Where Are You? Wireless WAY's to Enhance Collaboration.

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Abstract—Location independent learning is a feature of emerging wireless and pervasive networking environments currently appearing in educational institutions in the Nordic countries. At the same time as mobility is increasing, online forms of communication are enhancing our ability to construct new types of learning spaces. In these new learning networks local and remote learners combine via a combination of virtual and face to face interactions. As learners become more mobile locating other learners becomes an interesting issue, with concommittant implications for collaborative behaviour.

This paper describes a prototype position aware ICQ like collaboration tool, "Where Are You" (WAY). WAY provides users, who have a wireless device that complies with the IEEE802.11b (Wi-Fi) standard with the ability to locate themselves and their workmates in buildings that have a wireless LAN infrastructure and a WAY server. The intent is to assist people working in large campus buildings to locate one another and services that are in their local environment.

INTRODUCTION

Enabling collaboration and supporting and enhancing collaborative learning behaviour is one of the key areas identified by much recent work into new teaching approaches in computer science. One aspect of enhancing collaboration is assisting people in contacting one another and locating one another in order to collaborate.

Work on virtual collaboration and teamwork often focuses on issues of team dynamics, team formation, and team roles (here some research also focuses on gender issues). These concerns are well covered by others and, while important, are not the main concern of this paper.

In the work described here we target a different aspect of the problem. How can we use the technological infrastructure that is being introduced into educational institutions world wide to enable students to meet and collaborate more effectively? We examine location awareness from two perspectives, helping people to orient themselves and locate others, and assisting users to locate services and facilities in their environment, and gain access to those facilities.

Ultimately such an approach extends the physical environment into a virtual dimension, allowing users to interact

with aspects of the building that are not physically present, such as room booking systems, and geographically sensitive information sources and resources. Security and privacy are an important aspect of such systems, and our approach is presented later in the paper.

The remainder of the paper is structured as follows. In the next section we discuss the motivations for this work, and identify some related theoretical and practical work in this area of CS education research. The WAY system prototype is then presented and its user interface and functionality described. The implications and uses of the system in teaching and learning situations at University level are then discussed. We conclude with some observations about the possible uses of the system and outline future work on the development of WAY and its use to investigate collaborative behaviour and wireless network usage patterns.

BACKGROUND

Collaborative learning practices [1] have been the focus of considerable research in recent years [2]. A number of benefits of a collaborative learning model have been identified, including reducing teachers' workload, exploiting expertise in the student cohort and creating an effective basis for distance teaching. Teaching approaches range from types of online discussion, to fully fledged virtual learning environments [3].

The motivation to explore collaborative learning approaches is also due to increased pressure on teachers to be more effective in their teaching, teach greater numbers of students, and create new types of learning approaches that are tailored for the distance and Internet (online) learning paradigm.

In the context of team based collaborative learning models team composition is also a key area. Here research concentrates on how to create effective teams. In this context a number of authors have made comparative studies between learning and achievement outcomes and team formation strategies [4], [5]. Popular team composition techniques include the use of Belbin's team roles [6], and Briggs-Myer [7] testing to determine personality and role types of the student cohort before allocating people to teams. The idea is to constitute teams that will operate effectively in the learning situation, and where the potential for constructive collaboration will be maximized.

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The benefits of higher levels of collaboration and the positive impact on learning styles of enhanced use of group learning are a key aspect of many recent publications [8], [9].

Two factors related to the local environment at Uppsala University, Sweden, have motivated the development of WAY.

The first of these is the spontaneous group learning behaviour that students engage in during their years in the Masters program in information technology. We have observed over the last three or four years the emergence of a group study culture, where students arrange to meet spontaneously in unused lecture rooms in groups of three to six. There they study together, and work collaboratively to solve course related problems using the blackboards provided there. When setting up such meetings we have observed that they often contact one another by mobile phone to determine if their collaborators are on the campus, and if so, where they are in the building. How can we support this type of learning behaviour using wireless technology? WAY is one attempt.

The second motivating factor was a pilot study where we attempted to investigate the use of the wireless network by students in the IT programme. One of the outcomes of that study [10] was the realisation that we needed a non-intrusive method to observe how people moved about in the buildings and used the wireless infrastructure. The ability to observe in a non-intrusive manner was considered a key element in gaining more insight into the impromptu use of the wireless network facilities provided by the campus.

AN OVERVIEW OF WAY

The design of WAY draws inspiration from a range of related presence notification and interaction tools, notably 'I Seek You' or ICQ* as it is more popularly known.

Another popular online chat form is Internet Relay Chat (IRC), where people log onto a central relay server and create 'chat rooms', which other users can 'enter' and participate in group conversation. IRC is also a useful tool for collaborative work in virtual work teams, and has been used extensively in the Runestone project [11], a software development project course that is jointly run by Uppsala University (Uppsala, Sweden) and Grand Valley State University (MI, USA).

Given the popularity of ICQ, and online chat interfaces based on a similar 'look and feel' we decided that this was a natural starting point for the WAY graphical user interface. Consequently, the main WAY interface (see figure 1) provides an ICQ-like interface in which the individuals and work groups created by the user are shown.

Each user is represented by a name and an associated activity symbol. Activity symbols are based on the ICQ



FIGURE 1. ICQ STYLE MAIN GUI

symbolic conventions used in software such as mIRC for Windows and kvirc for Linux. Each entry associates a user with a status symbol that indicates if the member of the contact list is **online**, **unavailable** (i.e. in a **meeting**, or not to be disturbed **DND**), or **offline**.

Levels of presence notification vary between chat tools. IRC is synchronous communication with no presence notification. That is, IRC users connect to a server and join a conversation room, thus indicating that they exist in the virtual environment. A user of ICQ has a more powerful presence notification service. ICQ detects the activation of the other ICQ clients that are known to a given user. Remote users set a status that reflects their chosen level of availability and this causes an update in all the other clients to which they are known. WAY reacts to the activation of other clients in the

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^{*}ICQ, 'I Seek You', provides users with real-time feedback about the status of their 'contacts' and facilitates communication in a range of ways including file sharing, web based SMS to mobile devices, and synchronous chat between two users.

same way as ICQ, however, in WAY we have an additional level of presence information, namely physical location.

To request the current location of a person in a working group one clicks on the user in the presence interface shown in figure 1. If the requested user is online, and permits themselves to be located, their current location will be presented in the pop-up map window as shown in figure 2. User location information is updated every couple of minutes, and users who are moving within the building will change position dynamically in the interface window as their position changes, providing up to date location data.

Users can also choose to see all the users who are currently online. The identity of users may be concealed, or their presence disguised entirely, depending on the level of visibility each user has specified in their preferences. Presence information is presented floor by floor, since implementing a three dimensional map view of the building was too time consuming to be practical for a prototype.

Adding a user to a group or discovering a new user to add to a general list of contacts is accomplished using the search interface shown in figure 3. The interface permits searches based on partial information, such as first name, family name or partial email address. The system returns a complete record for any matching users that can be found in the user registration database. Once a user has been identified they can be added to a work group using the drop-down menu at the bottom of the window.

Visibility permissions for each group and/or user can be specified using the window shown in figure 4. There are three types of visibility category defined by WAY.

- Default: defines the visibility granted by the user to all other users of the system. Typically this will be quite restrictive, for example a lecturer might allow general users to locate him only during office consulting time once a week.
- Groups: defines the visibility to be granted to the members of that group. This would often be more generous, for instance lecturers might allow their colleagues to locate them between 9am and 5pm most days of the week.
- Users: defines the visibility to be granted to an individual user of the system. This provides the ability to further customise privacy by restricting visibility for individuals, even though the groups to which they might belong might have more or less restrictive privileges.

Individuals or groups can be selected using the drop-down menu at the top of the window. Once a selection is made time intervals when visibility is not desired can be created using the time settings fields and 'add' and 'delete' buttons on on the right hand side. The current time intervals associated with a selected group or individual are displayed in the white area at the bottom right of the window.

USING WAY IN UNIVERSITIES

WAY opens up several opportunities for CS education researchers. Providing a new approach to facilitating collaboration and service discovery in large campus buildings is a worthwhile goal. How well does WAY serve that goal?

To answer that question WAY has been designed to provide anonymous user mobility data. Among other things, the location and time data collected by WAY can be used to gain insight into students use the network. If WAY fulfills its function the data logs should show clusters of users, and peaks of usage when students are arriving at the University in the morning, or perhaps trying to meet up after lunch. It will take time to build a reliable picture of average usage, so results are not realistically expected in 2003.

Proposed studies during 2003 included student evaluations of the advantages of such as tool, and usability studies that can be conducted via a small group trial in late 2003 using computer networking students. The trial was made in a group project course for a group of 6 computer science students. The students were asked to use the tool during a project course of 10 weeks duration, and then answer a questionnaire.

Using the data collected from the questionnaires we hope to be able to draw some initial conclusions in two areas: usability and interface design, and benefits of WAY as a collaboration facilitator. This will be used to further develop WAY as a collaboration support tool. It already seems likely that WAY will be integrated into a more extensive virtual representation of the environment as specialised virtual learning spaces start to be deployed at Uppsala.

Observing and trying to understand how students use wireless resources in their study processes is another area where it appears that WAY can be of value. The log files from WAY provide detailed location and mobility information for the users connected to the system. It has been possible to collect similar information using base station connection logs in wireless networks, however, this does not provide the fine grain location information that is available from WAY. Using base station connection data one can only determine to which base station a unit is currently connected. Depending on the density of the base stations this might allow users to be grouped into three regions on a typical office floor.

The technique used by WAY allows users to be positioned within a room to an accuracy of approximately plus or minus two meters. For the purposes of determining if groups of people are working together the type of accuracy provided by WAY is advantageous. WAY potentially allows us to identify several independent working groups clustered around tables in a single room, a level of accuracy that cannot be achieved using the base station method.

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FIGURE 2. A SNAPSHOT OF THE WAY POSITION SCREEN

WAY provides administrator functions that allow usage to be plotted over periods from a single day to several months. Animation of the motion of the mobile units over a day or week is also possible. Analysis of these logs can provide insight into how, when and where students are using the wireless network. It is hoped that this will allow us to pose interesting questions about student study patterns, and discover if some of our suppositions about the use of lecture and study rooms are supported by actual use patterns.

In the current study we are interested in determining if wireless network access encourages students with laptops and wireless access to congregate flexibly. Normally the constraints imposed by the location of the plugs giving access to the fixed network in the building limit the locations that students find useful for joint study. This is increasingly true as students use the Internet more and more as a research tool, and rely on Internet access to locate documents and code examples for their studies.

Another powerful advantage of deploying and using WAY is that one can observe student clustering in time and space within the buildings covered by the wireless infrastructure. This allows us to study what facilities and spaces are used and when they are used. This data can be used to draw some preliminary conclusions guiding the design of adaptable, multi-purpose, learning spaces.

A potential beneficial by-product of increased network availability is that students can use empty teaching rooms for collaboration and programming, instead of going to dedicated lab rooms. This would have the effect of increasing the utilization of lecturing locations and reducing the demand on laboratory spaces. Having a better picture of how spaces are used can help planners to create more cost effective teaching and learning facilities.

User security and privacy has been built into WAY. This means that users have absolute control over their level of visibility to other users on a per user basis. While individual users do not have access to location information, such information is logged by the system, and available to system administrators. It is important to protect user privacy, and avoid a 'Big Brother' image when developing tools like WAY, however it is also the case that abuse of the system must be detectable by administrators. The solution adopted allows users to determine the level of privacy they wish to implement in relation to other users, while allowing the system administrator to oversee all users as a trusted agent. This is a model common to many computer applications, and we believe

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FIGURE 3. LOCATING AND ADDING A WAY USER USING THE "USER SEARCH" INTERFACE.

that this approach is an appropriate compromise between user privacy and responsibility.

CONCLUSIONS AND FUTURE WORK

This paper describes the features of a software tool (WAY) that enables users to locate themselves and each other within large buildings equipped with a wireless LAN network.

Two major uses are envisaged for WAY. The major use is as a presence notification and location tool which can be used to enhance and support collaborative work practices. It is this feature that we have concentrated on in this paper, and will investigate further. Another use is to locate local resources using the current user location in conjunction with system knowledge about the resources in the building, e.g. printers and future virtual learning spaces.

Investigations into collaborative work practices using WAY are based on several approaches. Active evaluation of

the value and usability of the tool based on direct student feedback is the first step. Further work is planned during 2004 during which we intend to gather more comprehensive usability data using questionnaires.

Characterisation of the longitudinal data collected using WAY can also be used to gain insights into how students congregate and work, both in the short and long term. Investigations based on long term non-intrusive observation of students are planned for 2004.

Using such data we hope to characterise how students and staff use wireless networks and collaboration tools in their day to day activities. In addition such studies are expected to yield insights that can inform the design and layout of teaching spaces in the future, and answer questions about whether wireless networks really allow campus locations to become more multi-purpose and collaboration friendly.

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Privacy settings	Time settings Period when he/she/they can see my position
Save	From 0 Hour 0 Minute To 23 Hour 59 Minute Add Delete
Done	

FIGURE 4. SPECIFYING VISIBILITY SETTINGS IN WAY

Future developments in WAY include integration with a calendar and planing tool, to enhance support for group work. Integrating WAY into a virtual representation of the campus buildings to allow interactions to occur on both a virtual and physical plane is also something that we are considering.

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