

A Comparative Analysis of Web-based Collaborative Systems

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Abstract

E-collaboration and collaborative systems bring geographically dispersed teams together, supporting communication, coordination and cooperation. In this paper we review forty-four products and research prototypes that offer collaborative services. The findings of our survey provide a list of the basic collaboration services, such as non real-time discussions, email, whiteboard, real-time discussions, screen sharing, file & document sharing and document management, and the examined products are presented with regards to those services. In sequence, they are classified to five functional categories, also defined taking into account the analysed features. In conclusion, important issues of collaborative computing are touched upon, and areas for improvement are identified.

1. Introduction

The worldwide web technology and electronic networks have created an environment, where place no longer matters. E-collaboration and collaborative tools bring geographically dispersed teams together for virtual meetings across great distances. This results to tremendous time and cost saving, greatly decreased travel requirements, faster and better decision-making and improved communications flow throughout the organization. Even organizations, whose parts live all in the same building, often experience difficulties, which real-time collaboration from desktops could improve. Broadly defined, the field of collaborative computing, encompasses the use of computers to support coordination and cooperation of two or more people who attempt to perform a task or solve a problem together [1], [3].

Collaborative systems are typically categorized along two primary dimensions [2], [3]:

- Synchrony: the most basic division is between synchronous and asynchronous conferencing [7]. Synchronous conferencing is intended for users interacting in real-time, while asynchronous conferencing refers to non-real time collaboration.
- Locality: the whereabouts of the users are taken into consideration and there is distinction between face-to-face or collocated interactions, and non-collocated or distance collaboration.

Another issue that is critical in supporting groups to collaborate refers to document management. Document management systems enable users to directly manipulate documents, index and store in order to retrieve them when needed, communicate through the exchange of documents, collaborate around documents and even model and annotate the flow of documents [11] All subjects studied in the following pages, take into account the above basic considerations concerning collaborative software.

The objective of this paper is to review forty four the existing systems offering collaboration services, group them in functional categories based on the kind of services they provide, identify strengths and weaknesses, define areas for improvement and set the basis for future considerations. The idea for the review came in the context of a European project and was in sequence further developed as part of a PhD thesis.

The paper is structured in the following manner: The next section describes some of the most common collaboration services, and in sequence, a correlation of the systems and their features is provided. In Section 4 the functional categories as well as their basic attributes are identified, and the systems are classified to the predefined categories. Finally, Section 5 sums up all driven conclusions and future issues are also presented.

2. Characteristics of Collaborative Tools

An effort has been made to codify the most important services collaborative tools provide. The services considered are below briefly described:

- *Bulletin board*: a message board, where a conversation can be carried on over time. The user can leave a message for someone, and they can answer it and the initiator can respond back to them later.
- *Non-real time discussions*: the subject is set and the discussion is carried on over time. While the subject is still open, anyone can share his or her opinion at any time.
- *E-mail*: the most common and widespread communication tool. It allows wide contact over the Internet and its primary use is for text messages, normally relatively brief. Often the messages are accompanied by file attachments.
- *Email notifications*: email notifications are sent to inform about changed project information, entries in the calendar and to-do list, new activities in the group, or revisions and changes in documents.
- *Online paging/messaging*: instant alerts “pop up” on the user’s screens, serving as informal messages, or notifying about scheduled meetings, etc.
- *Chat*: real-time text talk, where messages appear on both users screens. Usually, a split screen is used, where the local typing appears in one part and the remote in the other. There is no particular subject set and it does not scale to more than a very few users.
- *Whiteboard*: an overlay screen is used for notes and sketching. People can work on text or graphics simultaneously. Most shared whiteboards are designed for informal conversation, but they may also serve structured communications, or more sophisticated drawing tasks, such as collaborative graphic design, publishing, or engineering applications. Shared whiteboards can indicate where each person is drawing or pointing, by showing telepointers, which are color-coded or labeled to identify each person.
- *Real-time discussion*: a subject is set and the discussion is carried on with all participants online, more like a real-life discussion.
- *Audio/Video conferencing*: use of audio or video to enhance human presence in meetings. Video is advantageous when visual information is discussed, and may also be used in less direct collaborative situations, such as for providing a view of activities at a remote location.
- *Task list*: lists of actions to be performed, pending activities, unresolved problems and scheduled

meetings are kept and the user is notified for new items in the list.

- *Contact management*: an address book is provided, where contact information about meeting participants or project partners can be found.
- *Screen sharing*: both people have the same view of the screen and possibly the remote user can take control of the other user’s system. Screen sharing can mean either that only the view of the screen is shared - essentially a graphic representation of one screen is passed to the other screen, or applications can be shared, in which case events from the remote keyboard and mouse are used to drive the local input and pointer.
- *Surveys/Polling*: decisions are made online, and surveys on different topics are conducted. Occasionally voting results are graphed and disseminated.
- *Meeting minutes/records*: minutes are disseminated among participants, action items are posted, or the team’s thoughts are gathered so as to constitute the starting point for subsequent meetings.
- *Meeting scheduling tools*: creating meeting agendas and lists of issues or using calendars for organizing meetings.
- *Presentation capability*: users can conduct presentations, i.e. show and annotate PowerPoint slides.
- *Project management*: projects and project milestones, meetings, memos and project interactions are tracked. Project management with the traditional meaning of the term, i.e. creating Gantt or Pert charts and calculating the project budget is not considered.
- *File & document sharing*: documents and files are available to a group of people to view. In the simplest form, files come as email attachments and users can work with them using their local applications. Alternatively, files are uploaded to a site/server.
- *Document management*: document management includes sharing of documents. Documents are stored in a central server and users can work on the documents, either using their local applications, or the tool’s functionality. Occasionally, there is possibility for version control, search, electronic signing and access control.
- *Synchronous work on files/documents*: files/documents can be edited simultaneously by a number of users, either on each other’s screen, or on a whiteboard.

3. Comparative Analysis of Systems

There is a wide range of software products that offer collaborative services.

Table 1. Collaboration tools and their characteristics

Products	Features																				
	Bulletin board	Non real-time discussions	Email	Email notifications	Online paging/messaging	Chat	Whiteboard	Real-time discussions	Audiotape conferencing	Task list	Contact management	Screen sharing	Polling	Meeting minutes/records	Meeting scheduling	Presentation capability	Project management	File & document sharing tools	Document management	Synchronous work on documents/files	
CommonSpace																					
DocuTouch																					
Documentum																					
TeamNow																					
CentraNow																					
Conscious @nyWARE																					
CuSeeMe Conference Server																					
DOLPHIN																					
Evoke Collaboration																					
Facilitate.com																					
Groupiter																					
HelpMeeting																					
MeetingRoom																					
PlaceWare																					
Web-4M																					
appSmartForum																					
FirstClass																					
InstantTEAMROOM																					
Intranets																					
Project place																					
TeamTalk																					
Jungle																					
WebBoard																					
MeetingPlace																					
NetMeeting																					
PictureTalk																					
Sametime																					
BSCW																					
Business Manager																					
Caorus																					
Collab Fab																					
CVW																					
Cybertz Office 3																					
eRoom																					
Forum																					
GroupPORT																					
GroupWise																					
HyperOffice																					
InfoWorkSpace																					
Intranet e-Business Platform																					
JointPlanning																					
QuickPlace																					
TeamOn																					
VEGA																					

We have reviewed forty-four systems that are either available commercially, or are research prototypes. More information about each tool is given in Table 2 in section 4.

Consecutively, bearing in mind the features analysed in the previous section, we were able to range the tools with regards to the services they provide and present the results in Table 1.

4. Categories of Collaborative Tools

A review of the literature reveals several classifications of systems that support group work.

Kraemer and King for instance [13], provide a classification of the Group Decision Support Systems (GDSSs). GDSSs are categorized with regards to the hardware they need, the software required, the people they involve and the organizational data needed.

The hereby classification is targeted to the services the collaborative tools provide and makes no reference either to the equipment or the organizational data needed. For a more accurate definition, a graphical representation of the categories in relation to their most important characteristics is provided (see Fig.1). The five categories feature in a two-dimensional graph. The x-axis represents the level of functionality concerning collaboration. This axis commences with services providing simple communication functionality and leads to these services, which enhance collaboration and human interaction. The y-axis on the other hand, represents the document management capability. The services are ranked beginning with the file & document sharing facility concluding to the synchronous work on documents, from bottom to top.

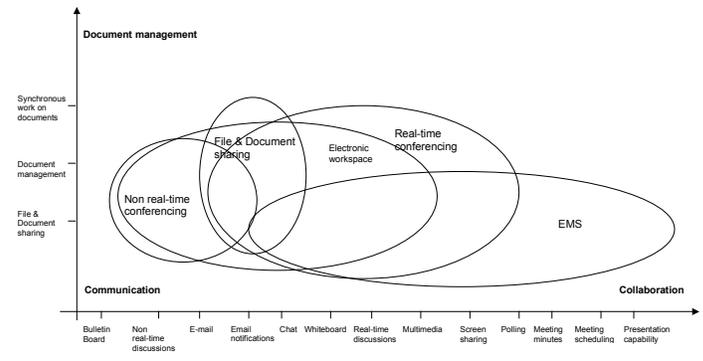


Fig.1. Categories of Tools

The five categories can now be properly defined. At the same time the typical characteristics of each category are cited:

- **Web-based file & document sharing / Group Document Handling:** The core functionalities of this category involve working with documents and files. In the simplest form, users only have a shared view of files/documents, while advancing, there is also possibility for individual editing, document/file management and storing in a central database, as well as collective authoring and revision of documents. Synchronous work on documents can also be a part of a group document-handling tool. In addition, basic communication capabilities, such as e-mail notification and e-mail, are provided.
- **Real-time conferencing:** The focus of this category is on real-time. Files and documents are shared, and in addition users can see and work on

documents simultaneously, or on each other's screen, or on a whiteboard [10]. Audio and video conferencing are quite common. Real-time text talk and real-time discussions are also possible.

- **Non real-time conferencing:** File and document sharing is a characteristic of this category too. Typically though, tools that can be classified as offering non real-time conferencing services provide space for asynchronous and threaded discussions and have mailing capabilities. People with common interests can carry on discussions over time, or share documents, either as mail attachments, or by uploading them in the shared space provided by the tool.

- **Electronic Meeting Systems (EMS):** Meeting conduction is the basic functionality of the EMS category. Meetings can either be regular (same time, same place), synchronous (same time, different place), or asynchronous (different time, different place) [9]. Meeting participants are notified through email, and have the possibility to chat, conduct real-time discussions, use audio and video conferencing facilities, write or draw in real-time on a blank slide, participate in surveys – anonymously if preferred - and make group decisions, share documents and files, show and annotate PowerPoint slides, share live software applications and even work simultaneously on documents. Apart from the work-centred activities, the team also engages in team-centred activities including greeting, seeking additional participants, introduction and parting. Finally, meeting-centred activities support the meeting process including its setup, maintenance of the agenda and minutes, and distribution of the minutes after the meeting [8].

- **Electronic workspace:** The electronic workspace category is the broadest of all, including a variety of tools with a large number of features. The primary idea is to provide teams with a common space to coordinate and organize their work. Groups can centrally store documents and files, work with them, solve problems through discussion, keep to-do lists and address books with information about group contacts, and even track project milestones and project interactions. There are workspaces for different groups, and users may be members of several workspaces (e.g. one workspace corresponding to each project a user is involved with) [4].

Table 2 gives a full list of the systems examined as well as the category each tool belongs to. Obviously some tools can be a part of more than one category. In this case, we have tried to select the category that more accurately represented the tool's functionality. Anyhow, it should be noted that our classification is subjective and that slight "movements" of tools from one category to another, can easily occur.

Table 2: Classification of Collaborative Tools

Tools	Organization/Country	URL	Category
CommonSpace	Sixth Floor Media, USA	http://www.sixthfloor.com	File& Document sharing
DocuTouch	DocuTouch Corporation, USA	http://www.docutouch.com	File& Document sharing
Documentum	Documentum, USA	http://www.documentum.com	File& Document sharing
TeamNow	TeamNow, Denmark	http://www.teamnow.com	File& Document sharing
CentraNow	Centra, USA	http://www.centranow.com	Electronic Meeting Systems
Consensus @nyWARE	SoftBicycle, USA	http://www.softbicycle.com	Electronic Meeting Systems
CuSeeMe Conference Server	CuSeeMe Networks, USA	http://www.cuseeme.com	Electronic Meeting Systems
DOLPHIN	GMD, Germany	http://www.darmstadt.gmd.de/	Electronic Meeting Systems
Evolve Collaboration	Evolve Communications, USA	http://www.evolve.com	Electronic Meeting Systems
Facilitate.com	Facilitate.com, USA	http://www.facilitate.com	Electronic Meeting Systems
Groupster	Stepup Systems, Australia	http://www.stepup.com.au/	Electronic Meeting Systems
HelpMeeting	HelpMeeting LLC, USA	http://www.helpmeeting.com	Electronic Meeting Systems
MeetingRoom	GroupSystems.com, USA	http://www.verlana.com	Electronic Meeting Systems
PlaceWare	PlaceWare, USA	http://www.placeware.com	Electronic Meeting Systems
Web4M	JiTech Technologies, USA	http://www.jitech.com	Electronic Meeting Systems
aspSmartForum	AspSmart, France	http://www.aspsmart.com	Non real-time conferencing
FirstClass	Centrinity, Canada	http://www.softarc.com	Non real-time conferencing
InstantTEAMROOM	Lotus, USA	http://www.lotus.com	Non real-time conferencing
Intranets	Intranets.com, USA	http://www.intranets.com	Non real-time conferencing
Project place	Projectplace International AB, Stockholm	http://www.projectplace.co.uk	Non real-time conferencing
TeamTalk	Trax Softworks, USA	http://www.webcom.com/	Non real-time conferencing
Ujungle	Ujungle, USA	http://www.ujungle.com	Non real-time conferencing
WebBoard	O'Reilly Software, USA	http://www.webboard.oreilly.com	Non real-time conferencing
MeetingPlace	Latitude, USA	http://www.latitude.com	Real-time conferencing
NetMeeting	Microsoft, USA	http://www.microsoft.com	Real-time conferencing
PictureTalk	Pixion, USA	http://www.pixion.com	Real-time conferencing
Sametime	Lotus, USA	http://www.lotus.com	Real-time conferencing
BSCW	GMD, Germany	http://bscw.gmd.de	Electronic Workspace
Business Manager	Info Parc, Austria	http://www.infoparc.com	Electronic Workspace
Caucus	Caucus Systems, USA	http://www.caucus.com	Electronic Workspace
Collab Fab	Collaboration Fabricators	http://www.collabfab.com	Electronic Workspace
CVW	Mitre, USA	http://cww.sourceforge.net	Electronic Workspace
Cybozu Office 3	Cybozu, Japan	http://cybozu.com	Electronic Workspace
eRoom	eRoom Technology, UK	http://www.eroom.com	Electronic Workspace
Forum	SiteScape, USA	http://www.sitescape.com/	Electronic Workspace
GroupPORT	Groupware, USA	http://gpn1.groupware.com	Electronic Workspace
GroupWise	Novell, USA	http://www.novell.com/	Electronic Workspace
HyperOffice	myWebOS.com, USA	http://www.hyperoffice.com	Electronic Workspace
InfoWorkSpace	General Dynamics, USA	http://www.infoworkspace.com	Electronic Workspace
Intraspect c-Business Platform	Intraspect Software, USA	http://www.intraspect.com	Electronic Workspace
JointPlanning	Bridgeline Technologies, USA	http://www.jointplanning.com	Electronic Workspace
QuickPlace	Lotus, USA	http://www.lotus.com	Electronic Workspace
TeamOn	TeamOn, USA	http://www.teamon.com	Electronic Workspace
VEGA	Universities of Bern, Lausanne	http://vega.vptt.ch	Electronic Workspace

5. Discussion and concluding remarks

Without any doubt, collaborative working based on information sharing is becoming a necessity. All five categories of tools providing group communication and collaboration, address some of the coordination problems that decentralization, joint ventures, mobile working and outsourcing of business functions have created [4]. Widely dispersed working groups can jointly author, comment and annotate documents (Web-based file & document sharing), organize and conduct electronic meetings (EMS), and engage in synchronous or asynchronous group discussions (real-time/non real-time conferencing).

File & document sharing is clearly the most common and at the same time most needed collaboration service. The majority of the examined tools provide file and document sharing functionality and often, document management facilities. Geographically dispersed work groups, either consisting of project team members, usually working in different organizations, or of interactive employees of the same company, have the common, compelling need to share the information included in documents and files of various formats and to be able to work with that information, preferably using their local applications. Therefore, basic file/document sharing and management functionality should be integral part of all collaborative tools.

Non real-time collaborative software is not necessarily intended for professional activities. More often, people use it to create discussions around any

issue they are interested in. It is commonly integrated in e-commerce sites, to attract frequent visitors, or it can be part of a company intranet to involve employees. Services provided by non real-time collaborative tools are usually also included in systems belonging to the other categories.

EMS enable people to work together more effectively- especially during large, face-to-face meetings. They are especially useful if sensitive issues need to be discussed, which participants may be reluctant to talk about openly and in case of extreme opinion differences among dominant personalities. Also, it is considered best to use EMS, when consensus is needed before going forward, when there is limited time to collect information from a large group of people, a very complex decision based on many criteria must be made, and the meeting content needs to be quickly documented and used for desired impact on the organization.

However, the real need for electronic meetings is located in case of remote participants, where important decisions for the work progress need to be made, without physical collocation being possible. EMS should be more effective during such meetings, also supporting the social activities necessary for building trust in geographically distributed teams and enhancing team awareness. The use of video-conferencing could provide a solution, although it can be quite costly. Other ways, possibly more effective and at less cost, could be maintaining a collection of background information about team members, including photographs and/or video segments. This information could be accessed during the introductory phase of meetings and participants would learn to associate the voice with the face. Of course, this approach requires work to create and maintain it [8].

The electronic workspace category of tools combines some of the basic features of the other four categories. Access to shared information is provided at any time and place, using minimal technical infrastructure.

There is a continued challenge to support not only small groups or moderate-sized organizations, which have traditionally been the focus of most collaborative tools, but also much larger scale tele-collaboration, such as inter-organizational communications. People from across a company and from customer, supplier and partner companies need to get together to innovate, resolve issues, make decisions and get work done.

A shared, web-based workspace can best address that need, when it includes workflow functionality. Using web-based workflow technology, business processes, part of which are initiated or performed by

users via a web browser, are automated. The systems we reviewed do not explicitly handle workflow, that's why we did not include workflow in the examined characteristics.

However, for business to business transactions, web based workflow provides many advantages. Workflow technology allows companies to extend their organizational boundaries to seamlessly include their customers and suppliers [6]. All types of traditional documents, as well as the new non-traditional digital forms of information, such as voice messages, e-mails, video, and web pages, can constitute input to the workflow process. A work item can move through multiple organizations linked over the Internet to achieve the required goal. In addition, authorized users can track workflow activity through the various heterogeneous organizations from their desktop.

Although there are some tools-members of the electronic workspace category that offer basic workflow functionality, mostly dealing with the routing of documents through a predefined review or approval cycle, there is a clear need for an extension of the category to include integrated workflow services, which need of course to be customized to the needs of particular organization and application domains. These services could include [5] notifications to the users of activities to be performed, visualization of the context of an activity, complete handling of the action flow (e.g. calculation of the next step, routing of the involved data, etc.), and monitoring of the state of the work process. Research toward that direction has been performed and BSCW-Flow has been proposed as an extension to the BSCW system [12].

References

Due to space limitations, references are not included in the paper but can be made available by email request to Georgia Bafoutsou (gbafou@cc.ece.ntua.gr).