ESoCE-NET White Paper

The "Concurrent Innovation" paradigm for Integrated Product/Service Development

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Introduction

In the global business scenario, the human capital is deemed to be an essential competitive advantage by all involved business entities, being them individuals, enterprises and networks. Within the emerging knowledge economy, industrial competitiveness is based more and more on the creativity and productivity of knowledge workers in the development of new products and services. They are expected to fully exploit their individual potential whilst operating with and within business organizational arrangements aimed at primarily maximizing corporate efficiency and productivity. Within enterprises, value networks, companies' clusters, as well as professional communities, the knowledge workers' creativity and productivity issue has already been addressed in different ways, all considering the human interaction and collaboration as key enabling mechanisms to enhance creativity and innovation. Moreover, it has been recently demonstrated that the element of individual diversity is a decisive driver for innovation (Fleming, 2004).
The cross-functional teamwork fostered by the Concurrent Engineering practices (Lake, 1991) as the mechanism for inducing parallelism in the new product/service development process as well as to minimize the risk of expensive re-design loops in its later phases, resulted also in a stepwise improvement in the way in which knowledge workers were interacting within the new product development process, to the benefit of their effectiveness and capability of expressing their potential. This effect was further amplified by the subsequent deployment of the Extended/Virtual Enterprise paradigm in which collaborative teams were intended to overcome organizational barriers by including partners, suppliers and customers.

Advanced collaborative problem solving methodologies for maximizing the creativity of knowledge workers in teamwork activities for new product/service development are emerging to address also specific cognitive and social aspects of collaboration.
Nonetheless, despite of the good results achieved so far, best in class corporations are currently perceiving that they are approaching a limit of the possible improvements actually achievable in the exploitation of knowledge workers' human capital within current organizational structures. The authors argue that a Copernican revolution is required where the individuals breaks out of the company borders and a network of knowledge worker peers (professional community) become the center of the organizational constellation. The breakthrough concept is to create an entanglement between the network of individuals and the organizations, by allowing the knowledge workers to be at the same time, an "employee" of the organization and a "member" of the professional community. Knowledge is created in the community through peer collaboration and then offered for exploitation to the constellation of organizations.
The underline assumption is that a peer environment enable individuals to express their full creative potential, by making them feeling part of a shared intent (social dimension), being empowered to higher knowledge creation possibilities (collaborative knowledge) and controlling the potential economic benefits deriving from their achievements (explicit business dimension).
This paper defines the conceptual framework of a new paradigm for integrated product/service development, referred to as *Concurrent Innovation* (CI), which is deemed able to overcome the current limitations in the exploitation of the human potential in new product/service development.
The *Concurrent Innovation* is proposed as a systematic approach for managing innovation cycles, from the generation of new ideas to the large deployment of new products/services, enacting the full exploitation of all the involved individual intellectual capabilities.
The implementation of the Concurrent Innovation paradigm in actual business environments is realized through the introduction of new organizational entities, the human centric *KBS virtual professional communities*, which are intended to interplay in entanglement with traditional business entities, as well as with collaborative networked organizations such as companies' clusters and Virtual Enterprises.

The "KBS" Virtual Professional Communities

The KBS Virtual Professional Communities are new organizational entities, characterized by a value system accounting for an appropriate balance of the Knowledge, Business and Social (KBS) dimensions, designed to best support innovation and maximize the realization of individuals (Bifulco et al, 2005) . The KBS Communities are association of individuals identified by a specific knowledge scope and aimed at generating value through members' interaction, sharing and collaboration.
The generated value consists of:

- Advanced Knowledge
- Business services
- Social capital

This interaction among the members is optimized by the synergic use of ICT-mediated and face-to-face mechanisms. The KBS Community members temporarily aggregate in Virtual Teams (VT) for addressing specific business activities. It is up to the members, which can be both company employees, researchers, individual professionals, common people etc., to decide the type and the extent of their individual involvement in the community activities, which is complementary to and co-existent with their working occupational forms. The operational processes of KBS communities are founded on the principles of people empowerment and self-organizing leadership and make use of

advanced methodologies for supporting peer-to-peer collaborative interaction for the generation of new knowledge and value for customers.

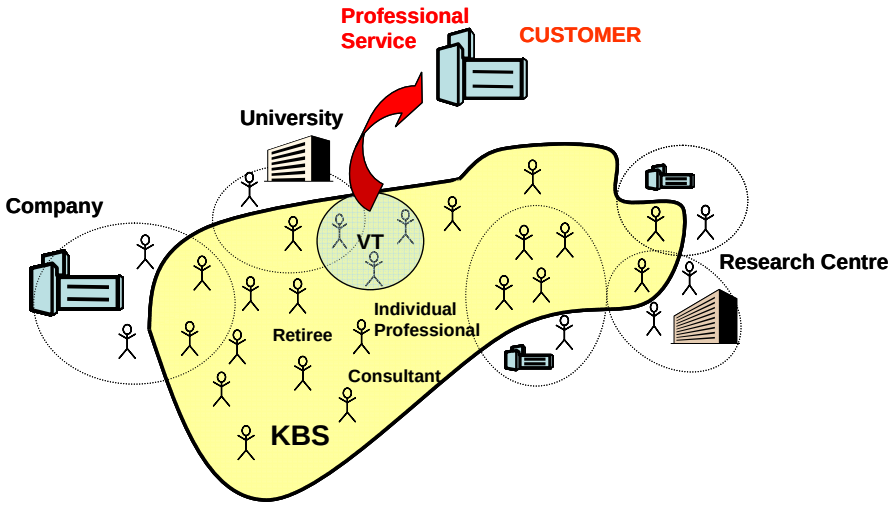

Figure 1. The KBS Virtual Professional Community

The innovativeness of the KBS Community concept rely on the comprehensive and appropriate inclusion of the three fundamental dimensions, namely Knowledge, Business and Social, all necessary for a sustainable, motivated and durable community:

- the absence of the business dimension would result in a limited activity scope, putting at risk the KBS Community sustainability and members' viability to spend significant time in the community activities.
- The lack of the social element, ensuring trusted relationships among the members, would limit the readiness to approach business opportunities and impair the free share of knowledge among members.
- Not addressing the knowledge development element would limit the usefulness of the community for the build-up of the knowledge society, reduce motivation of the knowledge worker and impairs his aspiration to obtain higher recognition and even economical reward

The KBS communities are intended to overcome the limitations faced by Community of Practices (CoP) (Levit et al 2001) (Wenger 1998, 2000) (Gongla et al. 2001) in overcoming organizational barriers to collaboration This is due to the lack of an explicit business dimension in the community which:

- jeopardizes members' motivation and even viability to spend significant time in the community activities
- reduces the scope of community activities
- impedes a deep sharing and an actual co-development of knowledge and competences
- induces mistrust because of hidden Companies' or members' business interests
- prevent individuals and their companies to accrue the economic value which is actually generated through the community activities.

The KBS Virtual Professional Communities interpret the necessity of evolving towards more balanced Knowledge-Business-Social (KBS) collaborative entities. The harmonization of the three elements can be characterized, in a symbolic way, as the blending of the three basic colors (Blue for the

Knowledge, Green for the Business, and Red for the Social dimension), resulting in one determined chromatic integration for each specific community. This color represents the inherent characteristics, as well as the delivered values, of a certain kind of Virtual Professional Community. This characterization approach, the "KBS Chromo-Framework", has been used for developing a community evaluation methodology. The Figure 2 represents the example characterization of a Community of practice in the KBS Chromo-Framework in comparison with a more balanced KBS Virtual Professional Community.

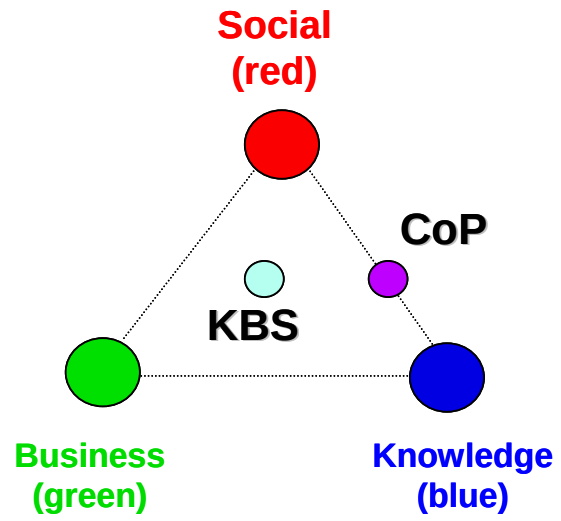

Figure 2. The characterization of an example Community of Practices in comparison to a more balanced Professional Virtual communities within the KBS chromo-framework

Being intended to deliver advanced knowledge, the KBS community composition is designed in a such a way to allow the interaction of individuals with not-aligned discipline, background, competence, attitude and culture in general. Depending on the nature of the KBS community knowledge scope, two main typologies can be identified:

- "Incipient discipline KBS communities", characterized by a knowledge scope coincident with a potential new knowledge discipline, resulting from the multidisciplinary integration of a number of established disciplines (for instance the psycho-vibro-acoustics for transport applications). The Community constituency will include all experts from the single disciplines as well as from the impacted product systems. Common people are essentially included with the role of end-user of the relevant integrated product.
- "Challenge-oriented KBS communities", characterized by an "unstructured" knowledge scope, which is indirectly defined by the definition of a specific challenge (for instance the definition of the next generation of a certain kind of product/service). In this case, where the multidisciplinary concept it brought to its extreme, it is not possible to identify privileged knowledge areas and, in principle, experts from all disciplines can be included. In this kind of community common people are expected to play, in addition to the end-users' part, a more significant role in the actual development of the new product/service, by leveraging independent logical and creative capacities needed to complement and overcome the

potential barrier to breakthrough innovation coming from "disciplined" knowledge and experienced competences.

The "Concurrent Innovation" paradigm

This paragraph presents the fundamental principles at the base of the emerging *Concurrent Innovation* (CI) paradigm and its relationship with the recent paradigm shifts faced by the integrated product/service development. The CI is thought to allow the realization of a "collective intelligence" out of all the individual intellectual capabilities involved in the development of new products and services, an issue that was addressed only implicitly and in a very limited extent by the *Concurrent Engineering* and *Virtual Enterprising* approaches.
The *Concurrent Innovation* paradigm is based on a new ordering principle addressing the interactions among individuals in the integrated product/service development. This principle represents a step-forward in the way in which "concurrency" is addressed, being characterized by a direct focus on human beings (human-centered). The concurrency aspect was addressed as well by the *Concurrent Engineering* and the *Virtual Enterprising* approaches, but from different perspectives, "activity-centered" in the first case and "organization-centered" in the latter.
In the early nineties, the *Concurrent Engineering* paradigm emerged on the basis of a new principle addressing the **organization of work activities** within the new product/service development: the interactions among the sequential tasks constituting the new product/service lifecycle (such as concept, design, validation, manufacturing, etc.) were not to be exercised through the definition of their interfaces, but should have taken place concurrently, by means of tasks' interactive parallelism and early involvement of functions responsible for later product/service development stages.
Years later, the application of a new ordering principle, addressing this time the **interactions among the business entities** involved in the new product/service development, determined the emergence of the *Virtual Enterprising* approach: the definition of collaborative risk-sharing business relationships and the identification of the participating business entities, shall be carried out concurrently with the product/service development, in lieu of the definition of standard sub-contracting business interfaces consequent to the product development. The business interaction is not defined at the interface level, but takes place concurrently, by means of shared and distributed strategic decision processes.
The Concurrent Innovation paradigm is based on an ordering principle that directly addresses the **interactions among individuals** involved in the new product/service development: ad-hoc task-teams of individuals self aggregate concurrently with the task definition, independently from organizational constraints. An implementation mechanism is provided by an approach which allows individuals to be employed by Value Network companies and, at the same time, be member of professional communities. The human interaction is not defined at the interface level by roles and tasks allocated by parental organizations, but takes place by initiatives of individuals, through self-commitment and self-organizing leadership .
From a high level perspective, the three paradigms described above can be characterized by an unique methodological approach and based on the removal of pre-defined structured interfaces among individuals, aimed at responding to the increasing speed of change in the business environment. This common triggering factor can be decomposed in the followings:

- the progressive **shrinking of product lifecycle**, demanding for the continuous reduction of the "characteristic times" of the new product/service development, and challenging, at limit, the possibility itself of implementing pre-defined work processes;

- the increasing **complexity of new products/services**, demanding for the inclusion of disparate competencies for the development of bundles of product and services eventually delivering higher "value" for customers
- the increasing **personalization of products/services**, demanding for a deeper inclusion of the individual end-users within the integrated development of product/ services.

The evolution of integrated product/service development resulting from the implementation of the three paradigms can be characterized by the incremental extension of a number of features, including the "concurrency", the "intensity of interaction among individuals", the "entanglement of organizational settings " (starting with the entanglement between design and manufacturing departments, to the entanglement between different organizations, towards the entanglement between Organizations and Communities). The Figure 3 depicts in a pictorial way the evolution of the integrated product/service development in response to the increase of the triggering factors.

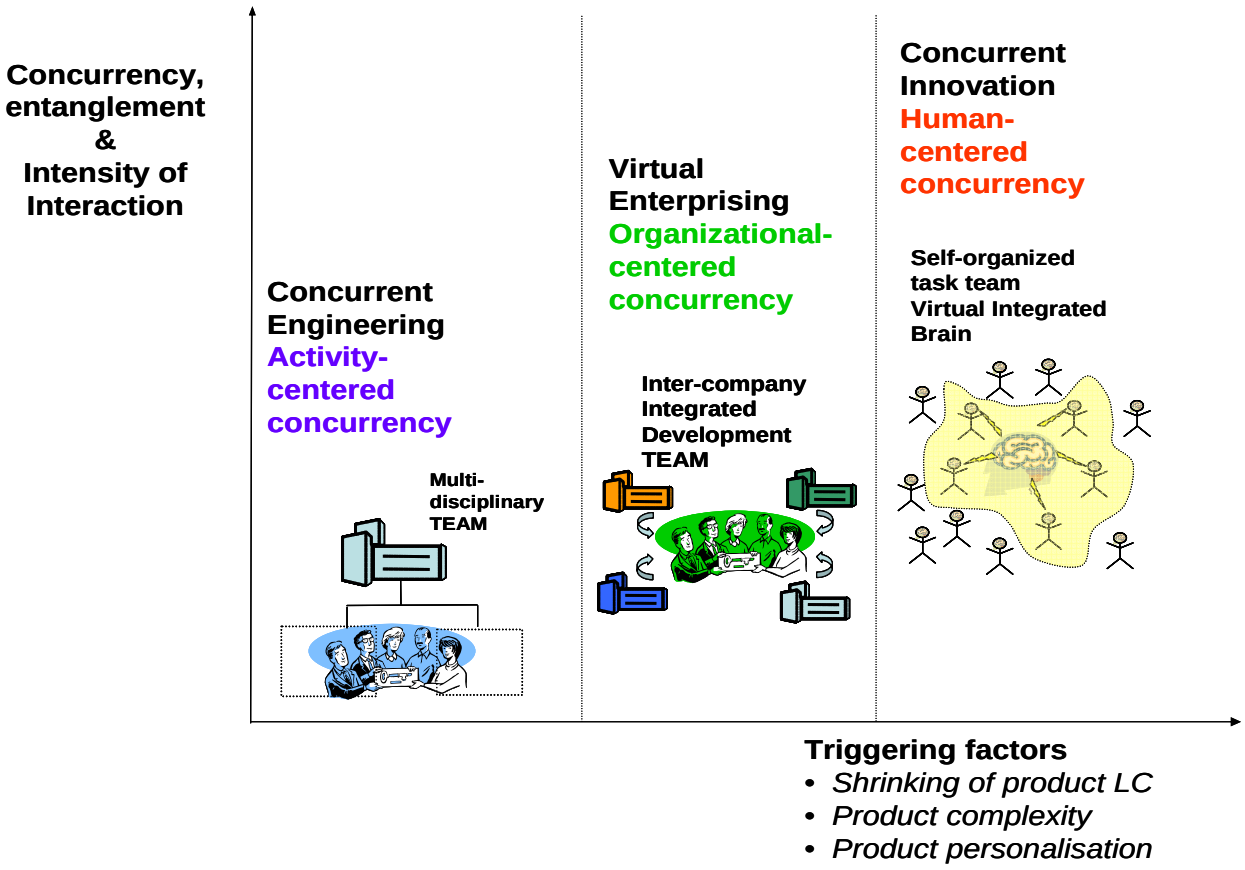

Figure 3. The evolution of new product service development in response to the increase of the triggering factors for change

This evolution aims at creating the conditions for a seamless interaction among humans, as if they were individual neurons of one "integrated brain" able to deal with the development of increasingly complex new product/service. As the human intelligence can be interpreted as an epiphenomenon of neurons' interaction, which is made possible only if the extent and quality of interrelations achieve a

certain extent, the realizations of a "collective intelligence" can be attained only when the quantity and quality of interactions among individuals achieve a certain critical level.
The industrial age ability to deal with complexity has moved from the decomposition of tasks (Ford mass production) to the scale down of large organizations into Value Networks, to the disintegration of organizational structures into a professional business ecosystem composed by KBS communities entangled within Value Networks.
The concurrent innovation paradigm furthers the liberation process of workers from task, discipline, and organizational barriers which had paradoxically been introduced in the industrial mass production age for enabling social and economic development.
The Table 1 reports the key characterizing elements of the three examined paradigms which are intended as further expansion of the previous one (i.e. the *Virtual Enterprising* approach is including the *Concurrent Engineering* principles and practices, and in turn the *Concurrent Innovation* is including the *Virtual Enterprising*).

Paradigm	Key features	Scope	Strategic objectives	Models, practices and tools
Concurrent Engineering	➢ Cooperation ➢ Shared Knowledge ➢ Problem Structuring	Product lifecycle	Product Focus Increase **efficiency** (time, cost) of the product/service development process while maintaining an high quality level.	Product/service Model Intra-organizational and co-located teams Multidisciplinary integration of technical disciplines Sub-Contract based IPR transfer Integrated (centralized) ICT systems
Virtual Enterprising	➢ Collaboration ➢ Shared risk ➢ Problem definition	Market opportunity lifecycle	Organization Focus Increase organization **effectiveness** in the competitive environment for business sustainability	Organization Network Model Inter-organizational and distributed teams Multidisciplinary integration of technical, organizational and business disciplines Agreement based IPR distribution among organizations Service-based distributed ICT system
Concurrent Innovation	➢ Co-creation ➢ Shared intent ➢ Problem identification	Social innovation lifecycle	Human focus Increase **creativity** through full realization of individuals' human potential. Innovation driven business competitiveness. Capability of determining systemic innovations.	Human Network Model Dispersed teams (time, space and organizationally) Multidisciplinary integration extended also to social and cognitive sciences Tracking-based IPR allocation among individuals ICT system supporting Ambient Intelligence

Table 1. The characterizing elements of the Concurrent Engineering, Virtual Enterprising and Concurrent Innovation paradigms

The "Concurrent Innovation" process

The implementation of the *Concurrent Innovation* (CI) paradigm through the introduction of KBS Virtual Professional Communities in the business ecosystem and their structured interplay with traditional business entities and networked organizations (such as Companies' Clusters and Virtual Enterprises), is enabling a breakthrough in the way "Innovation cycles" are managed. The *Concurrent Innovation* paradigm defines a methodological approach for managing and sustaining innovation cycles, so incrementing the probability of realizing truly "systemic" innovations. The Figure 4 shows the reference phases in which a generic innovation cycle related to the integrated development of a new product/service can be decomposed. This phase decomposition represent the theoretical abstraction of all the logical steps, which, in principle, could be applicable to the innovation cycle of all products/services.

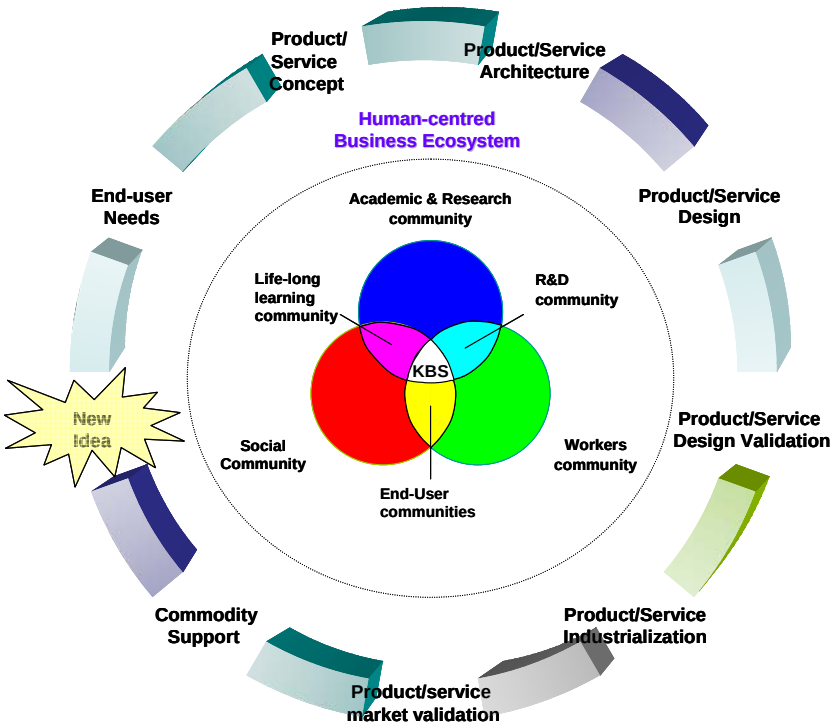

Figure 4. The reference phases of the innovation cycle and the human-centric business ecosystem of knowledge workers

The innovation cycle is realized within a Business Ecosystem where traditional and networked business entities are entangled with KBS Virtual Professional Communities, Research and Academy institutions, common people and end-users in their living environment. The human centric representation of such professional ecosystem is reported in the figure, by highlighting the different communities to which an individual may belong to and the interaction among them with reference to the Knowledge, Business, and Social dimensions.
Different actors are involved in each phase of the innovation cycle and are generally identified in the Table 2. The participation of common people at the innovation cycle is more concentrated in the initial phases (generation of new idea, identification of end-user needs, concept definition) as well as in the final ones (product/service market validation, product support for the new commodity), in which they play the roles of end-users and developers at the same time. The specific mechanisms for their engagement along the innovation lifecycle are addressed in detail by an emerging methodological approach that is implemented through the so called "living labs".

Life-cycle phase	Output	Leading Actors	People participation
New Idea	Formalised product/service idea (key functionalities, user needs and alternative concepts)	Self organising **Virtual Teams** within the KBS community, aimed at generation of ideas for new product/services (VT1 type)	Yes
End-users needs	Formalised and validated end-user needs	Self organising **Virtual Teams** within the KBS community, aimed at validating user needs for new product/services (VT2 type)	Yes
Product/service Concept	Product concept selection and validation	Self organising **Virtual Teams** within the KBS community, aimed at concept selection and validation (VT3 type)	Yes
Product/Service Architecture	Product architecture selection and validation	Self organising **Virtual Teams** within the KBS community, aimed Product architecture selection and validation (VT4 type)	
Product/Service Design	Preliminary design and prototype	**Virtual Enterprise** (VE1 type) established as a temporary aggregation of companies in the business environment, utilising the professional services of a **Virtual Team** aimed at supporting the first implementation of new knowledge (VT5 type)	
Product/service Design Validation	Detailed Design validated	**Virtual Enterprise** (VE2 type) established to carry out the new product detailed design	
Product/Service Industrialization	Validated production system	**Virtual Enterprise** (VE3 type) established to carry out the new product industrialisation	
Product/Service Market Validation	Product/Service ready for market deployment	**Virtual Enterprise** (VE4 type) + **large demonstrators testbeds**	Yes
Commodity support	Product ready for market deployment	**Virtual Enterprise** (VE5 type) +**End-user community**	Yes

Table 2. Involvement of different business actors in the reference innovation cycle phases

The Figure 5 shows an example business ecosystem, consisting in KBS Virtual Professional Communities entangled with a Cluster of Companies, whose core members are companies' employees, researchers and individual professionals. The KBS communities include also

professionals that are external to the cluster, as well as the end-users of the cluster product/services. Innovation cycles start within such KBS communities, whose knowledge sharing and creation mechanisms support fruitful interactions among all the "innovation stakeholders" that origin the ideation of innovative product/services, and progressively involve the cluster's business entities in the subsequent phases of the innovation cycle. The figure 5 represents example activities related to the "product/service design" phase of the innovation cycle, in which a Virtual Enterprise, supported by a Virtual Team of a KBS Virtual Professional Community, is producing the prototype of an innovative product for a cluster's customer. The innovation cycle ends with the industrial validation and the consequent large deployment of the innovative product/service, which possibly overcomes the borders of the cluster.

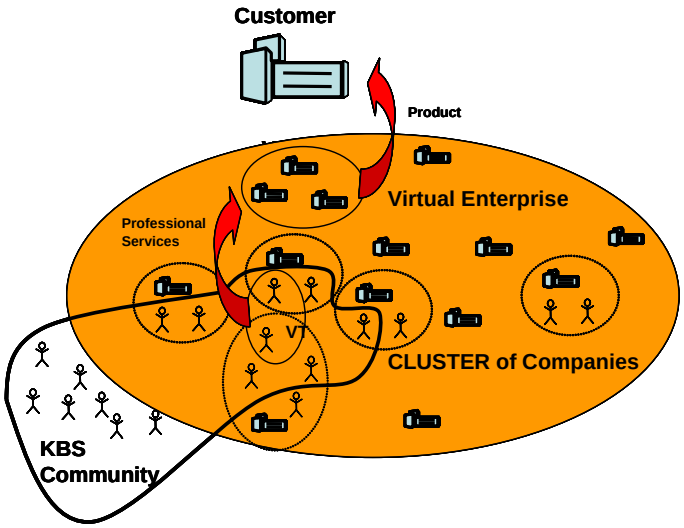

Figure 5. An example business ecosystem, consisting in KBS Virtual Professional Communities entangled with a Cluster of Companies

The proposed validation approach

The assessment of the beneficial effects coming from the implementation of the Concurrent Engineering paradigm has been object of many studies aiming at correlating the implementation of Concurrent Engineering practices to company business performance metrics. Among others, an emerging Concurrent Engineering assessment methodologies (Hull et al 1996) (Collins, et al 2002) makes use of a data base built through the application of the assessment methodology to a significant number of Fortune 500 companies, to provide best in class reference values as well as an experimental validation of the effectiveness of the CE approach.
The proposed validation approach for the Concurrent Innovation paradigm is a generalization of such assessment methodology in which the parameters characterizing the level of implementation of the CI paradigm (e.g. concurrency, entanglement etc.) will be experimentally correlated to business success of new products/services.

Conclusions

The paper has presented the fundamental principles and the practices defining the Concurrent Innovation paradigm. The Concurrent Innovation is intended as a systematic process allowing the realization of a "collective intelligence" out of all the individual intellectual capabilities involved in the development of new products and services, able to attain higher level capabilities.
This thesis is not demonstrated in this paper, but its feasibility is guessed by the authors, on the base of the observation of the effectiveness of human interactions, in terms of creativity, capability of understanding and intellect capabilities at general, when motivated self-organized teams aggregate to pursue a common goal.
Confidence on the CI effectiveness comes also from a generalization of the statistical study carried out at MIT (Fleming 2004) showing the positive influence of discipline disalignment on the probability of achieving breakthroughs. The interaction of fully disaligned individual intellects, with their own specific peculiarities, freed by discipline, task and organizational barriers, is thought to further increment the breakthrough probability.
A full collaborative approach has also been followed by the authors in developing the theory at the base of this paper and their experience was that the most original thoughts were coming out from a truly co-creation process, in which the interaction between themselves was actually needed to achieve the higher intuitions.

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