) Models for VOs on different organizational levels and in different tasks during its life-cycle, and e) Models of management styles and their impact.

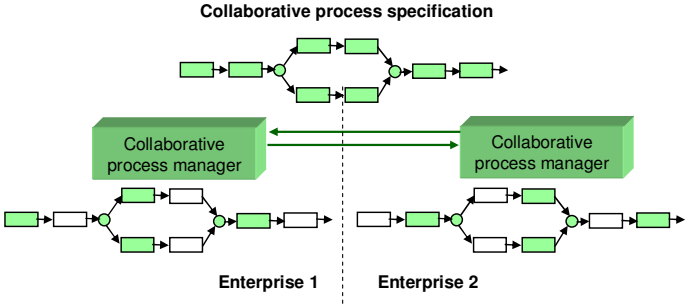

Figure 7 – Distributed business process management

- Guidelines for the set-up and operation of performance management of the VO.
- VO Management e-Services, containing most of the functionalities as e-services to support efficient VO-management. The developed functions are: a) A dashboard acting as the entry point to the management system; b) A modeling framework supporting the creation and operation of the VO management; c) A configurable set-up tool for the definition of the key performance indicators for the VO; d) A distributed measurement collection tool for catching real-time measurement in different environments and by different means, e) An alerting system supporting proactive VO management; and f) A simulation based tool for evaluation of alternative strategies in VO management.

In the PVC area:

- PVC Conceptual Framework, establishing the "Why" and "Who" aspects for these communities, through the identification of the environmental characteristics that justify the establishment of Professional Virtual Communities, the identification of stakeholders and of related value content offered by PVC, the dimensions (social, knowledge, and business) and value classes that are addressed in the PVC deployment, the PVC reference life-cycle and the governance and operation principles to be adhered to in the PVC life. The conceptual framework establishes the collaborative concept of PVCs and the motivational mechanisms founded on social, knowledge and business aspects, which sustain the aggregation of professionals through a PVC.
- PVC Business Model, addressing the general "What" aspect that is the reference objectives and mechanisms for value delivering and sustainability of PVCs. The Business Model is expected to characterize general PVCs, which individually would then develop own Business Plans and strategies to acquire and maintain a competitive edge towards other PVCs. The model is structured in accordance to a reference value proposition to customers and stakeholders, and includes the definition of mechanisms deployed to manage and grow the community assets and to deliver value to customers and stakeholders, as well as the identification of measurement based control methods to pursue operational effectiveness and efficiency (metrics).
- Advanced Collaborative Platform, the digital environment to support the management of relationships, competencies and value-added operations of PVCs. The platform therefore consists of an environment accommodating collaborative functions and services to support the Social, Knowledge, and Business pillars of the PVC. It allows for evaluating Social, Knowledge, and Business behavior of individual professionals and for promoting specific approaches to achieve PVC strategic positioning.
- Collaboration Support Services, addressing the problem-solving process that is required for the collaborative treatment of each PVC business opportunity along its life-cycle, with respect to issues in both internal management and governance, and in interaction of PVC entities with the external environment. It includes methods for the selection of professionals best suited to successfully cope with the identified problems, for the collaborative working of the constituted teams, and for the evaluation of individual and team performances.

In the ICT infrastructure area:

- ICT-I reference framework, conceptual design of the ICT-I architecture and reference framework, including: a) ICT-I reference framework, CNO requirements identification, ICT-I rationale, ICT-I architecture, reference framework and services specification; b) Global approach for interoperability, interoperability scope, ICT analysis and proposal of a global approach for dealing with interoperability problems in the scope of CNOs.

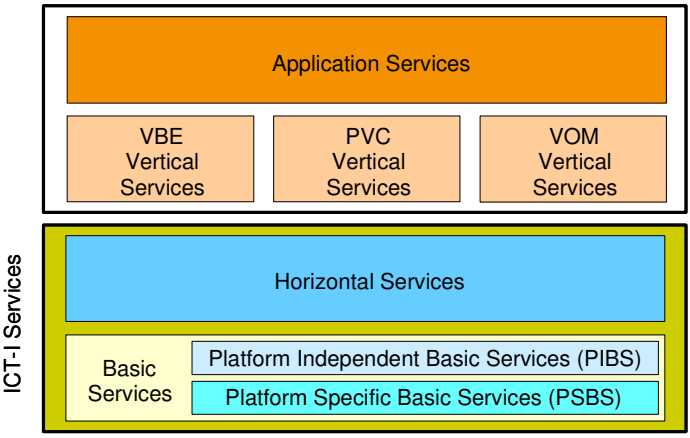

Figure 8 – ICT infrastructure framework

- ICT-I Business models, analysis and conceptual design of feasible business models to ICT-I clients (applications and developers) under the on-demand and pay-per-use models. It includes a set of business models and billing policies.
- Security framework, conceptual design of the generic security architecture and framework, including: CNO requirements identification from the security point of view, role of security in the ICT-I, security framework architecture and services specification, responsibilities and delegation policies, impact of the introduction of the security framework in SMEs as well recommendations to decrease this impact.
- ICT SOA-oriented infrastructure for collaboration, including the formal specification of services, their prototype implementation, deployment issues, interoperability standards, guidelines and examples for ICT-I access and use by client applications.

In the theoretical foundation area:

- Modeling foundation for Collaborative Networks, which includes: a) Portfolio of promising modeling theories and approaches, b) Examples of modeling cases, c) Mapping modeling needs – modeling tools.
- Reference model for CNs, including: a) Principles for a reference model for CNs, b) ARCON modeling framework, and c) Reference model for CNs.
- Soft modeling foundation for CNs, including: a) Motivation and approach for soft modeling in CN, and b) Experiments on soft modeling.

- Contribution to a theoretical foundation for Collaborative Networks, which synthesizes and integrates all results of the theoretical foundation and includes: a) Experiments of interoperability among models, b) A book on the theoretical foundation for CNs.

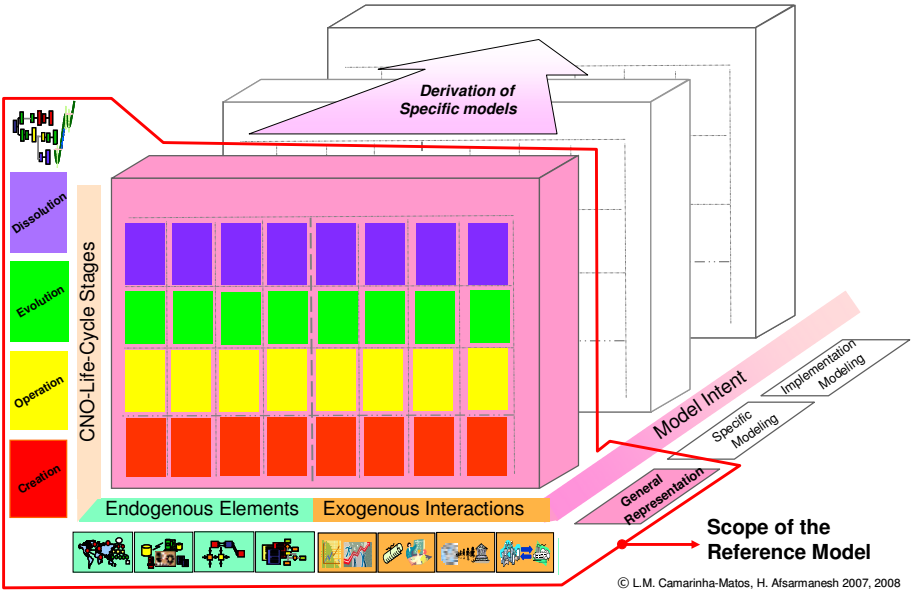

Figure 9 – ARCON reference modeling framework

The above results, except the theoretical foundation, are described in details in the following chapters of this book. The theoretical foundation results are included in a separate book (Camarinha-Matos, Afsarmanesh, 2008b).

5.2 Demonstrators

With the objective of performing a field assessment of the ECOLEAD results and also as an instrument for dissemination and impact creation, 9 demonstration pilots were implemented in real running business networks, eight functioning in Europe and one in Mexico, as follows:

IECOS scenario
IECOS (Integration Engineering and Construction Systems) is a Mexican enterprise that uses the VBE model integrating capabilities and competencies of its partners (mainly in metal-mechanic and plastic industry) to satisfy customer requirements. ECOLEAD demonstration activities within IECOS are oriented to the optimization of network management, which also will impact on partners (VBE members) performance. Therefore, the main end-user is the IECOS broker with the following objectives: improvement of the VBE member registration and characterization processes, formalization of the VBE performance management system, and semi-automation of the collaborative opportunity characterization to be matched against

partners' competencies, used for search and selection of best fit partners for VO configuration.

HELICE/CeBeNetwork demonstration scenario

HELICE is the Andalusian aeronautic cluster, which operates under the VBE model to increase process efficiency and business opportunities while fostering innovation in a sustainable structure. Similarly, the CeBeNetwork represents a supplier network, mainly located in Germany, in the aeronautical industry and a strategic supplier to the main customer Airbus. HELICE and CeBeNetwork have joined their efforts to generate and coordinate a joint global VBE, in the area of aeronautics, and which applies ECOLEAD results to better manage the new network operation, and more fluidly creating VOs. Specific functionality applied by the joint Helice/CeBeNetwork is the dynamic management of the competencies and trust levels of VBE members, as well as the organization of the VBE's Bag of Assets, and its performance based decision support, and agreement negotiation wizard.

Swiss Microtech scenario

Swiss Microtech (SMT) is a regional collaborative network created in 2001 by SMEs of the mechanical subcontracting sector to address together new markets and develop new products which are beyond individual SME's possibilities if they would stay alone. SMT has actually 7 SME members. The very fierce competition on the prices and the importance of the emerging Chinese market led to the creation of DecoCHina in 2005, an international VBE combining two regional networks, namely the SMT and a new parent Chinese network in the Guangdong Province. ECOLEAD demonstration activities within SMT were oriented to the optimization of network management, which also impacts on its partners (VBE members) performance. Therefore, the main objectives were: the improvement of VBE competencies management, formalization of the VBE performance and added value and a more efficient creation of regional and international VOs, as well as reaching electronic agreements and signing contracts among the VO partners.

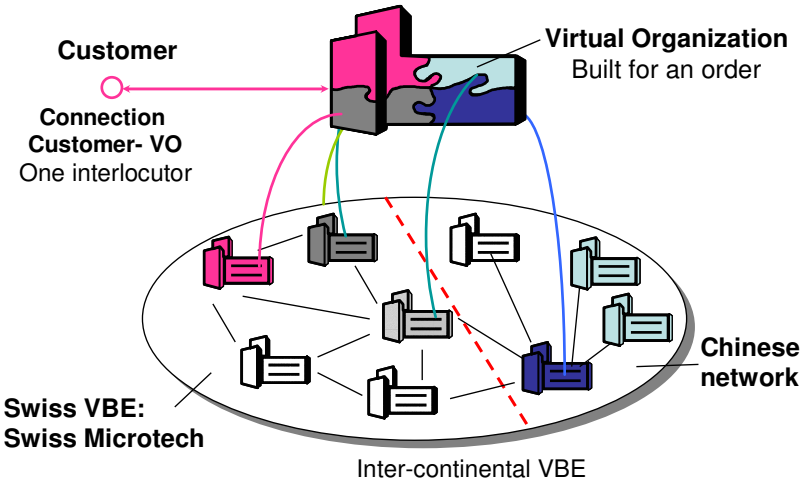

Figure 10 – The Swiss Microtech inter-continental VBE scenario

Virtuelle Fabrik scenario
The Virtual Factory (VF) is a network of industrial SMEs (operating as a VBE) in Switzerland and South Germany. The network provides a full range of industrial services and production to the customers. The network enables the SMEs to act in collaboration with other SMEs the same way as a very big industrial company. In ECOLEAD, the business case was part of the definition for a generic VO model. The application was focused on VO modeling, VO performance measurement, VO monitoring and integrated VO management supported by simulation.

Supply Network Shannon scenario
Supply Network Shannon (SNS) is an open network of companies in the Shannon region of Ireland, which provides a framework for companies to collaborate in joint marketing, training, development, and collaborative quotation development for participation in outsourcing networks. As such, SNS currently operates as a regional VBE with individual members currently creating sub networks on a global scale. The main application of ECOLEAD results was based upon the introduction of the structured VO management techniques to assist with the control and coordination of existing VOs in the network. This application includes the use of the VO-Model to maintain structured information about the VO, particularly in relation to the work breakdown structure, the individual management styles used in the network and the structured measurement of VO performance indicators.

ORONA / OIN scenario
ORONA stands as the Spanish leading company in the lift industry and belongs to the MCC, one of the leading business groups (made of 220 companies and entities) in Spain. The Orona Innovation Network (OIN), promoted by ORONA in 2002, is a research consortium supported by a network of experts (coming from universities, RTD Centers, companies in the sector, etc.) working in multidisciplinary and multi-company communities that centered their activity in: a) the discovery of new technological opportunities, b) the translation of these opportunities into innovative product ideas for short-distance transportation. In this scenario, OIN applied the ECOLEAD tools in two different cases, a) Virtual Organizations for Technology Platform Development and b) Virtual Organizations for New Product Development. Orona used the tools to a) formalize the network procedures, b) formalize and make easier the management of the network, and c) be prepared to increase the network with new external partners. All tools developed for VO management are thus relevant in this context.

AIESEC scenario
AIESEC is a non-profit, non-commercial, non-government global organization, run by students and recent graduates. AIESEC has offices in over 90 countries, with over 20.000 members globally. With ECOLEAD pilot, AIESEC aimed to build sustainable professional virtual communities for AIESEC alumni leveraging on the existing social ties and harvesting their economic potential. Therefore, this scenario focused on application of ECOLEAD results on PVC creation and life-cycle management, PVC governance, and virtual teams' creation.

EDINFORM / FEDERAZIONE demonstration scenario
Federazione Regionale Ordini Ingegneri Pugliesi is a regional Italian organization including all Apulian engineers – about 12.000. The objective for this scenario was

to organize a pilot panel of professionals selected among all the community members and composed of 100 units whose task was to test the proposed methodologies and ICT tools available from ECOLEAD and to provide a feedback about the benefits regarding the methodologies and tools for the professional activity they had.

Joensuu Science Park scenario
JSP is a technology park located in Eastern Finland. It is a regional development organization with global vision toward the development of the third generation of science parks which can evolve towards a combination of VBEs and PVCs. The main focus of the scenario was in the area of new collaborative working environments, namely support for PVC management and creation of virtual teams.

All these pilots were successful in demonstrating the usefulness of the various ECOLEAD results and also provided important feedback for future improvements and further research. Detailed descriptions of these results are included in other chapters of this book.

5.3 Training

Education plays a vital role in facilitating the dissemination and broad acceptance of collaborative networks. Therefore, ECOLEAD has organized several specialized training events for European industry as well as two summer schools oriented towards researchers and PhD students. A major outcome in the training area is a proposal for a "reference curriculum" for teaching Collaborative Networks at university level. This curriculum is based on the ECOLEAD consortium's experience in teaching and disseminating the corresponding concepts in the context of several international projects, as well as on the findings of a survey on this subject conducted worldwide (Klen et al. 2007). Guidelines for the application of the curriculum were also elaborated. A rich set of potential scenario cases and projects are also designed as a support for the accompanying hands-on lab work.

4. CONCLUSIONS

Collaborative networks are well recognized in the business context and society in general as a very important instrument for survival of SME organizations, especially in a period of turbulent socio-economic change. A growing number of diverse forms of collaborative-networked organizations have emerged as a result of advances in information and communication technologies, the market and societal needs, and the progress achieved in a large number of international projects.

Nevertheless most of the past initiatives have addressed only partial aspects, failing to address and properly support the various business entities and their inter-relationships in complex and fast evolving business ecosystems. The ECOLEAD project, as a large international initiative, has pursued a more holistic approach considering both the long-term and temporary organization alliances and collaboration among organizations and individuals. The extensive set of achieved

results in ECOLEAD represents a basis for a new framework for advance collaborative networked organizations.

The implementation of a large number of pilot demonstrators in real business scenarios was a key element for the validation of the results and to elicit new challenges for future research.

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