

Technological Challenges to the Research and Development of Collaborative Working Environments

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INTRODUCTION

Through emerging technological developments, the human being is increasingly becoming liberated in his or her role as a knowledge worker, becoming able to interact seamlessly with colleagues, resources, and information facilitating improved work processes and new value generation opportunities.

In this context, the ability to interact over distance across organizational, geographical, and cultural boundaries, as well as on site, is becoming increasingly important to the overall competitiveness of any organization, as collaborative tools and technologies are rapidly being adopted by both the market and society as soon as they become available. It is evident that the market for more advanced solutions is enormous.

Current developments with regards to e-collaboration technology point toward the integration of previously insular solutions into seamless collaborative working environments (CWE), which represent one such solution to future knowledge society needs (European Commission, 2004). This aim of this article is to identify the current key technological challenges research and development in the field of CWEs is confronted with. The findings are based on a study of twelve collaborative work scenarios from heterogeneous domains, from both commercial and scientific perspectives.

BACKGROUND

Collaborative working environments are defined by Hribernik, Nilsson, Fusco, and Niitamo (2005, p. 10) as

“integrated and connected resources providing shared access to contents and allowing distributed actors to seamlessly work together towards common goals.” The definition is rooted in the understanding of collaboration as the act or result “of working together to produce a piece of work,” according to Sinclair, Fox, and Bullon (1995). It further builds on three key aspects of collaboration (Thoben, Hribernik, Kirisci, & Eschenbaecher, 2003) supported by ICT (information and communication technology). Here, collaboration is viewed first as communication between actors (enterprises, institutions, groups, individuals, machines, etc.). Secondly, it describes cooperation on a technical level, which enables machines and computers to exchange data. The third aspect is coordination, which is described by the exact coordination of communication, cooperation and coordination processes.

CWE represent the next step in the development of collaborative technologies, moving from disparate, insular tools, applications, systems, and services to seamlessly integrated ICT environments for collaborative work from a multidomain perspective. Such CWE should provide full support for optimal interaction within the dimensions of e-collaboration as described in (Thoben et al., 2003): stages (initiation, management, operation, and dissolution), forms (ad-hoc, mediated, planned, and hybrid forms) and assets of collaboration (people, ICT-systems, knowledge, and processes).

In order to achieve an understanding of the type of challenges CWE research and technology development (RTD) needs to address, it is critical to understand requirements as set by real-world and potential future collaborative work scenarios. To gather requirements across a broad spectrum of domains relevant to CWE,

a study of twelve scenarios was carried out (Hribernik et al., 2005). The following scenarios were analyzed in the course of the study:

1. **Construction industry:** Large construction projects
2. **Maintenance:** Heavy duty field equipment and aerospace
3. **E-health:** Home care service chain
4. **Engineering:** Virtual enterprise collaboration hub
5. **Engineering:** Professional collaboration in virtual teams and organizations
6. **Humanitarian aid:** Environmental collaboration scenario for humanitarian aid
7. **Rural services:** Collaboration in agriculture and forestry
8. **Urban services:** Collaborative pollution control
9. **Emergency management:** Fire fighting
10. **E-inclusion:** Integrating the disabled into professional life
11. **Collaborative design:** Collaborative work within SME clusters
12. **Knowledge work:** E-professionals in the business and public sectors

From the individual requirements of each of the scenarios, a number of high-level requirements toward CWE can be distilled. These requirements are drawn on to identify major challenges to research and development of CWE, and are described in the following sections.

STUDY APPROACH

The twelve collaborative work scenarios listed above were analyzed in the course of the study. The selection of the scenarios was carried out by an expert group consisting of representatives from major industry players, research funding organizations, innovation agencies, and academic institutions. The scenarios were selected to be representative of sectors in which on the one hand e-collaboration is traditionally successfully employed, and on the other promises to enable new business models and forms of work. The selection encompassed well-documented e-collaboration scenarios in which CWE and related e-collaboration technology

had been implemented in the course of both research and commercial projects. A matrix for the analysis of CWE requirements was developed on the basis of the types (planned, mediated, and ad hoc), stages (initiation, management, operation, and dissolution) and assets (people, process, ICT systems, and knowledge) of each individual process step of the analyzed scenarios. For each of the dimensions, the analysis process was structured according to attributes defined in the CWE taxonomy documented in (Hribernik, Nilsson, Fusco, & Niitamo, 2006). Focus was laid on capturing requirements which identify collaboration functionality lacking or unsatisfactory in the current implementations of the individual e-collaboration scenarios. The requirements analysis matrix was subsequently out filled by actors involved in each of the scenarios described. This was carried out by means of structured questionnaires. Finally, the requirements analysis matrixes were quantified, analyzed, and a set of RTD challenges identified on the basis thereof. The resulting challenges were subsequently verified by means of a systematic benchmarking of 21 national research programmes relevant to CWE.

SCENARIOS STUDIED

The scenario dealing with e-collaboration in the construction industry represents the findings of a number of key German construction industry and academic organizations (Hribernik, Kirisci, & Hünecke, 2004). The scenario highlights the major collaborative processes throughout the life-cycle of a construction project: application for planning, application for building, planning and project management, construction execution, tendering subcontractors, site survey, and finally construction acceptance. The scenario exemplifies the need for hybrid forms of collaboration as well as requirements posed by a wide range of public, civic, and industrial stakeholders.

Customer relationship management (CRM) scenarios can be seen as a “traditional” application area for e-collaboration technology. This field has proven to benefit significantly from the introduction of CWE and mobile technology. The scenario analyzed here describes the introduction of mobile collaborative technology to the assistance/after sales and maintenance processes of a major mechanical engineering company in the field of drilling machinery and structures, down-

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