Multi Service System for Collaborative Learning in Enterprise Networks

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Abstract: - The paper addresses a new system for collaborative vocational training of employees within industrial networks. The system should enable the industrial companies' employees, especially in SMEs, to collaborate time and cost-effectively on different training issues. The system includes a collaborative platform built following the Collaborative Reference Architecture for advanced service platforms for Collaborative Working Environments (CWE). The key layers of the platform are: Core Collaborative Services layer, orchestration layer and Content/Context Specific Collaborative Service layer. The Core Collaborative Services include services for e.g. (human) resource discovery (discovery of trainers and/or partners for collaborative learning etc.), knowledge provision (provision of eLearning resources), selection of optimal communication services within virtual classroom (e.g. chat rooms, video meetings), learning group composition, collaboration traceability etc. These services are complemented with classical eLearning functionalities such as user registration, management of courses and contents etc. The higher Content/Context Specific Service layer combines different Core Collaborative Services and content specific solutions (e.g. specific learning objects, specific knowledge etc.). The system is currently applied for the vocational training program on methods for introduction of Information and Communication Technology (ICT) in networked SMEs in the recycling domain.

Key-Words: - Multi Service Systems, Virtual Classroom, Collaborative Working Environments, Core Collaborative Services, Networked Companies, Collaborative Learning

1 Introduction/Motivation

Industrial enterprises, especially SMEs, in different sectors are facing an urgent need to continuously train their staff on various topics [1].

There is a particular need to provide effective means for collaborative training of staff members, either within a company (with often geographically distributed subsidiaries and departments), or in business networks to which companies increasingly belong nowadays. On one hand there are topics (e.g. advanced networking methods, application of ICTs for networked businesses etc.) which by their nature require collaborative training. On the other hand collaborative training often has obvious advantages regarding pedagogical and cost effectiveness aspects [2], [3]. What is needed is a system for effective and continuous collaborative training on the job. Since specifically SMEs need to be trained on e.g. introduction of ICT solutions for collaborative work within different networks or supply chains, the application of a system for collaborative training is likely to be an optimal approach. The experience with the classical classroom training and/or classical eLearning systems within industrial companies clearly indicates that such approaches alone are not fulfilling the needs. They need to be complemented with advanced and cost effective web based interactive eLearning solutions for collaborative training. While many Learning (Content) Management Systems (LCMS) effectively support collaborative content generation, the systems for collaborative training in industry are still missing. The existing solutions mainly do not meet specific needs regarding different collaboration patterns demanded in industry due to e.g. often 'lack of time' for training (e.g. combination of asynchronous, synchronous, multi-synchronous training), different expertise levels and backgrounds of people to be trained on same topics, integration with working environments, effective sharing of training resources within industrial networks etc.

This paper addresses the solution which aims at satisfying industrial networks' needs on collaborative training in general, with the focus on SME networks. The proposed innovative collaborative training system includes:

- Collaborative platform
- Collaborative training resources - open set of resources
- Methodology for (collaborative) training
- Training services for industrial networks.

The system is primarily dedicated to support collaborative training on the job. The paper focuses on the collaborative platform, which represents application of the emerging Collaborative Working Environments (CWE) principles for collaborative training. The methodological aspects and training services aspects are briefly addressed.

The proposed solution brings several innovations through the new approaches in vocational training for industrial enterprises. The elaborated training system allows application of different training methods

including e.g. innovative blended learning approach (i.e. the courses may be prepared to be used in two different and complementary ways: in a sophisticated combination of classical ex-cathedra teaching, and novel collaborative eLearning approaches such as web based collaborative courseware/web based training). The main objective is to allow the trainees to properly understand the complex training subject and to effectively collaborate in achieving new skills.

The proposed methodology, as one of the key elements of the new training system, includes the advanced pedagogic approaches aiming, on one side, at the self-directed learning and interactive participation and problem solving by the trainees and, on the other side, at deployment of the collaborative learning principles and knowledge sharing among staff members of different companies (especially e.g. training on topics such as SME networks set-up and management, requiring common approach of SMEs). Such approaches are still not state-of-the-art in vocational training in industrial companies, especially not in SMEs. Therefore, a set of innovative pedagogic solutions (concerning a selection of topics to be trained individually or appropriate for collaborative learning, methods for learning by collaborative problem solving, role of mentors, ways of interaction between trainee and technical training system and mentor, adjustment of lessons to the trainees background knowledge, collaboration patterns and modes, ways to amplify synergy effects of collaborative training etc.) are elaborated to meet specific requirements regarding collaborative training of staff members in companies [4].

The proposed system is oriented to the training of employees in industry, addressing also the needs of training and consultancy organizations which are getting an innovative, easily adaptable and widely applicable for different topics, learner-centered training system. The new platform can be effectively used by training organizations (or departments responsible for trainings in enterprises) to provide different training services to the (networked) industrial companies. The platform enables such training organizations to provide e.g. optimal group composition for training, continuous mentoring support when needed, prompt updates of the offered training courses (by updating content) etc.

The system supports collaborative learning and knowledge sharing (training aided by knowledge sharing), enabling companies to collaborate with each other according to their preferences (e.g. collaborative learning among SMEs which intend to establish a business network). The system allows for an effective sharing of training resources (eLearning objects, knowledge, human resources etc.) within networked industrial enterprises. It will be an attractive solution for training on a number of topics interesting for this specific user category (e.g. new ICT solutions, legal and financial issues etc.).

The paper starts with Introduction, which describes the motivation for the work presented and brief overview of the proposed training system, followed by Section 2 dedicated to the general description of the new collaborative platform. In Section 3 the platform is elaborated in more detail: architecture, core collaborative services and implementation issues are addressed. Section 4 provides an example of the application of the proposed platform in an SME network, while Section 5 includes conclusions stressing the key innovations of the proposed platform and plans for future work.

2 Proposed collaborative platform

The key objective of the work presented in this paper was to develop a generic and widely applicable, modular platform to support collaborative training in industrial networks. The concept of the targeted solution for industry is presented in Fig. 1. The platform is intended to provide various Content/Context Specific Collaborative Services to support training in industry on specific content and under specific context, especially those enabling different teams to be involved in training processes. The targeted platform will be open for various services to support training on the job and involvement of different actors (different staff levels from shop floor workers up to technical staff and management, but also training service providers and individual trainers).

Under Content/Context Specific Collaborative Services (CCSCS) are, therefore, understood the high level services which provide support for collaborative training of different actors/teams within networked organizations (or within a single enterprise) and which are focused on specific training content (e.g. introduction of ICT in networked business processes, new networking methods etc.). These services are provided in specific context (i.e. specific companies and specific teams etc.) allowing for an effective involvement of actors/teams in collaborative training processes. These training services use the knowledge resources available in the networked organizations and training providers organizations, including eLearning objects, documents and information/knowledge on products/processes/ production units, needed for collaborative training within a specific application area.

The platform is a means for efficient provision of different services for collaborative training, as explained above. The platform is intended to be used in different types of (networked) industrial organizations, including networked SMEs but also large companies with geographically dislocated subsidiaries etc.
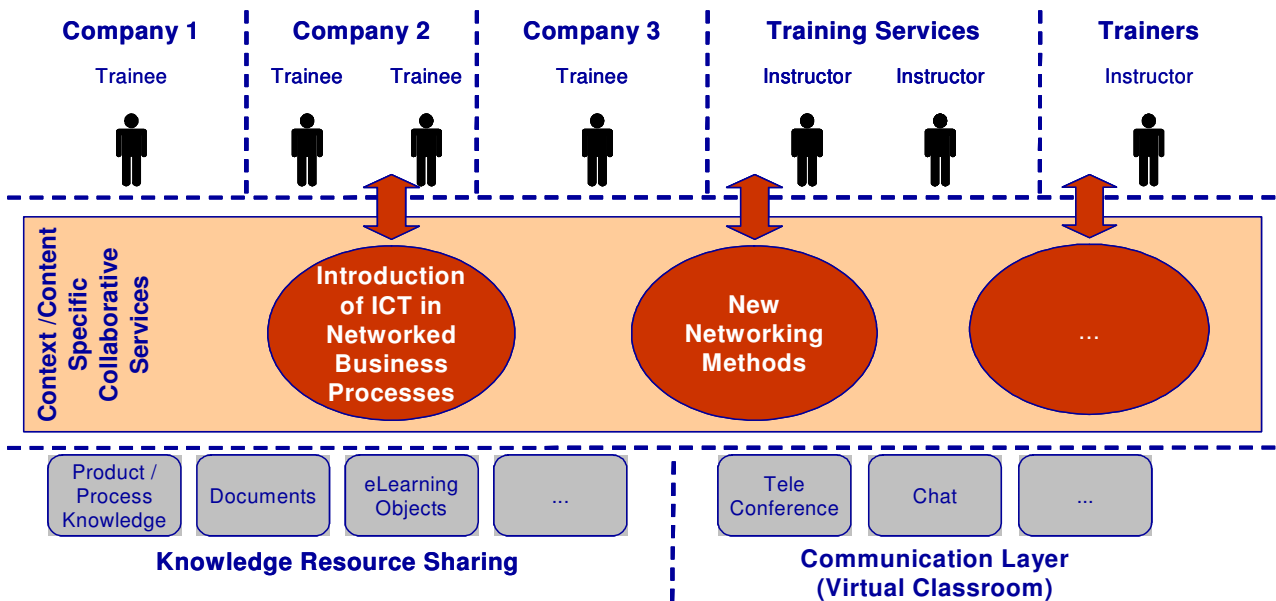
Fig. 1: Platform for collaborative training

3 Architecture

The architecture for the collaboration platform includes upper middleware which has to be smoothly connected to (various) information middleware, providing eLearning objects and information/knowledge on products/processes [5].

The proposed architecture fits with the (currently) proposed Reference Architecture for CWE as presented in [6][1]. The platform is fully in line with the findings of the Expert Group on CWE [7].

The proposed architecture (see Fig. 2) represents further elaboration of the initial architecture concept presented in Fig. 1. It includes the following layers:
- Core collaborative services (CCS)
- Orchestration layer
- CCSCS layer which includes set of services to directly support groups in the training activities in specific context and on specific content as explained above.

The CCS layer includes a set of CCS as explained in the text to follow in 3.1.

The orchestration layer provides the capabilities to build high level collaborative services - CCSCS. The architecture includes the orchestration instead of choreography, since orchestration describes a process flow between services controlled by a single party (see [8]) which fits better to the cultures/approaches accepted by industry. This layer allows to combine CCS and other applications (e.g. eLearning objects etc.) in order to meet specific needs regarding training content, but also regarding the training context, e.g. temporal aspect,

workflow, business process addressed etc. This layer provides the end-user functionalities, CCSCS as a synergic combination of CCS and other applications (allowing for different collaboration patterns). The 'uniforming' sub-layer assures harmonization and management of CCS, assuring their interoperability.

Two possible ways to implement the orchestration layer are considered:
- automatic (on line) orchestration of CCS to provide/update CCSCS
- off-line approach in which the combining of CCS requires some additional activities by system operators/training providers/users.

In this paper it is proposed to follow the second approach. The orchestration of CCS includes configuring and setting-up of these services for specific contents and context (e.g. pre-definition of optimal group size for specific content, pre-definition of possible collaboration patterns for specific enterprise networks etc.). Therefore, in this approach, an CCSCS is a selected and configured set of CCS and other applications assembled around the specific training content, under the specific context within a kind of 'micro CWE'.

3.1. Core Collaborative Services

This key layer includes CCS - a generic set of services supporting collaborative training among employees in networked industrial enterprises. These services cover functionality generic for different training contents (topics) and for different training contexts (different networks, teams, actors etc.), needed by higher level CCSCS. Based on the analysis of industrial needs, the proposed CCS include: resource discovery (e.g. discovery of the trainers for training, discovery of partners within a network suitable, interested and available for training, available for either asynchronous

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[1] The main objective of the Open Collaborative Working Group is to support a definition of Reference Architecture(s) to enable Cross-platform Interoperable CWE Services.

or synchronous collaboration, discovery of experts to support the trainees in solving specific problems etc.), learning group composition (adjustable to different collaboration patterns), training resources provision (taking into account different expertise of the collaborating teams), collaboration traceability (easily adjustable to different specific needs/constraints in a network) etc. These CCS will be combined with different communication services within a virtual

classroom (e.g. chats, video conferencing etc.) as well as with classical services provided by LCMS such as registration, scheduling etc. In many cases these classical services have to be extended to support collaborative aspects. For example, scheduling of collaborative training may need functionalities which are not provided by state-of-the-art LCMS.

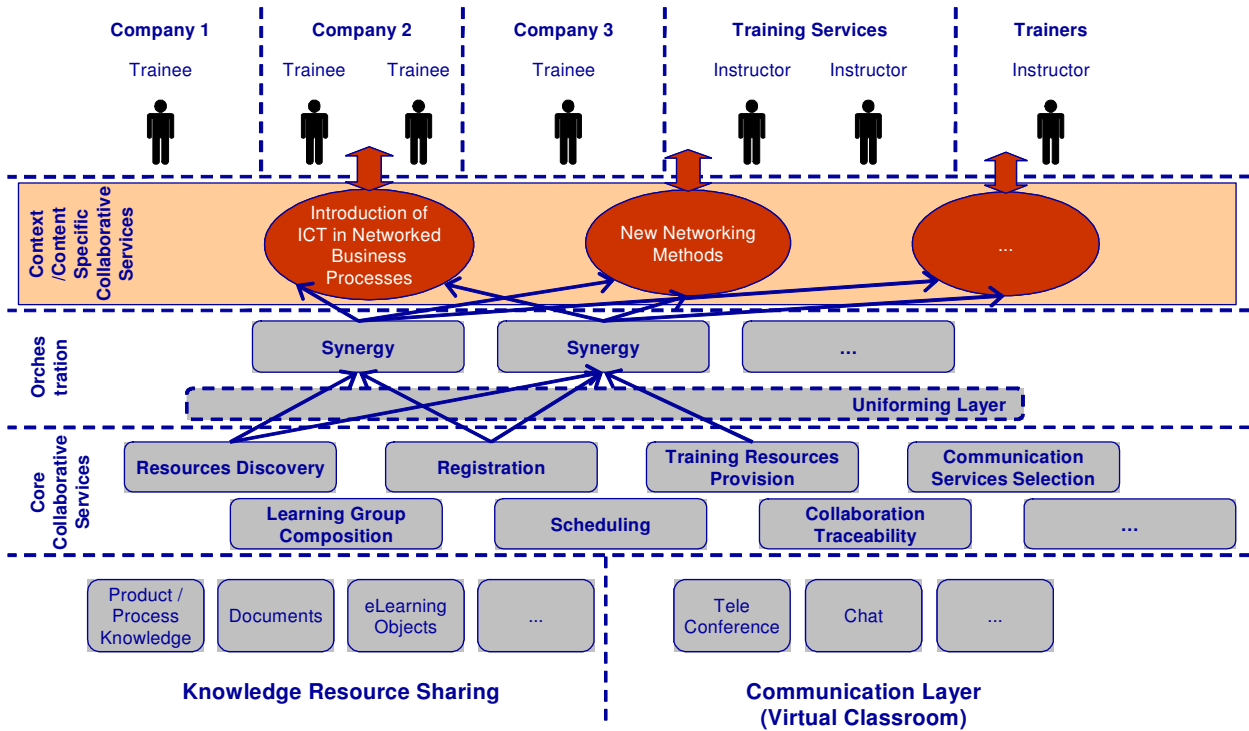Table 1 provides an overview of the key new CCS.

Fig. 2: CWE architecture

Table 1: Core services for collaborative training

CCS	Input/request	Output	Main functionality	Specific requirements
(Human) Resource Discovery	Request for specific expertise, trainers, partners	Appropriate and available expert(s), trainers, partners for training	Searching for expertise to support training (problem solving), trainers and partners Checking availability	Mobile users Already defined groups Different discovery approaches (see the text to follow)
Collaboration Traceability	Request for tracing of the group training	Info on the requested states of groups and collaboration, Info to react on certain events	Tracing of training collaboration: - continuous - event driven (event identification) Tracing of: - Team results - Content/course acceptance - Interaction (type, frequency etc) - Learning styles	Specific requirements regarding security, company specific rules
Training Resources Provision	Request for a specific knowledge for the trainee/group, request for learning objects	Knowledge provided to the actor/group following the optimal learning style for the group	Discovery of learning resources within the network. Selection of the most appropriate from a set of the available eLearning and KM functionalities to provide the requested knowledge (eLearning objects) in a specific context	eLearning objects, Documents, Stored user knowledge, Distributed databases with data from processes or products in the network, Dynamic delivery, Supporting different learning styles
Learning Group Composition	Request for optimal learning group	Optimal group (structure, members etc.)	Proposes group based on iden-tified available expertise, trainers and partners	Enterprise rules etc.
Communication Services Selection	Communication needs	Selected commu-nication	Select most appropriate for the specific collaboration training patterns etc. Provide basic communication functionality.	Virtual Classroom including voice, text, images, videos, Virtual reality, e-mails, chats

The key issue is that these CCS support different patterns for collaborative training among the teams: asynchronous, synchronous, multi-synchronous etc. [9]. For example, CCS for learning group composition and resource discovery allows for an easy switching from one pattern to another (e.g. from synchronous work to asynchronous work), which is specifically important for e.g. trainees from shop-floor teams. Since the platform (CCS) supports an effective combination of different collaboration patterns it is expected that the involvement of all teams in collaborative training will become more efficient.

The work on CCS is based on state-of-the-art research regarding collaboration patterns and collaborative work in general. For example, the development of the CCS for traceability of collaborative training takes into account current results of the research on traceability of collaborative work and knowledge modeling [10]. The current research on ontology issues is also of a high relevance for development of both CCS and orchestration layer [11], especially for e.g. training resource provision service, i.e. searching for training resources, eLearning objects or information/knowledge, within distributed data basses in an industrial network. Special attention is given to security and Intellectual Property Rights (IPR) issues, being one of the most critical aspects of collaborative work in industry [12].

There are obvious interrelations among the proposed CCS. For example, service for collaboration traceability may provide information on the learning style [13] preferred by the group, which will be used by the service for training resources provision to provide eLearning objects which mostly suit to the group etc.

The CCS can be combined to support various organizations of training and training methods. For example, different approaches for human resources and training resources discovery may be applied (at first discovery of human resources for a desired training topic and then appropriate eLearning objects, or, at first discovery of training resources and then corresponding partners etc.). As mentioned above, the platform may support blended learning approach by e.g. discovering resources, both human (partners and trainers) and training resources (eLearning objects, documents) for both classroom training and collaborative eLearning. The platform also supports collaborative problem solving training approaches, where trainee(s) are trained by solving specific problems, by searching for appropriate knowledge in distributed data bases or supported by appropriate expert(s) in the network (see above CCS), etc.

3.2. Implementation
The presented architecture is implemented as a service oriented architecture (SOA), allowing for full flexibility

and effective instantiation for different training processes.

The platform is designed to be easily integrated with different LCMS and is built as an internet-browser based (GUI) application, whereby a Wiki based module (from here on referred as Wiki) provides the basic collaborative functionalities, and more sophisticated functions are based on Enterprise Java Beans (EJB). The EJBs are deployed in an EJB container within a centralized application server (e.g. JBoss or Geronimo). The functionalities of CCS are divided into two segments, Wiki and application. The Wiki can be installed and tailored multiple times for different collaboration groups in different directories using the same database. In order to enable a common data interchange between Wiki and EJB application server, the same collaborative (distributed) database is used.

For describing business (training) logic processes and for the orchestration of CCS several business process management languages were studied such as: Business Process Modeling Notation (BPMN), a standardized graphical notation for drawing business processes in a workflow, Unified Modeling Language (UML), a general purpose modeling language that includes a standardized graphical notation that may be used to create an abstract model of a system, and Business Process Execution Language (BPEL), an XML based language[2] for describing long-running, asynchronous business processes. Due to its active development and that it deals with the functional aspects of Business Processes, BPEL as a Business Process Modeling Language is chosen to be used.

4   Application Example
The proposed system is applied for training of SME staff on introduction of new organization principles and appropriate ICT solutions in networked business in the recycling area [4]. The advanced ICT offer excellent opportunities to support establishment and efficient operation of new ways of organization among SMEs in different sectors and new work situations. However, the level of application of advanced ICT solutions, and consequently smart collaboration ways, in SMEs in many sectors (and especially in the recycling area) is relatively low in both new and old EU countries, causing quickly growing needs for ICT skills in SMEs. In addition, majority of management and technical staff in SMEs are often not well prepared to introduce advanced ICT solutions, which may cause even reluctance against modern ICT and the introduction of ICT systems for the business practice improvement requires an appropriate

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2 The Web Services Business Process Execution Language (WS-BPEL or BPEL for short) is seen as a key component of SOA. The work on version 2.0 of the language has been carried out by the OASIS WS-BPEL Technical Committee and is expected to be completed in 2006 or in early 2007 [14].

training of the leading staff. As advanced ICT solutions are rapidly entering the market, it is of crucial importance to continuously train the SME staff to select, introduce and use such solutions relevant for new work situations [15]. Management and technical staff of SMEs need to be trained also on how to drive the process improvement and introduction of advanced ICT on their own [16].

The solution developed is a collaborative learning system, based on the functionalities of the open-source software Moodle, which was used for the content creation and for provision of the content and course management functions. Part of the above described CCSCS layer functions is also provided through Moodle (Registration, Content Provision), while the CCS for resources discovery, learning group composition, collaboration traceability are developed within the new solution. Selection of Communication Services and Scheduling are the CCS realized as complementary services from Moodle and the new system.

The new system offers also a set of so-called training services, which include support (for training organizations) in training course (content) creation, organization and execution, continuous update of training courses (e.g. advanced organizational principles, state-of-the-art ICT, legislative aspects update etc.) upon the end-user request, and online mentoring - interactive support to trainees.

Support to system users in creation of the content and in organization and execution of the training courses is based on the developed methodology [4], expected to be for a number of applications overtaken by some of the user groups i.e. it is very likely that the consultancy organizations will be able to offer support to SMEs in all a.m. tasks.

Continuous update of training courses is, in contrast to the users support, mainly the service offered by the system developers but can also be requested by system users. Depending on the scope and size of updates this service will be offered as web based update of the system parts or update from CDs or other media.

The Online Mentoring is organized as a kind of Collaboration Environment for trainers and trainees [3] and includes a number of interaction forms, remaining open to adopt new mechanisms, according to the users' requirements and/or advances in ICT.

Initial testing results have demonstrated that the SME staff has a very positive attitude toward the collaborative learning approach, what is rather promising regarding the training results in the future.

5 Conclusion

The paper presents the RTD approach in development of a new platform to support vocational training in networked industrial originations which includes collaboration of different actors/teams in industry.

The key innovative aspects of the proposed solution are:

- a combination of innovative collaborative services with 'classical' eLearning tools and LCMS - upgrading of classical tools to more cooperative ones
- new collaborative platform fitting with the Collaboration Reference Architecture, being one of the first implementation of this architecture in eLearning domain in industry
- a set of new CCS for an efficient development of CCSCS to create collaborative environments for training in industry
- solutions which allow for different collaboration patterns and different technical background of the collaborating people and by this allow for much more effective involvement of different actors (e.g. trainees from shop-floor teams) in training processes.

The platform is currently under development. The first testing with a certain limited numbers of CCS indicates that a very effective support of collaborative training of employees can be provided by the targeted solution.

The future work will focus on further elaboration of CCS and upon tools to support development of CCSCS, i.e. tools for effective customization of CCS and their combination with different eLearning tools and objects, as well as combination with different knowledge management tools. Many RTD problems still have to be solved such as: collaboration among organised and ad-hoc teams, representation and handling of uncertainties within collaborative training, further elaboration of approach for addressing security and IPR issues specific for industry (e.g. different accesses to training resources and knowledge within networked enterprises are critical for acceptance of new collaborative environments in industry). One of the problems which ask for further research is provision of training resources according to a learning style which is the most appropriate for a learning group.

6 Acknowledgement

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