

WWW Based Collaboration with the BSCW System

Wolfgang Appelt

GMD – German National Research Center for Information Technology
Schloß Birlinghoven, D-53754 Sankt Augustin, Germany
appelt@gmd.de

Abstract. The World Wide Web offers a great deal of potential in supporting cross-platform cooperative work within locally dispersed working groups. GMD has developed the BSCW System, a Web based groupware tool using the metaphor of shared virtual workspaces. The system is particularly useful – and already used by a large community – for cooperation between researchers in distributed environments. This paper describes the principles, architecture and functionality of the current (August 1999) version.

1 Introduction

Collaboration between researchers involves a rich set of modes and means of cooperation. For example, several researchers may meet spontaneously, e.g., at a conference, and discuss new research ideas. They may decide to write a joint paper, distribute the off-line drafting of different sections of the paper to individuals, have face to face meetings to discuss the drafts, maybe with mutual reviews between meetings, until the final paper eventually emerges and is presented to the scientific community. Depending on the area of research, besides textual communication additional media such as graphics, spreadsheets, animations, presentation of software or the results of experiments will be involved in their cooperation.

To enable efficient ways of cooperation, these collaboration processes need to be supported by electronic means, in particular, when cooperation takes place within locally dispersed groups. These electronic cooperation tools need to support the usual work practices of researchers, in particular, they need to provide

- a rich variety of tools for asynchronous and synchronous collaboration,
- a smooth transition between asynchronous and synchronous modes of collaboration,
- a close integration into the normal working environments of the users, and
- cross-platform interoperability, since in general cross-organisational research groups use a variety of platforms.

In the last years the Internet and the World Wide Web (WWW) in particular have become the most important infrastructure for communication within the

research community. Email over the Internet has emerged as the primary means of interchanging multimedia information between researchers, and the WWW has become an important medium for dissemination of research results. The WWW has a number of advantages as the basis for tools to support collaborative information sharing:

- WWW browsers are available for all important platforms and provide access to information in a platform independent manner.
- Browsers offer a simple and consistent user interface across different platforms.
- Browsers are already part of the computing environment in many organisations.
- Many organisations have also installed their own Web servers and are familiar with server maintenance.

Given these characteristics, the extension of the Web to provide richer forms of cooperation support for working groups is both appropriate and desirable. Therefore, the CSCW (Computer Supported Cooperative Work) research group in GMD's Institute for Applied Information Technology (FIT) has developed the BSCW (Basic Support for Cooperative Work) system within the last five years which as its main goal seeks to transform the Web from a primarily passive information repository to an active cooperation medium.

2 General Approach of the BSCW System

Over the last years, CSCW research has led to a better understanding how to support electronic cooperation within groups in various environments. Empirical studies have shown (see e.g. [3]) the importance of joint information spaces (often called *shared workspaces*) particularly in locally distributed, loosely organised groups. The groups use such workspaces for the collection and structuring of any kind of information they need (e.g., documents, graphics, spreadsheets, tables, or software) to achieve the goals of their collaboration.

Such workspaces support primarily asynchronous modes of communication. This mode is normally the most important one for cooperation between researchers since in such an environment cooperation consists often in parallel, loosely coupled activities of the individual group members. Synchronous types of cooperation such as audio/video conferencing or chat sessions are usually of less importance but should also be supported to some extent. The usage of workflow systems – which are primarily addressing the execution of a set of tasks following a predefined sequence with allocation of responsibilities to persons or roles – is normally not appropriate in such groups.

The BSCW system is based on the metaphor of *shared workspaces*. The users access these workspaces with their normal Web browsers; the installation of additional software at the users' sites is not necessary. A further focus of the system is the information of the users about the activities within their workspaces, i.e., the system provides several *awareness services*.

Although the system primarily supports asynchronous modes of communication, it also provides some features for synchronous collaboration such as information about the concurrent presence of other users as well as interfaces to *synchronous communication tools* such as chat or audio/video conferencing.

3 Implementation of the BSCW System

The BSCW system is built upon a standard Web server: The Common Gateway Interface (CGI) – the standard API for Web servers – is taken to implement the BSCW kernel functionality, thereby extending a Web server into a *BSCW server*. The system is written entirely in the interpreted programming language Python (see <http://www.python.org/>) and the only additional software required to use the system besides a Web server is the Python interpreter.

Since Python provides good support for modularisation, the implementation of the kernel functionality and the user interface are largely separated, i.e., without modifications of the kernel code the interface can be customised to a large extent, even by people without detailed understanding of the code. The interface definition comprises a set of HTML template pages which can be edited easily. GMD provides these interface template pages in German and English, but users of the system have translated them to provide interfaces in additional languages (e.g., French, Italian, Spanish, Finnish, Russian).

The modular system design also allows extension of BSCW in a number of different ways rather easily. New operation handlers can be added to provide new functionality or act as interfaces (“wrappers”) to an existing application. It is also straightforward to access the persistent store of the BSCW system to store new kinds of objects without modifying the storage routines themselves. In particular, the choice of the interpreted language Python as the implementation language directly supports rapid prototyping.

An overview of the architecture of the BSCW system is given in Fig. 1. The main interface between the BSCW Server and the BSCW clients – these are normal Web browsers – is HTTP and HTML. Since HTML is not very powerful with respect to interface design, the system contains also an additional Java based interface (using XML) which has been released with version 3.3 of the system in June 1999. (This interface is described below in more detail; see also [4].)

Besides the BSCW server, i.e., a Web server extended with the BSCW functionality, the BSCW system comprises also a so-called *event server* which feeds the so-called *monitor applet* – a Java applet which can be started from a BSCW workspace – with events about presence and activities of other BSCW users (see below). This is a separate server whose functionality cannot be added to a normal Web server since HTTP and HTML are unsufficient for these particular features.

The BSCW system runs on Windows NT and various Unix dialects (including Sun Solaris and Linux). As the underlying Web server the Microsoft Internet

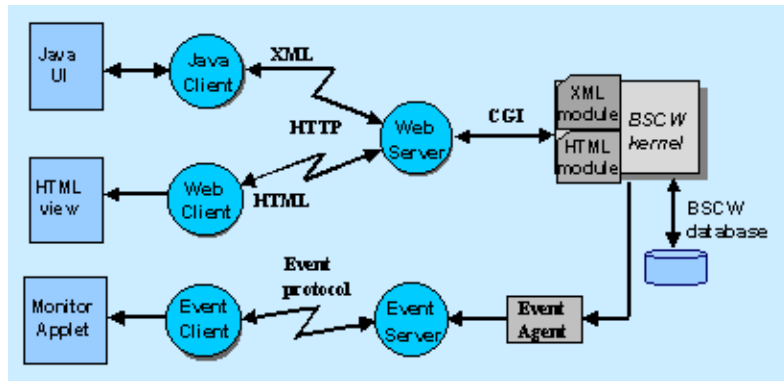


Fig. 1. Architecture of the BSCW System

Information Server, the Apache server and the AOL and CERN Web servers can be used.

4 Functionality of the BSCW System

As mentioned already above, the central metaphor of the BSCW system is the shared workspace. In general a BSCW server will manage workspaces for different groups. Users may be members of several workspaces (e.g., one workspace corresponding to each project a user is involved in). In addition, users may set up private workspaces which they do not share with others.

A shared workspace can contain different kinds of information such as documents, pictures, URL links to other Web pages or FTP sites, threaded discussions, information about other users and more. The contents of the workspaces are usually arranged in a folder hierarchy based on structuring principles agreed upon by the members of a workspace.

A cooperative system has to provide awareness information to allow users to coordinate their work. The event services of the BSCW system provides users with information on the activities of other users, with respect to the objects within a shared workspace.

Events are triggered whenever a user performs an action in a workspace such as uploading a new document, downloading ('reading') an existing document, renaming a document and so on. The system records the events and presents these events to each user in various forms, e.g., as event icons attached to the objects, via email or through messages in the monitor applet (see below).

The most common way of informing users about events is through the event icons attached to objects. Such an icon indicates that a particular event has occurred recently. Recent in this context means events which have occurred for an object since the user last carried out a *catch-up* action, an operation by which users can tell the system that they are aware of the events that have occurred

so far and no longer wish to see them (i.e., their event icons) in the workspace. Events can be caught up at different levels, from individual objects to complete workspace folder hierarchies. Event histories are, of course, personal to each particular user, e.g., an event may be new to one user but old to other users.

The system distinguishes five types of events which are represented by five different event icons accordingly:

- *New events* indicate that an object has been created since the user last caught up.
- *Read events* show that an object has been downloaded or read by someone.
- *Change events* indicate that an object has been modified. This category includes several event types, such as *edited*, *renamed*, and so on.
- *Move events* show that an object has changed its location. This category includes *delete* and *undelete* events (showing the object has been moved into or out of a wastebasket) and *cut* and *drop* events (showing the object has been moved into or out of a user's personal bag).
- *Touch events* are displayed for a container such as a folder to show that something has happened to an object contained inside (either directly or lower down in the folder hierarchy).

Each event entry describes what was done, when and by whom. Although this approach for providing group awareness seems very simple at first sight, information such as “User A uploaded a new version of document X”, or “User B has read document Y” is often very useful for group members in coordinating their work and gaining an overview of what has happened since they last contacted the BSCW server.

Furthermore, the system contains the following main features:

- *Authentication*: Users have to identify themselves by name and password before they have access to BSCW workspaces.
- *Version management and locking*: Documents within a workspace can be put under version control which is particular useful for joint document production, or they may be locked during an editing session to prevent other users from accessing documents temporarily.
- *Discussion forums*: Users may start a discussion on any topic they like and the system presents the threads in a style similar to the Internet newsgroups.
- *Access rights*: The system contains a sophisticated access rights model which allows, for example, that some users may have complete control over an object in a workspace whereas others have only read access or no access at all.
- *Search facilities*: Users can specify queries to find objects within BSCW workspaces based on names, content or specific properties such as document author or document modification date. Furthermore, queries may be submitted to Web search engines and the result of the query can be imported into workspaces.

- *Sorting*: As mentioned above, objects in a BSCW workspace can be ordered in a hierarchical structure according to the user requirements. Within a folder listing users may sort the objects according to several categories such as type, name, or date.
- *Document format conversion*: These facilities allow users to transform a document into their format of choice, e.g., a proprietary document format into HTML, before downloading it.
- *Annotation and rating*: Users may add notes (meta-information) to objects in a workspace and rate the quality of objects, e.g., of documents or URLs that have been created. When several users gave their rating, the system will compute a median value out of their individual ratings.
- *Upload and download of archives*: Rather than uploading documents one by one into a BSCW workspace, users may upload an archive such as a zip or tar file and extract the archive at the server which may reduce upload times significantly. Similarly, users may create an archive containing objects of a workspace and then download the archive instead of the individual objects.
- *Email integration*: Users may easily send email to other users of a BSCW server and can distribute documents in a BSCW workspace to specified recipients via email.
- *Special support for meetings*: The systems allows the creation of so-called *meeting objects* which are particularly useful for the preparation of meetings since they include features such as selection of participants, automatic invitation of participants who may accept or decline an invitation, or the distribution of meeting notifications via email.
- *Interface to synchronous communication*: Through this interface users can specify synchronous sessions and launch respective tools, e.g., audio/video conferencing software or shared whiteboard applications.
- *Anonymous access and moderation*: Anonymous access can be allowed to individual objects or complete folders, e.g., for *publishing* documents after they have been developed within a closed group. The access to public folders can be set up in such a way that users can upload documents anonymously but that they only become visible to others after they have been approved by a *moderator*.
- *Address book and calendar*: Besides the waste basket and the bag there are two further objects which are personal to each user: the address book where a user may collect the names of other (e.g., frequently contacted) users, and the calendar which contains the dates of all meeting objects related to the user.
- *Customisation*: Through user preferences the users can modify the system interface to some extent, e.g., whether or not they want to use an Javascript or ActiveX enhanced interface, and which functions they want to have available in the user interface (see also below).
- *Multi-language support*: The interface of the system can be tailored to a particular language by straight-forward extensions. Several languages (e.g., French, Italian, Spanish, Catalan) have been created by users of the system

and are publicly available. Each user may select his or her preferred interface language.

- *Administration and configuration*: For administrators of a BSCW server there exists a convenient HTML interface for system administration, e.g., configuration of the server or user management. A BSCW server is highly configurable through a set of configuration files which tailor the user interface of the system to particular requirements, e.g., the set of functionality which shall be accessible for the users.

The system comprises a rich set of functions, most of which had been introduced because of user requests (see below). Many features may not be needed by all users, e.g., because they are rather specific and may, for example, only be of interest to workspace administrators. Therefore, the system supports the concept of user profiles. Users can choose between a *Beginner*, *Advanced* and *Expert* profile. In the *Beginner* profile only a subset of the functionality is visible in the interface which reduces the number of buttons and makes it thereby easier to comprehend for novice users. In the *Advanced* profile, which a user might select after he or she has become familiar with the system, the functionality is increased and more buttons appear in the interface accordingly. In the *Expert* profile the full functionality of the system is available, often only “one mouse click away”, but on the expense of a rather complicated interface. Furthermore, each user may create his or her own interface by starting with one of the three predefined profiles and then adding or removing buttons to the particular requirements of the respective user. (More details are given in [1].)

In addition, there are a number of other tools contained in the BSCW system, for example, so-called uploaders, applications that transfer a file from a local file store into a particular location on a BSCW server. These tools provide more support for file uploading than is currently built into Web browsers. For example, they allow multiple file transfer or drag-and-drop uploading.

Figure 2 is an example of the user interface of the BSCW system. It shows a listing of the folder “SOFSEM 2000” for user “Bauhmann”. The folder contains two sub-folders (“Conference Proceedings” and “Submitted Papers”), a link to another Web page (“SOFSEM ’99 Home Page”), a text document (“Important dates for . . .”) and a discussion object (“Shall we extend . . .”). The icon in front of each object’s name indicates the type of the object. Behind each object is the name of the person who created the object and the date when it was created or most recently modified.

At the top of the screen there are buttons for triggering operations such as “Add Member” to provide access to this folder to other persons, or “Add Document”, “Add Folder”, “Add URL”, etc., to create new objects within the folder. Other actions such as “Catch up”, “Send”, “Rate” or “Copy” can be applied simultaneously to a group of objects which have been marked through the tick boxes in front of each object’s name. Further action buttons appear in a line below each object (e.g., “Modify”, “Verify”, “Fetch”, “Add Note”, “Edit” or “Replace”) since they are only applicable to one particular object.



Fig. 2. HTML user interface to a BSCW shared workspace

Behind four objects (“Conference Proceedings”, “Submitted Papers”, “Important dates for ...”, and “Shall we extend ...”) there are event icons which indicate that events occurred recently, e.g., the objects “Important dates for ...” and “Shall we extend ...” are new for user Bauhmann, the document “Important dates for ...” and some other document(s) within the folder “Submitted Papers” have been read and there are some further changes in the folders “Conference Proceedings” and “Submitted Papers”. Clicking on these event icons would give more details about the event, e.g., which user(s) caused the respective events.

Figure 3 gives another example of the user interface. Here a form is shown which the user has to fill in when he or she wants to upload a document into a BSCW workspace. The user has to select the file from the local file system (`/home/appelt/SOFSEM/sofsem.tex`), may specify a different name for the document on the BSCW server (“WWW based collaboration with BSCW”), and

Fig. 3. HTML form for uploading a document

may also add some additional information to the document (“Figures will be ...”). If the Web browser is not able to determine the MIME type of the document correctly, the user may set the MIME type explicitly and specify an encoding, if applicable.

The HTML based listing of the content of folders may look a bit unusual to novice users of the system but is mainly caused by the limitations of HTTP and HTML. The majority of users is today familiar with modern desktop graphical users interfaces such as Microsoft Windows or Macintosh OS. These interfaces contain also features such as *drag-and-drop* and pop-up menus that appear when clicking, e.g., on the mouse buttons. Unfortunately, the Web browser interfaces are not really graphical but primarily text oriented interfaces because the origin of HTML is mark-up of text.

To provide a more convenient and more familiar interface to the BSCW system, we therefore developed a Java applet which provides an additional BSCW interface. A user may launch this applet from his or her BSCW start page and access the full functionality of the system starting from this interface. At present, the functionality of the applet is primarily focussed on browsing through folder hierarchies in BSCW workspaces and the traditional HTML interface is still de-

ployed for a larger number of operations (e.g., for filling the respective data into the form sheet used for uploading a document or creating a new link object), i.e., only a subset of the BSCW functionality is currently fully integrated in the Java applet.

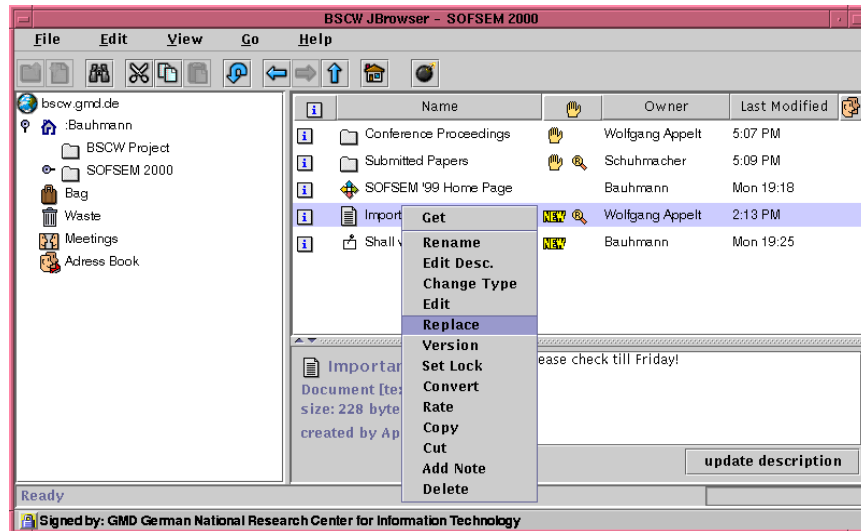


Fig. 4. Java browser interface to a BSCW shared workspace

Figure 4 gives an example of the Java based interface showing essentially the same content as Figure 2. This interface looks much less cluttered as the HTML interface because most of the action icons and buttons have been moved to pop-up menus which appear when clicking on mouse buttons. As Figure 4 shows, clicking the right mouse button when pointing to a document displays a menu with the operations applicable to documents ("Get", "Rename", ..., "Delete"). The list of operations in the menus are filtered against the access rights of the user, i.e., only those operations are shown which are allowed for the respective user.

Although primarily focussed on asynchronous modes of cooperation, BSCW provides also some features to enable synchronous communication, e.g., the *monitor applet* mentioned above which is connected to the *monitor server* (see Figure 1). BSCW server and monitor server communicate which each other: the BSCW server informs the monitor server about the events which the monitor server then distributes to the respective Java applets (see [5] for details).

The monitor applet includes the following features: When a user starts this applet, it will show other users who have also launched the applet and who are included in the user's personal address book. (It is assumed that users belonging to the same group – i.e., those who cooperate in some way – include each other

into their address books.) The applet can also indicate the activities of users visible in the applet. Furthermore, it can be used to start a chat session or send a message to other users.

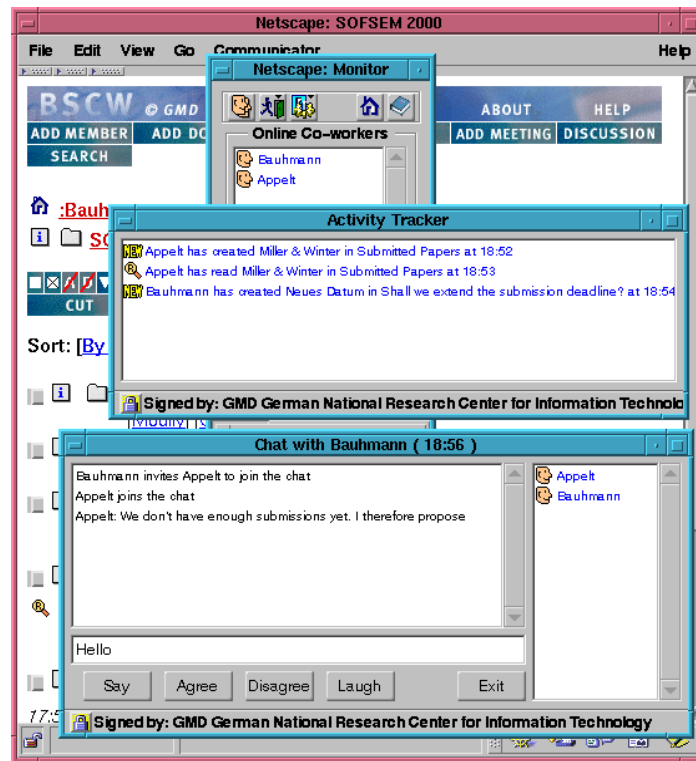


Fig. 5. Monitor Applet

Figure 5 shows an example of the monitor applet with three windows where one window shows that the users Bauhmnn and Appelt are currently working with the BSCW server. The second windows shows their activities and the third window has been launched by Bauhmnn for a chat session with Appelt.

5 Usage of the BSCW System

At a very early stage, we decided to test our ideas and developments in a real world setting: When the first version of the system was ready in October 1995, we made it publicly available on one of GMD's Web servers (<http://bscw.gmd.de/>) and invited all interested people to use the system for group cooperation. Furthermore, we also made the code of the system available for download so interested parties could install their own BSCW server. (Licences for the System

are now available from OrbiTeam Software GmbH, a spin-off company founded in 1998. Schools and universities can usually receive a royalty free license for educational purposes.)

In fact, we attracted several hundred users within a few weeks and soon received some quite considerable number of emails with respect to feedback on problems that users had with the system or improvements and extensions they wanted. Therefore, we decided that the future development of our BSCW system should be informed to a large extent by this feedback since this seemed a very promising approach to get a high acceptance from our user community. Since 1996, some additional funding for the development has been received from the European Commission's *Telematics Applications Programme* through the CoopWWW (1996/1997) and CESAR (1998/1999) projects.

Version 2.0 of the system was released in August 1996, version 3.0 in June 1997, and the most recent version 3.3 in June 1999. At present (August 1999) there are over 20,000 registered users at GMD's public BSCW server. On an average day, there are about 30,000 requests from users resulting in a data transfer of about 300 Megabyte.

The BSCW server software has been downloaded over several thousand times and we know of several hundred operating BSCW servers all over the world – many of them at universities – so we estimate that there exist several ten thousand BSCW users world wide.

A systematic evaluation of the usage of the BSCW system has not been carried out and is probably impossible considering the large number of users. We know, however, a number of different application areas where the system is used, e.g., project management in large projects with members from different organisations, conference organisation including handling of the paper review process, teleteaching applications including also some cases where teachers and students were located in different countries, and electronic support activities between large telecommunication companies with their customers. Two examples of BSCW usage in a university environment are described in [6] and [2].

6 Related Systems

When the first version of BSCW was released in 1995, it was the first fully Web based groupware system. At that time, other (commercial) groupware systems were based on private protocols and formats, requiring major software installation and maintenance. In 1996, BSCW won the European Software Innovation Award (ESIP'96) for its new approach in groupware developments.

Within the last few years, however, a number of other groupware systems have emerged which are based on Internet and Web technology. This includes systems which have been developed from scratch such as Hyperwave ([7]) or Livelink ([8]), but also systems which have replaced – more or less thoroughly – their private protocol and format by open standards such as the most recent versions of Lotus Domino ([9]).

We believe that BSCW is still one of the leading systems for collaboration support. Its strength is surely based on the large feedback from its user community which contributed much to the current status of the system.

7 Conclusions

The BSCW shared workspace system is a Web-based CSCW tool offering a wide range of features to support collaboration. In particular, the system is considered a very useful tool for cooperation in locally dispersed, cross-organisational groups using different system platforms.

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