From CSCW over CWE to CE: The Evolution of Needs and Tools MATES Revisited

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Abstract: Meetings, owning a central role in engineering projects, are the major way of performing the information exchange necessary for other engineers to make progress in their mutually depending tasks. They also play a central role in getting consensus and in achieving quality. However, when project members are not co-located this works less well. Travelling, standard remedy for this, is not an acceptable solution in the long run. Besides direct travel expenses, even greater cost are caused by wasting human time and energy due to commuting-like work situations. A solution must be "well integrated" and easily accessible in daily working situations. Current alternatives, like TV conferences in separate studios, still require co-location, scheduling, and disconnect people from usual working contexts. It must instead be light-weight and conveniently available, providing a media for the fine network of human interaction, the driving force in complex problem solving. Improving the efficiency of collaboration processes is the most promising way of increasing productivity in knowledge intensive projects. Primarily, easy-to-use means for interaction between people and between people and information, independent of place and time, are to be provided. The area of distributed information multimedia, groupware and CSCW is addressing this need.

Quote from "The Euro-presence White Paper", D. Schefström, CDT/Luleå, Sweden (1995)

1 Introduction

Collaboration involves people (employees, consumers, partners, suppliers, customers, experts) working together (interacting, communicating, exchanging, discussing, coordinating, approving) by sharing information (documents, and other electronic content, action items, schedules, workflow) and processes (sales, marketing, customer support, engineering, research and development, product development, accounting).

In the mid '90s the term "Computer Supported Collaborative Work, CSCW" was a quite popular one for use in discussions of the above issues which are today related to the term "Collaborative Work(ing) Environments, CWE".

References like [1] state “CSCW is a generic term, which combines the understanding of the way people work in groups with the enabling technologies of computer networking, and associated hardware, software, services and techniques”, whereas “Collaborative Working En-vironments are defined as integrated and connected resources providing shared access to contents and allowing distributed actors to seamlessly work together towards common goals” [2].

Basically, after a closer look these two definitions do not really differ from each other[1]! Hence, the authors, having themselves a background in the context under discussion, which originates from the second half of the ‘90s are questioning themselves, what have been the actual changes and evolution of needs and tools in this area since then.

Obviously, the needs today are as urgent as in the 90s. However, as illustrated by the series of workshops organised by the Global Engineering Networking (GEN) initiative (see, e.g., [7]) the automotive industry started already quite early to address CWE issues for improving development, engineering and manufacturing processes, whereas, for example, the aerospace industry seems only nowadays starting to put higher attention to them. Incidents like the delay in the delivery of the *AIRBUS A380*© for more than one year convey that, among others, deficits exist in appropriately organising collaborative working across the various geographically distributed AIRBUS sites and that potential for improvements is quite high here [8].

By revisiting the state of the art and practice during the time of the MATES project [2]-[6][2], this paper attempts to discuss and illustrate the evolution of CWE needs and tools since then together with a look into the future.

The paper is therefore structured as follows.

In the next section, a more detailed review of the CWE status in the mid ‘90s is given, centred around by the experiences gained by the authors themselves by way of their active participation in the MATES project (and other related projects, like the GEN cluster of projects). The sketch on “where we are today” is followed by a view on current trends and then by a discussion of barriers, prohibiting the successful introduction and deployment of CWE IT support and tooling (not only) in industry yesterday and today (but hopefully to a significantly lesser extent in the future).

[1] For this reason, from now on the term CWE is used in this paper.
[2] MATES was an IiM ESPRIT IV project funded by the European Commission under contract EP 20.598and run from 1996 to 1998.

2 Looking back to the Mid '90s

Apart from the quote in the abstract above from a source, which can be considered somehow the pilot vision underlying the MATES project, diagrams like the one as outlined by Figure 1 convey the basic understanding of what was considered in the mid '90s as significant progress, satisfying a major requirement in CWE, if available, i.e., as state-of-the-art component of a collection of advanced collaboration support facilities (here) on the user interface side [5]: The most important part is the document editor, here presented in the upper left part of the screen. It is reproduced at each participants workstation. The document editor is under the control of the speaker, who might be seen in the video window or heard through the audio tool.

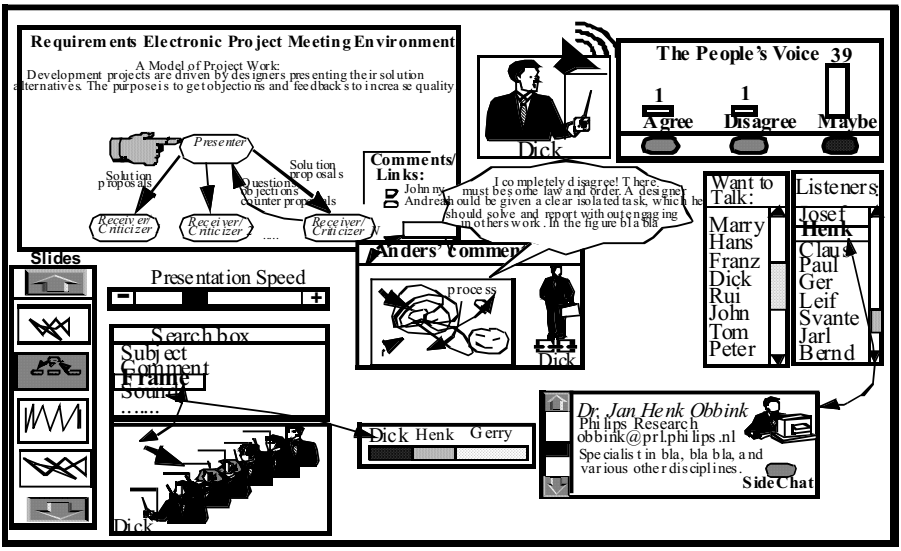

Figure 1:"Better-than-being-there" End Users View (from [5])

Participants may provide comments, which may be short spontaneous voice remarks or longer prepared sub-presentations utilizing any combination of media. In all cases, the comments may be attached to the relevant part in the presentation by means of the annotation tool, as illustrated in the lower right corner of the document editor window.

There are also tools for supporting browsing in each of the media. The figure shows examples of a document browser, where the user can jump between slides or pages and search with respect to different keys. There should also be a video browser, providing overview and fast access to desired segments. In the example figure this is made by showing video frame samples picked with a suitable interval. Similar ideas can be applied to provide an audio browser, which will identify segments with different speakers and identify their names. It may also be valuable to have a speed control tool, to slow down fast speakers, speed up slow ones, or quickly browse through less interesting parts. Usually, this is most easily done for stored, non real-time, material. The system maintains the temporal relationships between media, so that jumping to a place in one media will synchronize the others. Other components include the voting tool (upper right corner), which provides a way of asking questions to the participants and having the result immediately shown, and the want-to-talk tool, which maintains a list of people who want to make comments. The listener tool shows which people are attending, but also provides a convenient entry into the people information tool, which provides background information on people and how to take direct contact with them (lower right corner). Pushing the "side chat" button would establish a direct connection to the chosen person without distracting the overall audience.

Driving CWE force in the mid '90s has been the growing need to provide better support for distributed engineering processes to be performed by non-co-located teams (in car manufacturing, product development, software engineering, etc).

At that stage, corresponding industry was confronted with an increase of the complexity of its products and also by a need to reduce time-to-market. This often lead (and leads still today) to situations where not all the expertise or resources were found in one location or inside one company. New models for product creation processes, such as co-design, interaction with product marketing and co-maker-ship, have been introduced to companies. Also the restructuring of companies into smaller, more independently operating units increased the need for collaboration across sites and sometimes across companies. The manner of how distributed working was exploited within an organization required specific attention to the aspects of globalisation of the development process, of project management, of data management and of the engineering tasks themselves.

The generic problem was described as to support the process of getting consensus about topics to resolve and enable sharing of knowledge between persons separated in time or space (in consistence with this paper's abstract above).

2.1 Categories of Collaboration Services

Services which should support collaborative working were called (and are still called today) collaboration services. The technologies related to these services were (and are still) evolving quite fast. To be able to cope with this evolution a reference model has been defined within the MATES project (see Figure 3 below), which enabled required services to be specified and discussed independent of their final implemen-tation. It also provided a tool to assess the current situation, to propose improvements, to formulate an implementation plan with priorities, and to assess products to make the required services available.

From a functional point of view the Collaboration Services have been categorized in:

- **Communication Services:** These cover the exchange of data (in all kind of formats) between defined sets of persons, i.e., that data is sent either synchronously or asynchronously to defined sets of recipients. The exchange can also be categorized as having a low structural complexity and can vary from a more passive nature to an active one.
- **Cooperation Services:** The cooperation services enable users to make their (intermediate) results available to others and to participate in discussion forums. It is often required to control the group of persons having access to the data involved. Traditionally, this kind of services was often called groupware.
- **Coordination Services**: The way a (product creation) project has been organized, the working procedures and the allocation of responsibilities, highly influence the way people will collaborate. The coordination services allow people belonging to a team to work on the same set of files in an organized and controlled way, i.e. the services support the access to the work in progress.

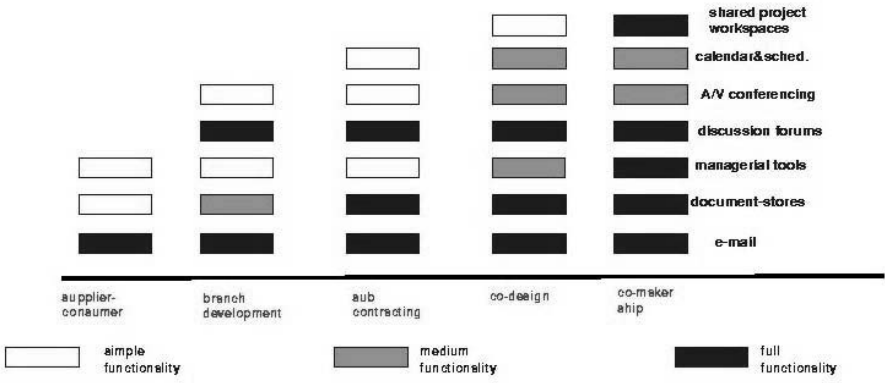

Figure 2: Collaboration Services and Process Models

In matching the related activities to corresponding services the MATES reference model has been developed (see upper part of the table in Figure 3).

The organizational processes highly influence[3] the collaboration between parts of an organization. From the discussions in [4] one can derive some indication for the intensity of collaboration and its importance in the context of distributed engineering related to the business relationships, such as, supplier-customer, sub-contracting, branch development, co-design, co-maker-ship/around-the-clock engineering, etc., in place. For sketching this in more detail some examples are taken from [4]:

- in a **Supplier-Customer model** one sees one to many relations between participants with a heavy information (brochures, catalogue information, mailing, background information, etc) flow from the supplier to the customer and a limited flow in the opposite direction (orders, product feed-back);
- in a **Sub-contracting model**, the relation is more balanced and the activities to be supported are getting consensus to a well-defined set of documents, and the exchange of requirements and specifications one-way and results the other way; partners work more or less independently from each other;
- in a **Co-design model**, the goal is to achieve consensus (at engineering level) during the whole project;
- in a **Co-maker-ship model**, a number of teams work together on single product by sharing the work in progress.

One should be aware that multiple collaboration models within an organization can co-exist, depending on the need of certain business processes or the maturity of these processes.

2.2 Collaboration Intensity

The intensity of collaboration varies as well, in time of a project and the type of collaboration model in place. This leads to a differentiation in loosely and tightly coupled teams. The more intense the interaction is the larger the need for specific tools. This intensity can be visualized on a scale from low to high as outlined by Figure 2.

In case of sparse interaction, the use of general tools like phone, tele-conferencing and e-mail will be sufficient. When interaction increases the need for document archives or discussion forums comes up and in projects with real intensive interaction shared workspaces, distributed configuration management, problem reporting, change management and even mail and instant messaging functions integrated in the project support environment will be helpful.

[3] Since the CWE issues and requirements reflected in the sequel are largely valid also today, it is changed from now on from past to present tense.

2.3 Spanning Space

Persons separated in space (located at geographic-ally separated locations) need specific services to support their collaboration. After all, face-to-face interaction is not only very costly in travelling cost but also in travelling time. The space dimension re-presents the distribution aspect of the collaboration services. The important problem is to give instantaneously access to the information involved.

A reliable and fast e-mail system, a discussion tool, video conferencing, electronic meeting support, instant messaging, shared document libraries and shared project spaces would support to this. Integration of (multi-media) instant message system and shared work project space with presence features would bring real time interaction within the proper (task oriented) context. Some of the solutions require synchronous interaction that can be limited due to time constraints.

2.4 Spanning Time

Separation in time (different time-zones or calendars) needs specific services to support interaction between persons. Different time zones and busy calendars complicate the scheduling of the interaction to narrow overlapping working times, if at all.

Asynchronous services offer solutions to cope with the difference in time. Part of the interaction does not require instantaneous reaction. The conflict of busy calendars can be handled to allow people to react on requests at a time that suits them best instead of being interrupted by phone or by people walking into their office. A reliable e-mail system or a discussion tool would give support to this. Integration of (multi-media) instant message systems and shared work project spaces with presence features would show whether real time interaction is possible.

2.5 Culture

People from different cultures react in different ways and this might have different causes, e.g. generic culture, education, religion, or coming from different companies after a merger.

These differences are difficult to tackle in a general way. The first step is to create awareness, learn to know each other and use supporting tools (audio and video conferencing) that allow recognising emotion such as voice and expression.

2.6 Team or Community

In projects where intensive collaboration is needed it is important that a team spirit or sense of community exist. Therefore, people need to know each other in person (hence, physical meetings as such can and should not be fully replaced by CWE means) and common goals should be established. Roles and responsibilities should be clearly defined.

2.7 Complications of Different Processes and Tools

It is obvious that several organisational entities can be involved in specific collaboration models. Quite often, these entities have a number of processes, procedures, or even implicit working habits in place, sometimes supported by tools. Cross company collaboration due to the acquisitions of companies, but also the collaboration with other companies provide evidence, that we have to deal with quite complex and partly also tricky challenges.

Examples of these are:

- at data exchange level, different data formats such as different word processors, planning tools, address books in several tools have to be coped with;
- different tools are used which are not able to interoperate;
- individual customisation of tools at various sites cause interoperability problems;
- tools with closed data bases, proprietary clients or protocols to access information are used;
- incompatible processes or procedures exist which need specific customisation of, e.g., configuration management tools, etc.

The difficulties mentioned here also hold for example for the collaboration between distributed groups in software development as well as other disciplines.

For loosely coupled teams the use of generic tools as e-mail and web/ftp archives together with agreements on data formats will be sufficient. In case of read-only exchange, one might even limit to PDF files. If documents should be editable by other persons then one has to agree on tool level and sometimes even on the version of the word processing tool. In case of more tightly collaboration where managerial tools (as problem reporting, configuration and change management, workflow, etc.) are involved tools with a Web-based interface could provide for a solution.

2.8 Results Emerged and Base Technologies Used

R&D projects like MATES and GEN consisting of partners spread across Europe were, of course, distributed (SW engineering) projects on their own. Hence, one of the goals of the projects has been to use tools, either from third party or developed by themselves - in MATES as part of the official work plan - to support distributed collaboration within the projects themselves. Usually, the approach of gradual introduction of tools based on the evolution of experience and needs was followed.

During the project the participants in the MATES project, experienced the following evolution with respect to the way of working and support by tools (for more details on the various tools mentioned also in the table below the cited MATES references will serve):

In the beginning some reflectors to distribute e-mail with attachments with any kind of file format to different collections of recipients were set-up.

The project experienced, however, that the use of mailing lists for discussions was not very effective if more than two or three persons were involved. To solve this a tool called HyperNews was introduced. This allowed more structured discussions and everyone could easily register for notifications and respond to reactions from other participants. Since HyperNews is a Web-based application, a project Web server has been set up at one partner's site, which did not have firewall restrictions.

Increased activities on the discussions forums, just before and after meetings or workshops, were notable. As a result the meetings have been more effective and allowed in the second year of the project to replace a number of physical meetings by video conferencing. Of course, there was a learning curve but it needed also some change in culture or working habits.

To allow access to finished documents for all persons involved the need for a project archive at a central place was felt. At first, the existing Web server was extended by an ftp server. Experience showed, however, that most persons did not use it (because it was not simple enough) and it was hard to maintain a proper structure. To solve this problem a simple Web-based application, MrPublish, developed within the project, was introduced, which allowed easy uploading of files and simple document management (with a limited set of attributes and search facilities) using a Web interface. The introduction of this service increased the discipline of persons to upload documents.

When the project progressed the need for collaborative working on deliverables by persons from multiple sites increased. Thus, a shared project workspace was introduced. MATES selected the BSCW server, which is also a Web-based application and allows to set-up shared folders, upload and download of files and limited versioning of files [9]. In these cases, the HyperNews server was used to announce new versions of deliverables in the BSCW server and to have the discussions about them.

One of the partners introduced multicasting based audio, video and whiteboard tools to create a vir-tual project room for their weekly project meetings spread across several sites. Other partners did set up a distributed software engineering environment consisting of the applications mentioned before and a configuration management system with remote access using a Web browser.

The various underlying standards used within MATES for all kind of collaboration services are listed in the third row of the table in Figure 3, whereas the tools used from third parties (in italics) and own tools (bold) developed for achieving the goals of MATES can be found in the forth row of the table in Figure 3.

	Communication	Cooperation	Coordination
Activities	addressed exchange of any type (text, audio, video, documents)of data	access to released results and discussion forums with optional access control	controlled access to work in progress
Services	e-mail with attachments, audio & video conferencing, remote presentations, remote application sharing	threaded discussion forums project and public archives search facilities, membership administration	shared project workspace, access to existing applications (EDM, problem tracking, workflow, process support)
Standards	H.32x&T.120, MBone, SRM, RTP, SRRTP, vCalendar, vCard SMTP, TCP/IP, IMAP, ICAP, http, html, MIME, JAVA, CORBA, IIOP		
Tools	H.32x and T.120 based conferencing tools *(PictureTel, Proshare, neT.120, Netmeeting)* MBone tools: **JointX, m*environment**	Commercial forums Commercial doc. stores *(Domino/Notes, AltaVista Forum, LiveLink, Netscape Suitespot)* **ProjectShell**	*BSCW*, **LiP** Integrations of: *Continuus CM/PT CVS*
	Integration on the desktop and with Web-browser		

Figure 3: The MATES Solution within the MATES Reference Model

2.9 Observations

In wrapping-up the state of CWE art and practice achieved at the end of the '90s to which MATES and GEN made some contributions future CWE (R&D) efforts were supposed to continue to establish and deploy distributed working environments to enable knowledge intensive projects to work independently of the physical location of its participants. Such environments were expected to provide solution for fast, flexible, and changing configurations of collaboration patterns, spanning company borders as well as allowing tele-working from home. This was anticipated to be best achieved by utilizing Internet technology, to be provided in the company Intranet as well as over segments of public Internet allowing project groups to be knit together forming virtual enterprises.

To reach this goal, it was stated that these environments must give the developer or service engineer full access to all project data as well as means for direct interaction with colleagues, either informally or through meetings, seminars or education. This should include access to all data needed for the tasks, ranging from results of co-workers, management information and plans, to external information sources and news. All this was expected to be provided in an integrated and easily accessible way from the users desk-top computer. Reaching information, through colleagues or through stored documents, should become a light weight operation of little effort. This would enable concurrent engineering and co-design across companies for the whole lifecycle.

The scenario sketched above was not in place at the end of the '90s, but was requested by the needs of industry. While a number of the necessary tools already existed, they were not yet been brought together, adapted, integrated and deployed into an environment supporting the complete scenario. New domain and task-specific tools were expected to emerge and existing ones to be adapted to the distributed context and to a level of quality to be agreed upon. The management of large volume of data (in size as well as the number of files and their implicit and explicit relations) in a distributed environment was recognised as a special, future topic to be addressed at that stage.

The stated goal of open and flexible collaboration environments, based on Internet technology, implied the use of standards to achieve the required acceptance and interoperability. It was required to provide for collaboration over public Internet segments and reach company internal information from the outside, while ensuring full authorization, confidentiality and authentication. Subsequent R&D projects were asked to act as catalysts for the deployment of improved network capacity. The demonstration of truly useful applications was seen as the most important driver for increased communi-cation bandwidth. Most of Europe was considered far behind the US in this respect, with serious negative effects on both productivity and the emergence of an IT industry exploiting the Internet market.

However, in the sequel of the '90s, these expectations were not met to the extent necessary for wide spread deployment and usage of CWE IT technology.

The reasons for this are manifold. Of course, the Y2K challenges and the related costs companies had to invest in order to cope with them lead to reduced budgets for other investments. The decline of the new economy overall contributed to a recession in the IT area. Furthermore, the attention for CWE dropped because UNIX-based multi-user project-support environments were replaced by PC-based individual development environments the years after Y2K.

However, it can be observed today, that CWE issues are getting renewed interests, which goes along with up-coming additional CWE application domains like the healthcare sector or the need for adjusting the business processes overall in companies due to the pressure of globalisation, which continues to contribute to create even more (globally) distributed organisations.

Interestingly, despite the turndown of CWE around the time of Y2K, the CWE R&D efforts of the '90s lead to a number of commercial SW results, which were and are further developed and sold by corres-ponding, still yet existing spin-off companies from these projects such as Marratech [11], recently bought by GOOGLE, in case of MATES, INCONY [12] for GEN or OrbiTeam Software for BSCW [9], etc.

3 Where We are Today?

Base technology for communication with persons have evolved and resulted in new types of service as "instant messaging" (like MSN Jabber etc. offering also audio, video and file exchange) or "VoIP" (like Skype and also SiP based services even extended with video).

A very important aspect is the function related to presence awareness. This offers features who of the people of interest can be contacted now, considering whether they are online and expressed with their status whether they are also available to contact. The main purpose of the CWE environments in the mid 90's concentrated on distributed engineering but now also other domains are explored and resulted in specialised environments such as:

- e-calibration environment from ESA [13];
- the Global Monitoring for Environment and Security collaborative environment [14].

In addition, the currently emerging tele-medicine solutions for remote consultation and even tele-operation can be considered as specialised CWE environments.

In case of the general purpose CWE environments also new approaches emerged. Web-based services offering collaboration support have become available such as the early implementation of Sitescape [15] that has evolved from one of the first Web-based collaboration implementations (Alta Vista Forum). More recently, IBM's Workplace [16] delivers an integrated collaborative environ-ment that includes a wide range of capabilities like e-mail, calendaring, presence awareness, instant messaging, learning, team spaces, Web con-ferencing, document and Web content management. The underlying service oriented architecture (SOA) provides a flexible and easy way to deploy just the capabilities any given individual needs. Solutions based on proprietary technology have become available. An example is Groove Virtual Office {17] offering features such as,

- replicated shared file space (allows disconnected use);
- calendars/ discussions/ notes and outlines;
- person to person interaction with presence awareness and text and voice chat;
- meeting support: collaborative meeting agenda and minutes development, persistent meeting space (dates, agendas, minutes & action items), meeting content automatically archived on PC;
- joint navigation and Web browsing, joint PowerPoint™ presentations, joint Word™ document editing, whiteboard;
- project management (roles, tasks, timeline, integrated with meetings).

Important properties of the tool are:

- secure encrypted replicated shared file space;
- it operates through firewalls (via secure http);
- auto-notifications of new content (symbols);
- easy management and set-up (tools, workspaces and users); the client application is a real Windows application (drag and drop for files);
- extendable platform (adding tools).

Groove Virtual Office has, of course, also some deficiencies:

- search facilities are lacking;
- no versioning of files is supported;
- limited printing facilities (calendar, message history, chat, discussion, forms, notepad, text);
- single platform (Windows).

Of course, some Open Source alternatives, like PHP, CVM and others solutions listed at sites such as [18], [19] and [20] have been developed as well.

In the Open Source software development, by nature, collaboration is important as well. Services as Sourceforge, Gforce and SourceCast are offering collaboration features that are important for this specific domain. These tools offer functions, such as:

- automatic concurrent version control;
- issue tracking;
- mailing list creation and management;
- files store of any type;
- discussion forums.

As can be noticed synchronous communication tools in these solutions are considered less important and are lacking.

Recently, a new term, Web2.0, has come up for Web-based tools that allow publishing by users. This means that it mainly concentrates on the asynchronous exchange of data, as part of the cooperation column in the MATES reference model above. Tools in this context are Wiki's, blogging, content feeds (RSS and a-like), podcasting, video-podding. The combination with RSS or similar feeds is interesting since it allows user controlled subscription to new information (cf. the notification mechanism in HyperNews mentioned above).

This resulted in the situation that Intel has selected a number of these tools to offer an enterprise solution for collaboration which are bundled by and extended with a dashboard by SpikeSource in SuiteTwo [21]. SuiteTwo is a family of intercon-nected services that enhance the value of dialogue inside and outside the corporate firewall, working with best of breed Web 2.0 software companies. The integrated suite delivers Wiki (SocialText), Blog (MovableType), RSS aggregation (NewsGator), and RSS syndication (SimpleFeed) capabilities that together deliver more than any one individually. Another service or tool in this area is ProjectForum [22] which positions itself as "Professional Wiki Software - Wiki Done Right".

4 Reflections on the Reference Model

Based on the observations above a number of additions to the solutions in the MATES reference model as presented in Figure 3 has to be made. At the services row in the column for communication instant messaging, presence awareness, unified messaging can be added and in the column for cooperation Web 2.0 tools as Wiki, blog, feed aggregation and syndication. Of course, a number of standards have to be added as well. Not shown in the MATES reference model but very important is the integration of the services into a kind of dashboard or cockpit, not only aware of the specific workspace but also for more fine grained context such as current task. This dashboard should be configurable by the user and the integration should go beyond the dimension of presentation integration, but should also include data integration across services and support basic processes.

5 Current Trends

The need for collaboration across space or distance and time dimension is still important, the need is even increasing, and the organisational dimension is important to add. The demand for collaboration across enterprises or institutes is rising. This will be reflected in stronger requirements on security, such as role-based-access-models. This need for the organisational dimension is created by the fact that beyond off- and near-shoring within one enterprise new models have come up due to outsourcing, business modularisation (companies concentrating on core activity and collaborate with others in co-maker-ship relations) and the trend of open innovation, where companies and institutes work together in pre-competitive research and development efforts.

Besides the "traditional" distributed engineering support also sales and marketing processes, supply chain management and product service processes require collaboration support. The type of processes involved has a consequence for the intensity of interaction between persons, the type of data and the intensity of control that has to be supported (cf. also the related discussion above).

Besides collaboration support in enterprises and institutes the need for similar kind of support is rising in the public and private domain, such as public services and governmental institutes - at first instance only for their internal processes but in the long run one can also imagine this in future interaction with persons or organisations outside.

In the healthcare domain tele-medicine in the form of tele-expertise requires that information about the patient (such as diagnostic reports, laboratory results, medical images or other parts of patient's medical records) is made available to remote expert or even to a group of multi-disciplinary experts at multiple locations – a need especially for rural, remote and/or sparsely populated regions with a low coverage of doctoral expertise. The provision of remote expertise may take place asynchronously, with the expert looking at the information provided and sending back a response, or in a synchronous manner involving a direct interaction between health professionals at multiple sites, involving the use of CWE tools supplemented with audio or video conference services. All of this can cut costs and save time. Furthermore it could contribute to improve patient and doctor satisfaction.

The paper "Beyond the Archive: Thinking CSCW into EHRs for Home Care" [23], gives an idea how CWE facilities can support home or remote healthcare by complementing an EHR system with collaboration support. Also, the passive Web sites for communities, from whatever background, can be extended even beyond the "Wiki" approach to allow more active participation by members.

The new generation of users ("the skype or gaming generation") is used to new features as has been offered by the "instant messaging" services, VoIP, video calls, WiKi's blogging etc. It expects similar type of interaction integrated in its future (professional) collaboration environment offering access to presence and contact information, for different types of direct communication means, within the context of the task at hand, e.g. at the level of the document they are accessing. One should also be aware that some of the CWE participants (despite the goal of CWE to span space or distance) are themselves mobile and moving around. They will use Internet hotspots at any loca-tion (which puts another claim at security) or mobile devices with limited bandwidth (either due to the physical limitation or due to high costs). Also for this situation the solutions should offer adequate support.

By browsing the Web and looking at Web sites such as AMI@work [24] and Collaboration@work [25] one can notice that there are many projects working on CWE issues, too many to discuss all of them here. However, based on information provided by some project's Web sites a reflection on this is given below. A white paper entitled "Context-Aware Collaborative Environments for Next-Generation Business Networks [26]" provides for an overview of trends in its research roadmap:

- people oriented group work support will be integrated in virtual organizations for 'frictionless' collaborative value creation;
- context awareness services (task, location, process, time), personalization, and presence awareness will support human-centred group cooperation;
- context-awareness (task or problem) will enhance knowledge sharing of individuals to enhance distributed group work;
- support of anybody, anytime, anywhere knowledge based collaboration.

Some other interesting documents that present good analyses, trends and roadmaps are:

- the "Book of Visions" [27] which gives also a view into the future with their "Long

term vision for CWE" and "Looking towards 2020";
- final reports [29] from the Future Workspaces project, with end-user visions, human factor and technical challenges and a roadmap;
- vision document on CWE of the CLOCK project [28].

Besides a list of research issues, the latter contains the following list of drivers for working on CWE:

- **The globalization of businesses**: This can mean the globalization of markets for products and services but also for labor, partnerships and alliances. In all these cases CWE must en-able users to bridge time and space as well as cultural and organizational differences in a seamless way.
- **The connected nature of business:** The use of CWE for providing synergic services could re-duce overall costs and increase productivity. At the same time there is a need for businesses to remain competitive by reducing time to market through leveraging ideas, patents, know-ledge from any part of the world rather than recrea-ting knowledge themselves. CWE is the key.
- **The increasing use of remote virtual teams**: Nowadays most organizations rely on remote virtual teams because they allow the best individuals to participate in the teams, regardless of geographical or temporal limitations. More advanced CWE will allow these teams greater access to knowledge of all kinds and permit that these teams operate in a way that is "better than being there".
- **The increasing complexity of collaboration processes**: This complexity can only be overcome with more advanced CWE that support the flexible modularization and orchestration of collaboration functions.
- **Intellectual Property**: Where the stakeholders belong to different organizations, their different Intellectual Property concerns must be taken into account. This is vital to build confidence and se-curity in collaborative knowledge environments.
- **Quality of life needs**: CWE allows a better and more flexible organization of the work/life balance, for example providing continuity of the working environment in the office, at home, in town (urban) and in remote (rural) areas.
- **Europe is facing an evolution of the Workforce**: Changing demographics, aging pyramid, diversity, women, minorities, the gaming generation, etc; CWE must be seen as a means of enabling digital inclusion.

6 Barriers

A lot of barriers for widely deploying IT support (not only) in industry still exist today. At individual level, the lack of usability (or of co-operativity addressing group usability) of the existing tool support prevents very often broader usage. Apart from the (IT) security and safety issues related to CWE and the corresponding hesitation of CIO's to tackle them, in companies, the inability and/or unwillingness of organisations to change their traditional ways of working often represent major hurdles to establish and deploy IT for CWE (see, among others, [10]).

Many of those "office-based" organisations, suitable candidates for implementing efficient and appropriate tele-working, very often don't put this into practice. Especially in Germany, for example, companies haven't yet developed sufficient trust in tele-workers. Managers still believe, that they are better able to control the performance of their employees when they are working in their company offices. Similar observations are reported from other major European countries, i.e., industry at large is still far away from using the benefits which are associated with CWEs.

If (larger) companies are willing to change, any progress takes quite some time. Anecdotal evidence is provided by a core group of companies, forming with different other partners consortia for three subsequent European R&D projects on CWE (sic!) starting by 1994 and ending by 2002. In retrospect, it can be concluded, that with the first project, all project partners were able to communicate via e-mail, in the second one, all partners had access to the Internet, but some had their Internet servers still before their firewalls. In the third project, these servers could be then moved into the DMZ.

Given the current huge range of options provided by CWE IT support this story sounds today a bit unbelievable, but barriers for up-take still exist today, as noted above. Therefore, the CWE community is asked to continue to lobby for and promote the benefits of its profession, but may be in a better position then in the past with the arrival of the new generation of users as outlined above.

The white paper "Context-Aware Collaborative Environments for Next-Generation Business Networks" [26], provides also for an overview of these issues:

- current group cooperation support (groupware) lacks integration, flexibility, tailoring, leads to overload;
- lacking interoperability of co-operation support (bottom-up task – group level) and business process management (top-down business management level);
- lack of context-aware and person-oriented support and lack of anticipation to external changes, new events;
- lacking adaptability in systems architecture and component-based design;
- lack of trust and security issues to allow for enterprise use, leaving the enterprise network.

7 Conclusions

A lot of research work has been done since the MATES project, however while observing the daily practise it is not yet adequately used. The section on barriers above discussed some issues related to this. Some important challenges to tackle are:

- simple use, installation, and management of the workspaces, meaning by the project itself;
- integration that goes beyond presentation integration, but also based on data and process integration;
- adaptation to project and personal preferences, e.g., based on flexible communication profiles;
- presence awareness in the context of current task, location and situation;

- create trust by proper security mechanism;
- keep organisational, cultural, social and human aspects in mind.

The CLOCK vision document on CWE [28] contains the sentence: “Lately the expression CWE is sometimes being replaced with CE (Collaborative Environments) to emphasize the fact that it is not only a working issue but rather a 24h/7days challenge as working time and free time are tending towards the creation of an overlapping CE pattern”. This illustrates that the topic evolves towards a pervasive service in the private, community, public and professional domains. Looking at the trends and roadmaps mentioned before it is evident that the topic is of great importance and provides promising opportunities but also that a lot of work still has to be done.

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