

# Constructing a Web-based Asynchronous and Synchronous Collaboration Environment Using WebDAV and Lotus SameTime

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## ABSTRACT

In this paper we present our practice of constructing a Web-based asynchronous and synchronous collaboration environment for supporting collaborative distance learning between a German university and a university in Italy. We utilize the recent collaboration-friendly Internet protocol WebDAV to implement a groupware system which can support document-centric asynchronous collaboration activities, e.g., collaborative document authoring, collaborative document management, etc., as well as an industrial strength product Lotus SameTime to provide synchronous collaboration support, e.g., team awareness, instant messaging, shared whiteboard, and IP audio&video conferencing. Our approach has efficiently integrated our own research work on asynchronous collaboration technologies with a high-performance industrial product and as a result, constructed a full-function collaboration environment with relatively low cost and greatly reduced development time.

## Categories and Subject Descriptors

H.5.3 [Information Interfaces and Presentation]: Group and Organization Interfaces – *Asynchronous interaction, Computer-supported cooperative work, Synchronous interaction, Web-based interaction*. K.3.1 [Computers and Education]: Computer Uses in Education – *Collaborative learning, Distance learning*.

## General Terms

Design

## Keywords

Synchronous Collaboration, Asynchronous Collaboration, Web-based Distributed Authoring and Versioning, Lotus SameTime

## 1. MOTIVATION

Since the summer semester 1999, the joint CS1 course “Introduction to Java Programming” (Info1 for short)[11] has been shared between three German universities and the Free University of Bozen in Italy taking advantage of software and hardware facilities constructed in the 3-year-project “Virtual Campus Hannover- Hildesheim - Osnabrueck” [8][25]. Info1 adopts a project-based teaching/learning method, which in the context of collaborative learning emphasizes interactions where students actively participate in the learning process while solving a problem as a group. Put simply, project-based teaching/learning in Info-1 consists of two important parts:

On the one hand, the course material is no longer structured sequentially according to some commonly used Java books, rather it is introduced with a comprehensive example project which implements the game “BINGO!”. As the course proceeds, the “BINGO!” project is elaborated step by step and new Java constructs, which are required for the example, are introduced. On the other hand, the students do not work in a lecture-centric way, but are rather divided into many small groups, each of which is required to implement a project which is similar to “BINGO!” in program structure during the whole semester. Since our two partner universities temporarily changed their teaching schedule, in the winter semester 2000/2001 Info1 was mainly given at the University of Hannover, Germany and the Free University of Bozen, Italy to over 300 first year undergraduate students. We used 6-channel-ISDN video conferencing to give synchronous lectures from Hannover to Bozen, and based on the synchronous teaching, the students from Bozen and Hannover also worked collaboratively on the same projects.

In order to more efficiently support project-based collaborative distance learning in Info1, we began in the winter semester 2000/2001 to construct a Web-based collaboration environment which is able to support asynchronous collaboration through a WebDAV (Web-based Distributed Authoring and Versioning)-based groupware system and synchronous collaboration through Lotus SameTime [13]. In general, the implementation of the full-function collaboration environment is mainly motivated by two aspects:

*First, project-based learning in Info1 needs a full-function collaboration environment which can technically ensure the smooth running of Info1.*

Although the importance of collaboration among students has been recognized for a long time in the distance education area, at present most of collaboration environments are not satisfactory in practice. Usually, these collaboration environments are designed as “scattered” applications, which either completely separate the asynchronous and synchronous collaboration sessions, or take some separate collaboration tools to achieve a rigid integration of both. At the beginning of our system design, we also intended to take an easy approach using some popular, separate collaboration tools to support collaborative distance learning in Info1, e.g., email for document transferring, newsgroups for asynchronous information exchange, Microsoft NetMeeting for IP audio&video conferencing, etc. However, during our tests, such sort of a “scattered” environment proved itself to be technically problem-prone since it lacked a uniform user interface and the many separate designs also complicated the use of the system. Moreover, these separate collaboration tools have also some natural drawbacks which can damage the whole collaboration effect, e.g., email is not able to directly handle document version control when used for document transfers, the document-centric asynchronous collaboration session cannot interoperate with most of popular desktop tools, and some synchronous collaboration tools cannot achieve effective team awareness through a secure and convenient user authentication/authorization mechanism, etc.

In fact, the Info1 student community has several features which require us to pay more attention to the system design.

First, Info1 attendees are all first year undergraduate students who have usually a very different technical background. While some students are quite familiar with several popular collaboration tools, other students do not possess the same technical skills as their comrades. This feature requires us to reduce the technical complexity of the collaboration environment to the greatest degree.

Second, the Info1 student community is to a certain degree distributed. Here we refer “distributed” not only to the student groups which are constructed from the students geographically dispersed in Hannover and Bozen, but also to the local student groups in Hannover. With today’s dramatic price drop of computer and Internet connection, more and more students in Hannover would rather accomplish collaboration activities at home than in central computer pool at university. The various operating systems and various network environments applied by students outside of the central computer pool have further highlighted the drawbacks of “scattered” collaboration environments. As an example, most of synchronous collaboration tools such as NetMeeting cannot work well under Unix, or cannot achieve satisfactory quality in modem-based Internet connection. These features of the Info1 student community require us to explore more advanced and efficient collaboration approaches in order to technically ensure the smooth running of project-based learning in Info1.

*Second, project-based learning in Info1 needs a full-function collaboration environment which can efficiently improve the social contact between students.*

The social contact between students is a crucial and indispensable factor to guarantee the success of Info1 teaching/learning. At the beginning of the lecture, most of Info1 attendees do not know each other and as a result, lack necessary social contact which is

crucial to the future successful group work. As a matter of fact, some synchronous collaboration methods such as team awareness and audio&video conferencing have already proven to be efficient approaches to improve social contact within the geographically-dispersed user community. However, in previous teaching practice we have paid more attention to the asynchronous collaboration support than to the synchronous collaboration. Due to the lack of necessary synchronous collaboration support, the Info1 attendees have always complained to us that it was difficult for them to find their group members and further organize a meaningful discussion.

Actually, when communication is distributed, team awareness is an important factor which is crucial to the construction and promotion of social contact between students. Although currently some separate synchronous collaboration tools, e.g., NetMeeting, AOL IM, and ICQ utilize some general-purpose servers to realize user management and team awareness, this mechanism is not suitable for the distance education settings where the user community is relatively limited. In fact, constructing a full-function collaboration environment which can support sets of synchronous collaboration activities based on an efficient team awareness mechanism is the key to improving the social contact between students, which can consequently ensure the success of Info1 teaching/learning.

In order to provide the students with stronger collaboration support in Info1, we began to construct a full-function collaboration environment which can support both asynchronous and synchronous collaboration in the winter semester 2000/2001. First of all, we build a uniform user management mechanism for both asynchronous and synchronous collaboration sessions based on a common LDAP (Lightweight Directory Access Protocol) server. With regard to the asynchronous collaboration support, the recent collaboration-friendly Internet protocol WebDAV [7] is adopted to implement a Web-based groupware system whose design purpose is to substitute some separate asynchronous collaboration tools such as email, newsgroups, and FTP, and further achieve strong interoperability with some popular WebDAV-enabled desktop tools in asynchronous collaboration session. With regard to synchronous collaboration support, we started to adopt the industrial strength product Lotus SameTime to support most of popular synchronous collaboration activities, e.g., team awareness, instant messaging, shared whiteboard, IP audio&video conferencing, etc., whose emphasis is, besides technical considerations, to promote the social contact between students. Through a uniform user interface which is fully based on the standard Web browsers, SameTime can notably reduce the technical complexity of the system and at the same time, provide satisfactory quality in the usual IP environment taking advantage of some advanced network technologies. Our full-function collaboration environment makes full use of the latest technologies available in asynchronous and synchronous collaboration area and achieves a high-performance application with relatively low cost and greatly reduced development time.

## **2. RELATED WORK**

In general, collaboration environments can be divided into three categories: asynchronous collaboration environments, synchronous collaboration environments, and full-function collaboration environments which are defined as the combination

of the former two. In each category the collaboration environments can be further divided into academia products (including some open source products) and industry products.

## 2.1 Asynchronous Collaboration Environments

Asynchronous collaboration environments are usually constructed by groupware systems which are centered on collaborative document management and collaborative document authoring. Although email, newsgroups, and FTP are commonly used in the asynchronous collaboration area, they act only as complement to groupware systems due to some of their natural drawbacks while supporting asynchronous collaboration, e.g., the lack of functionalities of document version control, access control list management, etc.

With the prosperity of the World Wide Web since mid 1990s, Web-based groupware systems, which take HTTP (Hypertext Transfer Protocol) as basic protocol and Web browsers as standard user interface, have received increasing attention both in academia and industry. In academia, many groupware systems and general frameworks have emerged [1][21], typical of which is BSCW (Basic Support for Collaborative Work)[3] from German National Research Center for Information Technology, a successful academia product which has found hundreds of application cases until now. In industry, there are many successful products including Lotus Notes/Domino [14], OpenText (<http://www.opentext.com/>), and Documentum (<http://www.documentum.com/>), etc.

A groupware system is thought as a suitable vehicle for constructing an asynchronous collaborative workspace and further supporting collaborative work. However, the existing Web-based groupware systems are in most cases implemented based on HTTP, which is not a collaboration-friendly Internet protocol in nature [26]. As a result, most of groupware systems usually use some proprietary extensions or client-side tools in order to handle documents and thus do not possess good interoperability with some popular desktop tools. As an example, BSCW uses a proprietary user interface and implements asynchronous collaboration functionalities through CGI (Common Gateway Interface) extensions. Similarly, Lotus Notes/Domino uses some specific client-side tools, which are not commonly known by the usual users. In fact, HTTP-based groupware systems cannot efficiently reduce the technical complexity of the asynchronous collaboration environments, which is one of the greatest concerns in our system design.

In order to provide the Web with a more (asynchronous) collaboration-friendly Internet protocol, IETF (Internet Engineering Task Force) put forward a new Internet protocol WebDAV, which offers a new possibility to construct Web-based, interoperable groupware systems. WebDAV is designed as a replacement of HTTP at protocol level with the particular purpose of improving the interoperability of groupware systems. When WebDAV instead of HTTP is taken as the basic protocol of Web-based groupware systems, we need no longer use some proprietary extensions or client-side tools in order to accomplish asynchronous collaborative activities. Through some popular WebDAV-enabled desktop tools, e.g., Internet Explorer 5.0 (Web folders), Microsoft FrontPage 2000, Office 2000 (PowerPoint, Word, and Excel), Adobe GoLive 5.0, PhotoShop 6.0, Acrobat 5.0, MacroMedia Dreamweaver 4.0, etc., all document-centric

asynchronous collaboration activities can be “in-place” (directly on the remote server) accomplished without the need of any download and upload process. Therefore, WebDAV-based groupware systems provide a satisfactory approach for reducing the technical complexity of asynchronous collaboration environments.

Over the last three years many WebDAV-based groupware systems have emerged both in academia and industry [5][9][18]. Some industry products such as Documentum and Novell GroupWise [15] have also shown great advantages in the e-business area. However, when asynchronous collaboration in education is concerned, we usually do not need to directly apply such sort of powerful industry products. In fact, using some open-source products such as Apache mod\_dav [19][22] or IBM WebSphere DAV4J [10][17], we can easily implement a WebDAV-based groupware system with sufficient “tailored” functionalities necessitated by asynchronous collaborative document management and collaborative document authoring.

## 2.2 Synchronous Collaboration Environments

As we've mentioned, the commonly used synchronous collaboration environments in practice are those “scattered” environments constructed using some popular synchronous collaboration tools, e.g., NetMeeting, AOL IM, MSN Messenger, IRC, and ICQ, etc. The great drawback of these “scattered” environments is their lack of a uniform user management mechanism, which makes it difficult for users to identify other users so as to construct a meaningful synchronous collaboration session.

Actually, there are also some “all-in-one” synchronous collaboration environments which are designed based on a uniform user management mechanism. In academia some general frameworks and products include the Mbone paradigm [6], MetaWeb [24], Tango [2], and mStar [16], etc. The common drawback of these products is their lack of a uniform interface for sets of synchronous collaboration services. Taking the Mbone framework as an example, the suite includes VIC for video; VAT, RAT, and FPhone for audio; WB for whiteboard; and NTE for organized text communication. Basically, these products still belong to the category of “scattered” collaboration environments in spite of their effort to unify sets of synchronous collaboration services. Recently some general frameworks for synchronous collaboration environment design such as mStar have begun to take uniform design of synchronous collaboration services into account. However, until now most of implementations are still in the prototype phase.

In industry some “all-in-one” synchronous collaboration environments, e.g., Lotus SameTime, Microsoft Exchange Conference Server, etc., have gone much further in comparison with their academia counterparts. These industry products have adopted some advanced synchronous collaboration technologies and are able to provide satisfactory quality in the usual IP environment. Taking SameTime as an example, it provides an efficient team awareness support for all synchronous collaboration activities based on a central server, including also high-level LDAP support. A real-time “presence list” of team members enables users to easily find their partners, who either “sit” in the same “meeting room”, or “sit” in the same “chat room”, or are viewing the same document at the same time with them.

Moreover, since SameTime is designed based on sets of synchronous collaboration standards such as H.323 specification for audio&video conferencing, most of popular collaborations tools, e.g. NetMeeting, AOL IM can be directly used to participate in synchronous collaboration sessions on the SameTime server if the users wish to. In fact, together with some interoperable groupware systems, SameTime can further improve the interoperability of the full-function collaboration environment on the whole.

### 2.3 Full-function Collaboration Environments

A full-function collaboration environment is defined here as the combination of both asynchronous and synchronous collaboration environments. Because the full-function collaboration environments involve some sophisticated asynchronous and synchronous collaboration technologies, at present we do not think we could find some solutions which have achieved seamless integration of both asynchronous and synchronous collaboration in the real sense. In academia there is some exploratory work on the general framework design of full-function collaboration environment such as MetaWeb plus BSCW [24] and InterPOD plus TeamSmart [23], while in industry some products such as SameTime have also provided such sort of integration to a certain degree. However, due to the technical complexity in the full-function collaboration environment design, most of academia products currently are still in the prototype phase. Also most industry products can only provide limited integration, e.g., SameTime's asynchronous collaboration session can be only satisfactorily integrated with synchronous sessions in Lotus Notes/Domino environment.

Currently a notable trend in the full-function collaboration environment design is that instead of the effort of seamlessly combining asynchronous and synchronous collaboration sessions, many researchers switch to finding approaches for integrating asynchronous and synchronous environments to the greatest possible degree. Some systems such as NCSA Habanero [4], VNC [12], and GroupKit [20] have taken asynchronous collaboration, usually document-centric groupware systems, as the kernel of the full-function collaboration environments, and have tried to find the best way to integrate the synchronous session with asynchronous sessions. The key to the realization of this design idea is the availability of high-performance asynchronous and synchronous collaboration products which are designed based on sets of standards and more importantly, open architecture. With the development of technology and the continuous emergence of new standards, we can find new approaches and possibilities to improve the efficiency and quality of full-function collaboration environments.

## 3. GENERAL DESIGN

In figure 1 we illustrate the infrastructure of our full-function collaboration environment.

In our full-function collaboration environment, the document-centric asynchronous collaboration activities, e.g., collaborative document authoring, collaborative document management, etc., are handled by a WebDAV-based groupware system. All synchronous collaboration activities, e.g., team awareness, instant messaging, shared whiteboard, IP audio&video conferencing, etc., are managed by SameTime. The common asynchronous

collaboration tools that can be used by students in asynchronous collaboration sessions are WebDAV-enabled document management and authoring tools including Microsoft FrontPage 2000, Office 2000, Internet Explorer 5.0 (Web Folder); Adobe GoLive 5.0, PhotoShop 6.0, Acrobat 5.0; MacroMedia Dreamweaver 4.0, Altova XML Spy 3.5, etc. On the other hand, all synchronous collaboration activities can be started or accomplished through a uniform user interface provided by SameTime. SameTime also provides a bit of asynchronous collaboration support mainly through its Discussion and TeamRoom databases. Under our Web-only installation of SameTime, such sort of asynchronous collaboration support is only taken as the complement to the WebDAV-based groupware system. As an important feature of the system, both asynchronous and synchronous collaboration sessions share a uniform user management mechanism which is implemented based on a LDAP server that is able to efficiently manage users and user groups on the basis of secure authentication/authorization. The whole collaboration environment possesses a full Web interface and all asynchronous and synchronous collaboration sessions can be either started or accomplished through standard Web browsers.

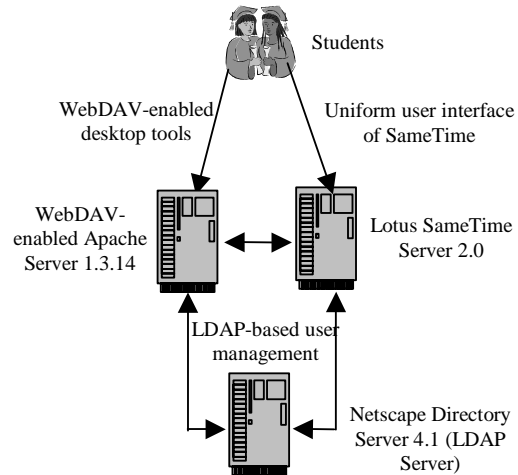


Figure 1. Infrastructure of the full-function collaboration environment

### 3.1 Asynchronous Collaboration Based on WebDAV

WebDAV is worked out by IETF WebDAV working group and was partly finalized in the form of IETF RFC (Request for Comments) in February 1999. WebDAV extends HTTP/1.1 and provides a coherent set of new methods, headers, eXtensible Markup Language (XML)-based request and response entity body formats to directly support collaborative work on the Web.

In general, WebDAV provides following four basic capabilities [7]:

*Properties:* The ability to create, remove, and query meta-information about documents, e.g., authors of a document, user comments on a document, etc.

*Collections:* The ability to create sets of related documents and to retrieve a hierarchical listing of their members.

*Locking:* The ability to control access to resources to avoid “lost updates” in a distributed, multi-user-authoring environment. Instead of strictly exclusive locking mechanism that locks the entire document for each user, WebDAV allows the shared locking of a document.

*Namespace Manipulation:* The ability to copy, move, or delete Web resources and collections of resources.

In addition, WebDAV has also several other functionalities which are now still under exploration by IETF. These functionalities include [26]:

*Advanced Collections:* The ability to extend the basic WebDAV collections to cater for advanced features.

*Versioning and Configuration Management:* The ability to support operations such as check-out, check-in, and retrieval of the history list.

*DAV Searching and Locating (DASL):* The ability to efficiently search for resources based upon a set of client supplied criteria.

*Access Control:* The ability to set and clear ACLs (Access Control Lists). This functionality is crucial for allowing cooperators to remotely add and remove people from the list of cooperators on a single resource.

Compared with some HTTP-based groupware systems, our WebDAV-based groupware system implemented for supporting Info1 teaching/learning has several notable features:

*First, support for easy deployment.* Since Info1 attendees have generally various machines, various operating systems, various network environments, and various Web browsers while accessing the collaboration environment, the client-side deployment implies in most cases a complex, cumbersome, and problem-prone process. As a protocol-level specification, WebDAV enables students to “in-place” manipulate document repositories through standard Web browsers without the need of any kind of client-side installation. This feature makes great sense when the groupware systems are applied in a distributed user environment such as in Info1.

*Second, support for collaborative document management and collaborative document authoring.* As we will discuss in section 4, the asynchronous collaboration in Info1 is mainly document-centric. Most documents of student groups need to be generated, presented, updated, accessed, shared, and exchanged directly on the Web. WebDAV defines a set of methods to support “in-place” document repository management, document editing, document locking, and document version control. These methods provide all necessary functionalities for collaborative document management and collaborative document authoring. In particular, they make the Web page authoring and maintenance very easy.

*Third, support for asynchronous information exchange.* Information exchange is one of the greatest concerns of our collaboration environment. Besides synchronous information exchange supported by SameTime, WebDAV provides support for another important type of information exchange: asynchronous information exchange primarily taking advantage of its capability of manipulating properties (meta-data) of documents. In a typical asynchronous information exchange scenario, the students can add description information to their own documents, or make

some comments on other students’ documents by setting properties. Likewise, the mentors and faculty can advise the group by setting collection’s properties. Because WebDAV’s property definition is completely based on XML, it provides students with a quite flexible way to accomplish asynchronous information exchange. The flexible use of asynchronous and synchronous information exchange in the collaboration environment can greatly improve the collaboration effect.

Apart from the features listed above, the most notable advantage of WebDAV-based groupware systems is their strong interoperability. Although most of WebDAV’s functionalities can also be implemented in a HTTP-based groupware system utilizing some proprietary methods such as CGI, these methods cannot be recognized by other client-side or server-side applications since they all belong to the proprietary extensions to HTTP. In contrast, WebDAV’s extension to HTTP is a pure standard in the real sense. With the increasing acceptance of WebDAV, WebDAV-based groupware systems can achieve strong interoperability with popular WebDAV-enabled desktop tools. These tools, which are commonly used by students, can greatly simplify the document-centric asynchronous collaboration process.

### **3.2 Synchronous Collaboration Based on Lotus SameTime**

Lotus SameTime is a real-time collaboration product that offers a complete range of integrated, real-time services while meeting synchronous collaboration needs among geographically dispersed users. The synchronous collaboration services provided by SameTime can fall into two categories:

*Conferencing services:* These services include a shared whiteboard, IP audio&video conferencing, and the ability to share programs and documents online. SameTime also offers a server-based Meeting Center where users can schedule online meetings in advance and store agendas and other meeting materials.

*Secure instant messaging services:* These services include team awareness, instant messaging, and chat. A “presence list” makes users aware of who is available (and who is online but unavailable) to receive an instant message or participate in a chat with one or more people.

Generally, we introduce SameTime to realize synchronous collaboration support in Info1 mainly because of four aspects.

*First, SameTime provides a central server-based solution which can facilitate user management and collaboration session management.*

On the one hand, SameTime supports LDAP-based user management which can share a common LDAP server with our WebDAV-based groupware system. Taking advantage of efficient authentication/authorization mechanism provided by a LDAP server, the collaboration environment can overcome some common drawbacks of user management in those “scattered” collaboration environments.

On the other hand, a central server-based solution can facilitate collaboration session management, which is usually difficult to achieve using some separate collaboration tools. As an example, in contrast to NetMeeting’s point-to-point meeting style, all meetings in SameTime are hosted on the central server so that we

can provide more reliable services and more efficiently manage these services. After a collaboration session is completed, all resources used by the session can be managed and handled on the central server for further use in other asynchronous and synchronous collaboration sessions. This crucial feature of full-function collaboration environment is usually lacking in some “scattered” collaboration environments.

*Second, SameTime uses a uniform interface to support all collaboration activities, which has to a great degree reduced the system complexity.*

Using SameTime, users need no longer utilize various separate collaboration tools as in a “scattered” collaboration environment. This feature makes more sense when the collaboration environment is applied among the users who have generally different technical background.

*Third, in comparison with some academia prototype products, SameTime provides a robust architecture which enables us to easily integrate our own research work on asynchronous collaboration into the system.*

As we will demonstrate in section 4, SameTime provides a simple way to integrate groupware systems with synchronous collaboration session and further achieve satisfactory collaboration effects through the mutual interaction between the both. Moreover, since SameTime is designed based on sets of synchronous collaboration standards, it can also achieve strong interoperability with most of popular synchronous collaboration tools such as H.323-based NetMeeting and AOL IM. In addition, the proxy support provided by SameTime also enables students to go through firewalls and access the collaboration environment from various network environments.

*Finally, SameTime offers a relatively low-cost solution to realize very good synchronous collaboration support.*

As Info1 will be further given in the following semesters, the one-time investment on SameTime (about 25,000DM for 400 users) is worthwhile. Because IP-based solutions need relatively low cost, especially concerning labor costs, the collaboration environment can be frequently used by students during Info1 teaching/learning process.

## **4. WORKING SCENARIO**

In this section we will demonstrate a simplified working scenario in our collaboration environment based on the work of a student group: “Next Generation”. The working scenario is also concerned with two special groups in Info1: faculty group and mentor group.

Besides project work, the central task of each student group is to build and maintain a “group homepage” on the Web. They need to demonstrate their project design, program structure, and the result of the project directly on their homepage. Faculty and mentors will guide the students in this process, and will also check the progress of group work through their homepages. Additionally, student groups have to hand in weekly reports to further describe their working progress, which serves also as an important construct for the final assessment at the end of the semester.

In fact, all asynchronous and synchronous collaboration activities in Info1 are centered upon above assignments of student groups. As an example, asynchronous collaboration is greatly necessitated by collaborative manipulation of a document repository of Web pages, as well as by collaborative authoring of the weekly report. During the asynchronous collaboration process, synchronous collaboration is also needed by students in order to find partners, discuss the project design, or remotely demonstrate the execution result of their programs. All these collaboration activities may occur in a distributed user environment at any time and in any place.

### **4.1 Asynchronous Collaboration Scenario**

The asynchronous collaboration in Info1 is centered on collaborative document management and collaborative document authoring. The documents involved in the student group work can be divided into two parts. The first part are the documents used to build the group homepage, including project design documents, Java source code, weekly report, etc. The second part are documents needed in synchronous collaboration sessions, e.g., a PowerPoint document which is utilized for presentation in a group meeting or TeamRoom. In most cases the second part of documents is derived from the first part and the only difference is that they are utilized in a synchronous collaboration session. In fact, the first part of documents is the main body of asynchronous collaboration and thus is directly managed in the WebDAV-based groupware system. The second part of documents can be also managed in the groupware system, but must be transferred to the SameTime server when used in a synchronous collaboration session.

Taking “Next Generation” group as an example, when Bozen students wish to edit some documents, they can choose one WebDAV-enabled tool, e.g., IE 5.0 Web Folder, and log into the WebDAV-based document server based on the user management mechanism provided by LDAP server. They are then presented with the directory structure of the document repository. Now the students can view and edit Web pages, manipulate document repository’s namespace, view the changing history of a specific document (e.g., Java source code, weekly report, etc.), or add some comments on some specific documents utilizing property manipulation. During this process, WebDAV’s locking mechanism ensures that only one student at a time is able to edit a particular file, which can prevent “overwriting” each other’s work. Moreover, all these WebDAV-based manipulation can be accomplished “in-place” without the need of any download and upload process.

When some documents are needed in synchronous collaboration session, they must be transferred from the WebDAV-enabled document server to the SameTime server. This process can be automatically accomplished by the SameTime server when the corresponding synchronous collaboration begins. However, if these documents have been changed during the synchronous session, they must be transferred back to the document server by hand in order to keep document version consistence. This process can be achieved using some WebDAV-enabled document management tools, e.g., IE 5.0 Web folder, DAV Explorer, or Network Place in Windows 2000. To date there are also some WebDAV-enabled tools which can remotely map a WebDAV-

based document repository directly to a windows disk. Such sort of tools can further facilitate the document transferring process.

## 4.2 Synchronous Collaboration Scenario

The most important synchronous collaboration support in our collaboration environment is team awareness. Figure 2 shows the group “presence list” of “Next Generation”.

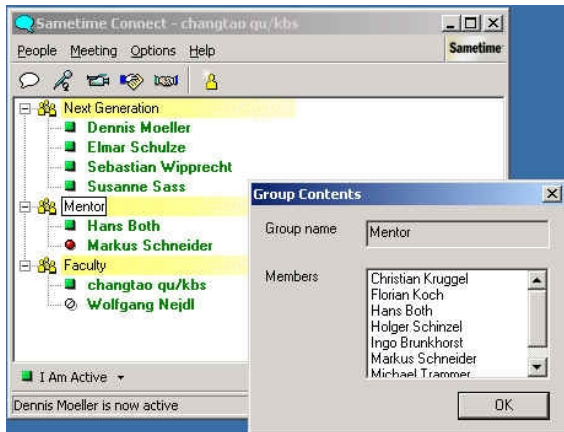


Figure 2. Group presence list

After logging on the SameTime server, the students can immediately find out whether their own group members, friends in other groups, mentors, or faculties are online or not. In most cases the students can get immediate help from mentors and faculty. When occasionally the students' own group members are not online at the time, they can also try to find friends in other groups, or simply participate in the discussion of other groups which work on the same project (averagely 10 groups work on the same project in Info1). In addition, the SameTime Meeting Center lists also scheduled or ongoing meeting organized by mentors, faculty, or other groups.

The “presence list” serves also as a uniform user interface which can be taken as the starting point for all immediate or “instant” collaboration services. These services include:

**Chat:** Text-based chat and instant messaging can consist of two (or more) students exchanging instant messages. Additional community members can be invited into instant messaging sessions to form group chat conferences.

**Meetings:** Meetings are either “instant” or “scheduled.” An instant meeting is a meeting that is started immediately from a presence list. A scheduled meeting is a meeting that is scheduled to start at a particular time and date. Scheduled meetings are created in advance in the SameTime Meeting Center. Students access the Meeting Center with a Web browser at the scheduled meeting time to attend the meeting.

**Screen sharing:** Screen sharing enables multiple users to work within a single application on one user's computer. Students in remote locations can collaborate within a single application to produce a document, spreadsheet, blueprint, or any other file generated from a Windows-based application. In a meeting that includes screen sharing, one student uses the screen-sharing tool in the SameTime Meeting Room client to share a screen or application on the local computer with other meeting participants

in remote locations. The other meeting participants also use the screen-sharing tools on their local computers to view and make changes to the shared screen or application.

**Shared whiteboard:** The shared whiteboard supports interactive presentations which closely resemble a slide show. In a whiteboard presentation, one participant presents images in the white-board tool of the SameTime Meeting Room client on the participant's local computer. Remote meeting participants can also view the images and annotate the images using the whiteboard tools running on their local computers.

**IP audio&video:** IP audio&video enables multiple users to transmit and receive audio&video over an IP network in a SameTime meeting. It is either “interactive” or “broadcast”. The “interactive” IP audio&video enables all participants in a meeting to both transmit and receive IP audio&video packets on the network. In an interactive IP audio&video meeting, one user transmits a stream of audio&video packets to the server and the server disseminates this stream to all other meeting participants. The “broadcast” IP audio&video enables a large group of users (or audience members) to receive the audio&video from a meeting but not transmit audio&video to other users in a meeting. As we've mentioned, all H.323-compliant clients such as NetMeeting can be directly used in IP audio/video meetings.

In figure 3 we illustrate a screen shot which demonstrates part of synchronous collaboration services provided by SameTime.

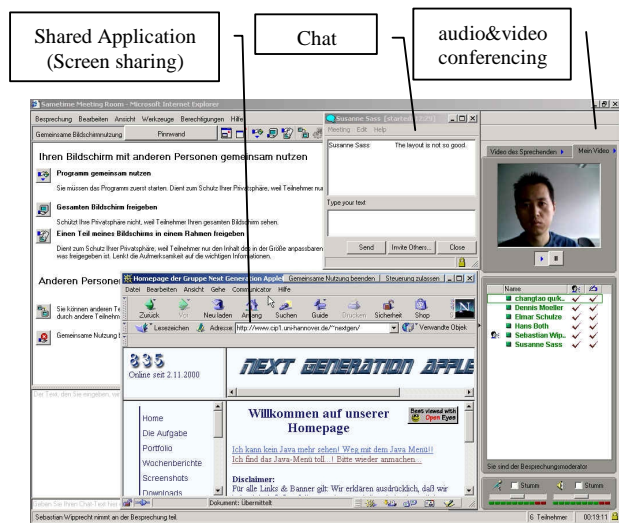


Figure 3. Screen shot of part of synchronous collaboration services

## 5. CONCLUSION

In this paper we presented our efforts of efficiently integrating industrial strength product with our own research work to construct a full-function collaboration environment which is applicable to distance education due to its relatively low cost and satisfactory quality in the usual IP environment. We put special emphasis on the synchronous collaboration and chose SameTime to offer a sound infrastructure upon which a robust application can be easily built. The collaboration environment greatly reduces the requirements on users' technical background taking advantage of the use of some popular desktop tools in asynchronous

collaboration and a uniform user interface in synchronous collaboration. It provides an applicable approach to the implementation of asynchronous and synchronous collaboration support in the distance education area.

## 6. REFERENCES

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