E-HUBs – COLLABORATIVE ENGINEERING ENABLED THROUGH WEB BROKER SERVICES

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Within the era of growing global competition companies realize that there is enormous potential to leverage knowledge and experience that resides outside their own core business activities, and that this expertise could be very synergistic to theirs if only they could tap into it. The main challenge for any enterprise to become competitive in this new business environment is to develop the right framework for exploiting new global services, information and knowledge networks. The e-Hub concept, an extended broker for engineering services, copes with this challenge in the domain of technical product development, and targets in particular the highly specialized engineering tasks involved with that. The e-Hub concept is based on the premise that this form of a collaborative intermediate will provide a perfect mechanism for cohesion building and the marketing of SME expertise. This paper presents the frame of reference for the e-Hub design, development and implementation. Following the general architecture of collaborations the constituent elements of the e-Hub reference model are deduced and specified. As a conclusion the e-Hub represents a novel approach to effective distributed e-Engineering and delivers the right business mechanism to achieve this within the technological, organizational and human constraints that are present.

1. INTRODUCTION

With the unrealistic expectations at the start of the B2B hype behind us, a new realism is setting in. Consequently, enterprises have started to rethink their strategy for future Internet enabled business and are taking a closer look at the broader picture of collaborative Commerce. Many believe that this is the right time to regroup and start the preparation of 'true' e-Business solutions. The concept of e-Hubs as extended broker services for distributed engineering collaborations aims to realize this in one of the most promising sectors of c-Commerce: e-Engineering, as a

dedicated internet supplied service that can be in-sourced in the product development processes of remote clients.

The benefits from the implementation of an e-Hub entity is that it provides not only a web hosted collaboration service for life cycle support of e-engineering partnerships but also a low cost entry for SMEs or SME clusters to offer dedicated services via the e-Hub distribution channels. In a recent survey in the USA 67% of SMEs stated that the biggest barrier to enter into Internet commerce was the steep investment curve. This can be overcome by community based service brokerage. Thus, a bridge between first generation B2B services and future sustainable forms of true B2B collaboration, involving shared enterprise processes, collaborative product development and the ultimate but hitherto elusive 'Virtual Enterprise', will be erected.

The e-Hub entity is a business entity supporting the work of volatile consortia carrying out collaborative engineering and design projects. It does not carry out engineering work per se but it could fulfil any other function that will support community creation, engineering project preparation and coordination work conducted by distributed multi-team consortia. The scientific challenge faced is that of identifying or defining functions that can be provided more efficiently by an entity such as the e-Hub rather than by design partners themselves. To do otherwise would be counterproductive and entail the erosion of profits for the hub as a whole and at the same time conflict with the interest of parties that the hub is meant to serve.

2. OBJECTIVES OF THE E-HUB DEVELOPMENT

The business objective of a Hub entity is to provide a balanced organizational, technological and human approach to future global co-engineering communities. A separate and important objective of the research is to develop a multi-faceted business perspective and test the viability of the broker entity in the growing international market of Internet services.

By applying the e-Hub as a business instrument, the costs of communication and transactions can be substantially minimized heading towards a higher knowledge-spill across individuals in an enterprise and the entire industry. Thus the e-Hub helps bridge the gap between existing e-solutions based on comprehensive workflow applications and more comprehensive, i.e. holonomic perspectives to collaborative engineering. When thinking of consequences for the concept at sight means that e-Engineering services need to offer the gamut of functionalities needed for remote and distributed collaborative engineering, i.e. from partner finding to contact and contract management as well as from knowledge sharing to QA and audit trailing (unlike projects like IST-DRAGON the focus is more on the hybrid services than on the software implementation). The approach to delivering this broad set of services must in all stages reflect the human entity in each of these service systems. Each system corresponds to a particular enterprise need in its own right, but is at the same time part of a bigger system.

Important lessons learned from other projects dealing with collaboration management were that (ANDRIESSEN 2002):

- E-engineering teamwork is 70% about people and organization and only 30% about technology.
- Broker services for e-Engineering need to offer the full spectrum of B2B services to be successful. Technology driven solutions too often lead only to islands of opportunity.
- Embedded mechanisms for partner management, marketing and business development are crucial to the relevance of any web hosted service.

The concept of the e-Hub responds to these lessons by creating a business entity that offers a complete set of embedded services to clients and providers and applies this in the selected area of collaborative engineering in support of product development in manufacturing as well as construction industries. Now what does this imply for the breakdown of these objectives into sub-goals?

Taking a short digression into the theory of networked enterprises and virtual organizations the e-Hub itself can be classified as a focal network with the e-Hub acting as the integrator of heretofore independent engineering service providers (ESPs). The network constituted by these ESPs is created, managed and enhanced by the e-Hub's functions and services. This induces a need for an integrated management concept describing the overall process of network administration facilitating the overall lifecycle management of the Hub community while maintaining its viability and at the same time the interaction of the community with its external client. Now the task being faced is twofold. On the one hand a conceptual framework for the community architecture and the collaborative process delivering the added value to a client is required. On the other hand, the e-Hub entity itself must be designed in terms of an architectural concept in order to assure its own viability – a viable system in a viable context. Thus, the development process of the e-Hub entity is as follows:

- Identifying a suitable framework to represent inter-organizational collaborations.
- Deducing the requirements emerging from the chosen framework in terms of functions, processes and services to be covered by the Hub entity.
- Modeling the Hub entity according to its constituent elements.
- Identifying, selecting and assigning methodologies, tools and instruments necessary for fulfilling the functions, processes and services to be covered by the management entity.

As an outcome of the research process outlined above the e-Hub intends to combine methodologies and tools in:

- Contact and contract management
- Mediation of project preparation processes
- Handshaking, community building and management
- Group communication and collaboration functions in shared e-engineering spaces
- Interfacing teams with unified product and process representations
- Interaction and interfacing with inward facing enterprise processes
- Process sharing and distributed project management

- Tools for product and process model configurations in project specific settings
- Learning strategies based on cross project knowledge management .

3. FUNCTIONS OF THE E-HUB WITHIN ITS BUSINESS ENVIRONMENT

The goal of the e-Hubs project to meet the requirements of two key industries - mechanical and civil engineering - calls for basic functions and services the e-Hub is obliged to encompass for value-adding delivery of services to its key markets. The core tasks of the e-Hub start with the necessity of bundling the right engineering services into the service portfolio. In addition to this active marketing of the defined service profiles for the identified key industries has to be conducted as well as the support of contract development and negotiation among suitable partners from the field of activities for a community management entity like the e-Hub should be provided. Above all this culminates in facilitating the overall project engineering comprising project planning and preparation as well as execution support. The functions and the processes entailed by four elementary groups of services are outlined in Figure 2 shown below.

The core functions of the e-Hub were derived from industry specific surveys on the needs of panel customer groups. Additionally, the literature dealing with the analysis of unsuccessful co-operations revealed the pathologies that caused their failure (HECK 2000). Based on this framework services that need to be offered by the e-Hub were derived by a context analysis. Nevertheless, a prerequisite to this proceeding was a basic vision of what the e-Hub entity is and what its constituent elements should be.

4. THE ARCHITECTURE OF FOCAL COLLABORATIONS – MODELING A VIABLE SYSTEM

With the textbook replete with requirements as shown above, the e-Hub concept was developed from scratch - with the concept being unprecedented especially in the field of mechanical engineering and manufacturing. A substantial guideline used for the systematic build-up and elaboration of the e-Hub environment can be found at FRIEDLI (2000). According to FRIEDLI any form of collaboration ought to be modeled following the architecture for collaborations as depicted below (see Figure 1). Taking a systems view of the collaboration as being embedded in a complex environment (here a market niche), where a collaboration solves a given task, the collaborating community fulfils a particular purpose within the environment. This purpose strongly depends on the current environmental conditions of a particular industry. Thus the purpose of the collaboration undergoes slight changes as long as the demands of the targeted market stay within a certain range of tolerance whilst the pool of competences necessary for covering the market needs will remain constant over time (see number 3 in Figure 1). In the particular case of shifting demands of the market niche the internal structure of the collaborative community

and the pool of competences are urged to restructure unless the occupied market is to be given up (see number 2 in Figure 1). While acting only within the micro-climate of the collaborative competence pool an additional potential for adaptation of any single enterprise exists within given constraints (see number 1 in Figure 2). Considering the given collaborative community as a complexity processing/handling system the dynamic aspect of its nature can not be overseen. Furthermore, FRIEDLI identifies eight constituent dimensions of collaboration design that need to be modeled when erecting a collaborative system. Taking these dimensions as management categories of collaborative systems, the process dimension is the starting point of implementing the collaboration. Due to the tactical focus of e-Hub activities in a project preparation phase the main management processes to be considered by detailed elaboration within the collaboration design phase can be assigned to the field of meta-processes (see Figure 1).

Figure 1- The architecture of collaborations by Friedli 2000

The transactional and structural processes on the other hand are operational in nature and are only of minor interest for the e-Hub prototype implementation achieved in the e-HUBS project to the current state.

Central meta-processes to be mentioned here are brokerage and partner selection processes, contract and mediation processes as well as aspects of project management. These identified interaction processes between the e-Hub community and the external client need to be embedded into a stable system where basic functions of the e-Hub business are brought together. This immediately leads to the second dimension of collaboration - the community. Within the e-Hub project the business plan for the Hub entity calls for a particular architecture allowing a plug-and-play solution for the community of engineering service providers. In accordance with the business focus of the e-Hub, aspects such as identity, purposefulness, cohesion and viability need to be considered when designing the management processes inside the e-Hub. As an answer to this the theory of Viable Systems developed by Stafford Beer (BEER 1979) in the early 70ies offers a comprehensive model for the representation of community models and distribution of necessary management functionalities inside the system (see Figure 2). The Viable System

approach is a framework for the design and analysis of business entities following the fundamental law of ASHBY, namely "The Law of Requisite Variety", which postulates that only complexity can absorb complexity (ASHBY 1956). This implies that any artificial, human made system that is designed to successfully fulfill a defined purpose in a chosen environment (which itself has a certain level of complexity and degree of unpredictability of behavior) has to provide a minimum of behavioral variety to cope with that environment. The variety provision can be achieved by systematic management of all involved elements (here the ESP). The normative, strategic and operational management functions are necessary for maintaining the coherence of the business unit. However, the model does not state how these functions are to be embodied, i.e. the establishment of a strategic board or committee is not further specified. As a conclusion there is an open space to how these functions are materialized in the novel concept of e-Hubs. Latest e-business solutions such as distant team building or virtual vote allow an incorporation of these managerial bodies by modern means. The community of engineering service providers can be classified as a focal network of collaborating partners gathering around a managing entity (e-Hub) sustaining the existence, development and service delivery of the community. The managerial core of the e-Hub is the representation of the partial systems marked as 2, 3, 4, and 5 in Figure 2.

This notion of focal engineering networks differs fundamentally from the frequently postulated paradigm of un-hierarchical networks with interfaces between all involved partners. The Viable System thus suits the vision of the e-Hub rather well, as it is not a hierarchical model but puts emphasis on the cohesion of the system as a whole together with a concurrently entailed limitation of individual autonomy of its constituent elements.

Figure 2 -The Viable System Model as a reference architecture for the engineering community

With regard to the concept above the question arises what exactly an internal structure of the e-Hub would look like. One major outcome of the e-Hubs research project was an elaborate reference architecture modelled in Unified Modelling Language comprising the core functional elements of the Hub entity. It fulfils what

was identified as requirements from the community management as well as the project support in the client – ESP-community interaction.

Figure 3 below shows the structure of the e-Hub’s architecture. On the first structural level it consists of three domains of modelling perspectives. Starting with the process view encountered in FRIEDLI the processes run inside and around the Hub entity. A set of partial models of engineering (management) activities collectively form the Process Model. The product representation forms the core element around which the distributed engineering process is designed. Thus the Product Model contains all partial models dealing with the representation, description and structuring of the engineered product. Finally, the Meta-Model codifies all interfacing aspects as a connecting link between the Process and Product Models. Here the representation of the collaboration as a system with its workflow information, rules and roles of interaction are brought together. The key objective of the first generation e-Hubs is to provide these “connection services” between externally designed and owned Product and Process Models.

Figure 3 - The e-Hub architecture - A domain driven approach

On the second level the underlying resources, functions and services are represented with their structural and informational backbone. The guiding principle here is the hybrid character of the e-Hub entity bringing together state of the art IT solutions with human beings in an independent business entity. On the third level the all comprising aspects such as cooperation lifecycle and performance assessment are covered. As mentioned before the different partial models of the architecture outlined above are modelled in UML, allowing also the build-up from scratch of basic business processes inside the e-Hub using the messaging functions.

5. CONCLUSION AND OUTLOOK – THE E-HUB AS A COLLABORATION LIFECYCLE INTEGRATOR

This paper has presented the motivation for and the structural implementation of e-Hubs, a novel approach to the challenges in collaborative engineering arena. A mediation e-solution called e-Hub was outlined before the background of the ongoing reorientation after the decline of a far-reaching e-hype a realistic approach to the facilitation of engineering community creation and project preparation for collaborative engineering ventures. The path of research was based on a generic reference architecture for collaborative systems and closed with an introduction of the global structure of the information model of the broker entity. The e-Hub service is aimed to start at the very early stage of product engineering. In terms of the degree of virtuality of products dealt with and services offered by the e-Hub this is considered the entry level of collaboration management. The first e-Hub prototype, currently under development will focus on services that manage, encode and enforce tactical decision making at the start of engineering partnerships. The emerging challenge for future research is to integrate these tactical services into a novel business entity that offers a broad set of services over the complete product development life cycle, eventually covering the transition from collaborative product engineering to distributed manufacturing networks.

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