Introduction

Several types of applications currently advertise their new “community support” features. Using this label Web platforms and electronic commerce systems are equipped with annotation functionality and various communication features.

In general, community support includes all methods for supporting communication and coordination in a group of people. It includes support for direct communication, support for indirect information exchange and support for matchmaking. Community support is closely related to the application areas of knowledge management, customer relationship management and change management since these also deal mainly with support for communication in a loosely coupled group of people.

Using networked computers for supporting communities can be tracked back into the beginnings of the Internet. But only in the recent years integrated (Web-based) community platforms have found broad attention in research and development.

Such platforms are already in use in several different application areas. In the university domain communities like the students attending one course, the staff and the students belonging to one department or the alumni of a school can be found. The single communities can profit from the extended communication medium a community platform provides or can become a community with the help of such a platform (for example the alumni of a department that does not provide a special alumni program or alumni reunions – as it is the case for most European universities).

Like in most large companies at universities different groups have built a variety of isolated, heterogeneous community platforms and information portals. One important request recently has been to link these isolated applications.

In this context two aspects of interoperability can be identified:
1) The exchange of information among the community support systems, and
2) the common usage of user profiles by several community support systems (identity management).

After a short introduction to the topics of community and community support we discuss the possible usage areas of community platforms in universities. Then we present some systems at use and under development at Technische Universität München (TUM), and identify some challenges to the implementation of community support systems at universities in general. Since one core requirement to the heterogeneous sets of community platforms in university environments is interoperability we then address this issue in more detail. The solution developed at TUM is presented and motivated to be usable also in other application domains.

Abstract

Community support systems (community platforms) that are providing a rich communication medium for work- or interest groups are gaining more and more attention in application areas ranging from leisure support and customer support to knowledge management. One of these application areas is the support of teaching and research activities in universities. In this article we first identify possibilities for community platforms in universities and present some applications at Technische Universität München (TUM). From the current situation at TUM we motivate that a key feature of future community platforms has to be interoperability, and concentrate on how to provide interoperability in general, and how we are doing it in the environment at TUM. In particular we focus on service independent identity management as one central aspect of interoperability.

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Communities and Community Support

Communities

In general a community is a group of people who share some interest, identify with a common idea or more generally belong to a common context. Thus, a community can be seen as a descriptive identity for a set of people.

Early sociological work points out that communities always need a locality and interaction (Hillery 1955). While the demand for a common physical locality is no longer seen necessary, the demand for interaction is still valid. However, no active interaction among all community members is required but rather the possibility of interacting with the rest of the community (the existence of a communication medium). In more practical terms this possibility of interaction implies the existence of a common communication channel, of common protocols and awareness of the existence and of the membership in the community.

Another characterization is that communities are based on the will to exchange knowledge. Ishida (1998) summarizes this in the following quote: “In a community, people want to know what the others know.” This issue can be extended to the request for collaboration in a community. A community is not just a set of people who have something in common and who have the possibility to communicate, but of people who are willing to help each other, who are collaborating to the advantage of all.

To summarize so far, a community is characterized by:
- a boundary (common interest, common idea, common context),
- a sense of membership,
- ongoing interaction, and collaboration, mutual support.

In addition to the collaboration itself the main activities in communities are communication and finding people to communicate with. Hence, community support can be seen as “communication and matchmaking support”. Community support systems have to provide a “medium” that can be used for the interaction among the members. This can be a clubroom with bulletin boards, a club magazine or regular physical meetings. In the same way networked computers can be used as medium for the interaction in a community. Such a solution often is labelled as platform for community support (community platform) or as community support system.

When talking about community support systems one also should mention the terms “local community” and “virtual community”. Local communities are groups of people who have their roots in the real world, meet face-to-face regularly, and use electronic information systems only as an add-on to extend their reachability. Virtual communities are groups of people who would not otherwise form a community without the assistance of electronic media. The members of a virtual community only or at least mainly communicate through electronic communication channels. Computer mediated communication is an enabler for the virtual community. In contrast to local communities, this situation offers new possibilities and dangers of anonymity. In most cases however the virtual communication is enhanced with physical meetings. Even in communities that began as pure virtual communities the members tend to ask for and arrange physical meetings.

Community Support

The use of networked computers to support communities can be traced back to the beginnings of the Internet: The second service in the initial Internet, the file transfer service was soon “misused” to transfer messages from one person to another – email was invented. Quickly mailing lists followed and Usenet group services were available – both on the Internet (Arpanet) and on alternative networks formed of loosely connected computers (e.g. FidoNet).

However, community support did not start with computers. Support for the building and the maintaining of communities can be classified in classical approaches like private letters, leaflets, magazines, paper whiteboards, specialized radio and TV programs, and approaches based on networked computers (bulletin board systems, MUDs, MOOs, “community networks” (Schuler 1994)).

Both support types, the classical and the electronic ones, have their advantages and disadvantages. For classic media the advantages are availability, familiarity, and ease of use. For electronic media the advantages are dynamicity, speed, ease of replication, and distribution; disadvantages are barriers to usage, problems with access, and lack of availability.

Generalizing the functionalities of different electronic community support tools and matching them with the basic characterization of communities presented in the previous section one can identify the following basic concepts of community support applications:

- Providing a medium or channel for direct communication and for indirect exchange of comments on objects within the common scope of the community. The information channel can be enhanced with features that use information about the community member to do (semi) automatic filtering and personalization (Riecken 2000, Schubert & Koch 2002). Providing awareness of other members and helping to discover relationships (e.g. by visualizing them). This can help to find possible cooperation partners for direct interaction.
In the recent past several (Web-based) services have been implemented that combine these features and offer an integrated support platform for communities (community platform).

### Community Platforms at Universities

At universities different possibilities for the usage of community support systems can be identified. Examples can be found in the research, teaching and alumni domains.

**Community support systems for teaching**

The set of all participants of a course can be seen as a community. The community is clearly defined (e.g. by explicit enrolment), the members have common interests and some kind of cooperation (learning about the topic of the course), and there is an ongoing interaction (in the course and in assignments). A community support system could help in exchanging organizational information like general announcements or announcements of date or room changes. In addition the system could provide a platform for collaboration and direct communication. Course material could be provided on the platform and discussion forums could offer the possibility to continue exchanging about the contents of the course even away from the regular meetings. With multimedia components the integration of remote students and lecturers is possible. This is of special interest for universities with distributed campuses.

Different work already addresses these possibilities under the labels of e-learning or computersupported collaborative learning (CSCL). One example is the CommSy project (Gumm et al. 2000, Bleek et al. 2000). However, these systems usually are very focused to the e-learning and assignment management issues and do not support other tasks at universities.

**Community support systems in departments and research groups**

Community support systems could help to support the information flow in university departments. This includes the exchange of information about lectures and course programs, announcements and events, the discussion of course- and department related questions and the knowledge management in the department and research groups.

Knowledge management is a broad application area for community support systems. The reason therefore is, that knowledge usually is hard to externalise. So finding experts and the direct interaction among people plays an important role in transferring knowledge (Borghoff & Pareschi 1998). Community platforms offer possibilities to collect information from the members and keep the relation to the publishers. Examples for information (items) on a departmental platform would be literature references, hyperlinks, and information about projects, persons or organizations. Additionally, the possibility to publish annotations and the possibility to use user-specific categorizations could be introduced. In the research group of the author a web-based knowledge management application named CommunityItemsTool is developed and used for knowledge management in research groups (Koch et al. 2001). For supporting information exchange on the departmental level an additional Web platform has been created and introduced. It will be described later in more detail.

In contrast to enterprises at universities knowledge management cannot be limited to the own organization. Especially in the scientific area it is important to exchange knowledge with researchers at other universities and research institutions and in enterprises.

**Community support systems for student communication**

The communication among students is an important part of academic life at universities. Not all universities have a compact campus. So, regular meeting of students by chance is not guaranteed. Community support systems could support the bridging of such spatial distances. One application would be finding partners for learning and working groups. Another example would be support of communication and match making in the leisure area.

A special add-on for students would be the integration of partners from outside the university (alumni or companies) on the platform. This could motivate and support the communication among students and companies. Possible scenarios include be the installation of a market place for student jobs or a market place for ideas.

**Community support systems for alumni**

Several European universities started to integrate their alumni in the university network recently. Central institutions are founded that maintain alumni databases and that organize common events to foster the communication among alumni and of alumni with the university members (faculty and students).

Community support systems could help to create a common identity of all alumni of a university and thereby create an alumni community. A communication platform for alumni could support both the information flow among university and alumni and among the alumni. The set of alumni of a university thereby gets a more graspable form and is more easily addressable for university members and for students.
Community Platforms at Technische Universität München

Like at many universities at Technische Universität München several activities to support groups with community support systems evolved in the recent years. In this section we want to give a brief overview of some of the current systems or systems that are currently under construction. In addition to presenting the platforms we also discuss challenges that result from the heterogeneous set of platforms.

Platforms for departments and research groups

The main part of the existing platforms are applications for information exchange (knowledge management) in single local research groups, international research groups, whole academic programs or departments. These platforms are based on various technologies – from Lotus Notes to PHP-based Web servers and application service provider (ASP) solutions like Yahoo! Groups (http://groups.yahoo.com/).

The different platforms show the problems already mentioned in before:

Users have to register explicitly at the different platforms and have to enter their profile information (e.g. the demographic information and interests) again and again.

There is no possibility to automatically publish information on different platforms or to ask for information or news from different platforms.

To solve some of these problems we began to develop a generic community platform that provides the possibility to easily support different (overlapping) communities in one installation. The resulting system was labelled “Informationsdrehscheibe” (German for “information turntable”). As in Yahoo! Groups and other similar platforms it is easy to create a new space for a new community. In contrast to those systems it is also easy to exchange information among these spaces or publish information to multiple spaces.

The platform offers the following functionality:

1) Creation of community spaces: Every registered user can create a new community space. Such a community space can have members (association of platform members with the space). If the space is declared “open” every user can decide herself if she wants to become member of the community (space). In closed spaces the administrators of the space have to decide about membership applications or have to invite members explicitly. Information can be published to the platform (see below) and be associated with one or more of the community spaces. Additional attributes of a community space determine if you have to be a member of the space to associate information items with the space. A community space has a freely editable homepage and any number of static web pages that can be edited by the community members.

2) Publishing structured information: The most important functionality in the community spaces is the publishing of information and comments. Therefore, different (extensible) information object classes can be defined. On the departmental platforms we currently provide templates for announcements, events, bookmarks, project descriptions, research topics descriptions, job offers and special items for the academic programs and courses like thesis offers. Instantiations of these information object classes are called (information) items. Such information items can be created by any registered user of the platform and can be associated with any number of community spaces. Items can be rated and it is possible to publish annotations and comments to items. The items can be displayed on any (Web) pages in the community spaces. Selection is possible based on the association to the communities or on the item attributes (e.g. the item type). This selection can also be performed according to user profile attributes to achieve personalization.

3) Communication and matchmaking: By adding comments to the semi-structured information items asynchronous communication among the members is possible. One example therefore is the discussion of questions in academic courses. In addition to these asynchronous communications the platform does not support any further support for direct communication. Here we assume that the users already use other communication channels (e.g. email, telephone). The platform just provides contact information and awareness of other users. The awareness is provided by displaying lists of community members, by prominently displaying the authors of information items, and by offering services to search the user database.

The authentication and the user profile management is done for the whole platform independently from the community spaces. In her profile a user can store community-spanning interest descriptions, and subscribe to notifications about new information in all communities the user is member of. Notifications are sent by immediate email or in a daily or weekly newsletter. Further information about Drehscheibe can be found on the project Web pages at http://www11.in.tum.de/proj/imc/drehscheibe/.

A single installation of the platform could theoretically cover all applications in the whole university. However, this approach (one central platform for all) according to the experiences of the author leads to resistance from the responsible persons in the different
departments. It is seen as restriction of their own individuality and freedom – especially in German universities.

So in the moment we already have two instances of Dreh scheibe operating at TUM – one for the department of Computer Science (Informatics) where the system was designed and developed for four years now, and one for the department of Economics. More installations are already planned in other departments and research groups.

The usage of the two operating instances is quite different. While in the computer science department the platform is mainly used to distribute announcements from the department and the lecturers to the students, in the economics department the platform is used for communication among students. With the same set of functionalities different usage focuses have developed. One reason therefore could be the different composition of the students and the spatial distribution of the students. While in the computer science department there are mainly students in their first course of study, in the economics department there have been older students that already have finished an engineering diploma and are now doing a MBA. In addition to the difference in age and experience the two groups differ by the spatial distribution. While most lectures for computer science students are in one area of the campus, the MBA lectures (and therefore the students) are distributed over large areas of Munich.

Alumni community

One section in the departmental platform described before (Drehscheibe) is dedicated to alumni. Here it is possible to look up class lists and contact information of co-alumni (if they provide the information and give the permission to share it). Additionally, announcements to (co-)alumni can be published.

Technische Universität München has started to strengthen the network of TUM alumni in the past years. Therefore, the university administration founded an own group, the Alumni & Career Center. The group maintains an alumni database, is organizing events, and is supporting the alumni groups of the different departments.

In the future a dedicated alumni platform for all TUM alumni will be launched by the Alumni & Career Center. This platform should offer faculty-spanning information and special communication functionality that is not yet offered by the departmental platforms (e.g. Drehscheibe). In this context the alumni database will be made available online – to support matchmaking and finding of co-alumni and to allow for online update of contact information by the alumni themselves. First parts of this platform (the online database updating functionality) are already available now.

TUMmelplatz, Entrepreneurship community

As described in earlier it is interesting to provide a communication platform for alumni and current students. At TUM this should be provided by extending the alumni platform to a full communication platform for all people related to TUM (code-name “TUMmelonplatz”). This platform should also become an entry point to the different departmental platforms. As first part of TUMmelplatz we have just opened an Entrepreneurship-Community. This section is placed in the context of the UnternehmerTUM initiative, which has the goal to promote entrepreneurship at TUM. The community platform will support offline activities and provide information about entrepreneurship and be a place to communicate and meet around entrepreneurship – for students, faculty members and alumni.

Leisure support – studiosity.de

Finally, we also tackle the issue of supporting the communication among students around leisure topics. We created a community platform for all students in Munich called “studiosity.de” (http://www.studiosity.de). The platform supports direct communication and publishing and commenting of recommendations and reviews in the leisure area. There are topic areas for movies, restaurants, clubs etc. In the future we are planning to introduce mobile access features in this platform – to make collaboration among community members possible even when they are on the road. This work is taken out in the COSMOS project (Reichwald et al. 2002). There are also plans to use the experiences with the mobile access features to community platforms to extend the other campus platforms described before (to provide an “Active Campus”).

Challenges for community platforms in the university domain

As we have presented in the previous sections at Technische Universität München different platforms for supporting communities exist and are currently developed. The situation is even more complex if you include initiatives where groups from TUM develop and operate platforms with external partners (other universities, research centres or companies).

Approaches to centralize the systems have failed in the last years. One reason for these failures might be that community platforms (and also portals that are operated on a voluntarily basis) need the commitment of a core set of people who are closely related to the platform. In contrast to companies, where such commitment can be organized, in universities this commitment usually is voluntary, results in extra work and
needs degrees of freedom to develop. In central platforms this freedom is often missing. A community platform must be open and offer possibilities to integrate the identities of the supported communities.

Acceptance could be reached by providing one open central platform. Another possibility would be to allow different platforms and support their implementation. The problems that we have already addressed in (different logins, cold-start problem with different user profiles, no information exchange among platforms) could be solved by interoperability among the platforms. At TUM this approach was taken.

Interoperability and Identity Management

In the previous section, a part of the current set of platforms at TUM was presented and it was motivated that it is not possible to centralize the different platforms easily. On the other hand there is the desire to overcome the borders of the single platforms.

For overcoming the borders of single platforms the team took the following three basic scenarios into account:

1) The user is working with personal software agents that provide an interface to the different platforms for the user, i.e. that forward information from the user to the different platforms and collect information for the user from different platforms.
2) The user is interacting with only one platform that is exchanging information with the other platforms.
3) The user is interacting with the different platforms – but is supported thereby. The support is mainly that the user can use the same login on all platforms and that identity information and information for personalization is exchanged among the platforms.

Our first target was to make setting up and using different platforms as easy as possible (Scenario 3). Scenario 1 should be made possible through designing high-level (agent-like) remote interfaces into the platform and will be addressed in the future. Scenario 2 will also be investigated more in the future.

In the Cobricks project we have designed and built a generic support platform for communities, which could be used stand-alone or be integrated into existing portal or community support frameworks. The community support platform had to be highly configurable, it had to be possible to exchange or reuse information (especially user profile information) with other platforms, and the platform should be accessible by different kinds of user interfaces and through information agents.

The key issue in the design was to identify generic service modules with open interfaces and to implement them to be highly configurable. From the requirements in the different community platform projects we have derived the following core services for this architecture (also see Fig. 1):
- item management (content management)
- comment/annotations management
- user profile management
- community/category management
- personalization and filtering
- matchmaking
- messaging, event management

Figure 1: Interacting community support platforms
Item management is about managing contributions from members and from community moderators. Items are typed content objects with meta-information based on their type. The meta-information is used for searching and for filtering (personalization). Annotation management is about managing member annotations to items (ratings or comments). User profile management deals with managing information about users. While user profile management handles single profiles community management is about managing the member list(s). User profiles and item meta-information are combined in the personalization modules. In addition to generating recommendations on demand these also do proactive identification of interesting information and generation of notifications (e.g. newsletters). Matchmaking services compare user profiles to identify like-minded users. Finally, the messaging service handles messages sent from services or users to members of the community and deals with availability management and filtering.

The modules are implemented independently from user interface issues and can be used from a generic web portal module, from modules managing new user interfaces or from existing portal and community frameworks. To make this possible the modules return results in XML, which then is further processed in the calling modules. In addition to integrating the modules in existing user interfaces or creating a new Web user interface for them we also allow user information agents to directly interact with the modules. Therefore, the modules provide a very high-level (agent-like) remote interface.

More detailed information about the Cobricks project and about the ideas we are developing there can be found in (Borghoff et al. 2001), (Koch 2000, 2002) or (Koch & Lacher 2000). In the following we will further describe how we achieved first results in information exchange and easy handling of different platforms with the set-up described in here.

Exchange of Content

Content is structured data and comments that are collected by community members. In addition to the members of the community, this information might also be useful for members of other communities.

One possibility to determine automatically for which communities new information might be interesting would be the application of classification methods from knowledge and information management. We have decided against using these methods because communities should have full control of what happens with content that has been created by members and wherefrom new content emerges.

In the current set of interoperable community platforms (see Fig. 2) this exchange is mainly used if the same community is at home on different platforms. Examples are the lecturers holding lectures for the minor subject economics in computer science pro-
Identity management – exchange of user profile information

More important than the exchange of content is the reuse of user profiles. That means that information that is provided implicitly or explicitly by a user on one platform not only is available for the collecting platform but also for other platforms. So a user can use the same login with different platforms and the user gets personalized services immediately when entering a (new) platform.

Managing which information is available for which application is called identity management. Identity management is something we do in normal conversation everyday when we decide on what to tell one another about ourselves. In interactions with others we consider the situational context and the role we are currently acting in as well as the respective relationship with the interaction partners. This results in different sets of information being released to different interaction partners. Sometimes this leads to the situation that a person is known under different names in different contexts, e.g. by using special names, nicknames or pseudonyms suiting the occasion (Köhnopp & Bertold 2000).

An identity management system would allow people to define different identities, roles, associate personal data to it, and decide whom to give data and when to act anonymously. An identity management system would empower the user to maintain their privacy and control their digital identity. For community support systems a user-centric identity management system would make it easy for the user to use different communities and thereby lower the entry barrier to online communities.

At TUM we have built an identity management platform (Koch & Wörndl 2001). Our technical approach is to separate user profile information from services that make use of it and store it in a central place where it can be maintained by the user and be accessed by different services (with permission of the identity owner). The core component in our architecture is a user profile repository service (IDRepository) that stores information about an identity and offers the identity owner and authorized services interfaces to access this information (see Fig. 3).

The IDRepository follows a similar idea as industry approaches like Microsoft Passport, Novell DigitalMe, the Liberty Alliance project and XNS. In contrast to these solutions the ID-Repository server supports complex user attributes and focuses on user control. Another distinguishing factor is that the server offers a functionality to store more than one identity and to link identities to each other (defining data propagation paths).

For the repository we have several possibilities placed between the following two extremes:
- one central identity server for storing all identities of all people
- one or even several servers per person storing different identities

We imagine that in the real world there will be identity providers – services that operate servers (see Fig. 4). These services might also offer certification services for profile information.

The services that read the profile information should have a possibility to cache the information for some time. Here we need a means for keeping the cache up to date (and for the user to request deletion of the cached copy). After the negotiation of the basic lease this whole process can be seen as replication of the data with a master copy.

Now that we have outlined the general architecture for storing and accessing profiles, there is the question of how a profile should be structured to be of general use and allow interoperability.

Some information standards have been defined in the past for user profile information. Examples are the vCARD standard (Howes et al. 1998) or the standard included in W3Cs P3P specifica-
tion (P3P 2000). These approaches mainly choose hierarchically structured sets of attribute value pairs, i.e. there are attribute names like “personal.address.zip” and values of different data types stored for these attributes. So called ontologies are used to define the attribute and data type names and hierarchy.

When reviewing information needs in community support applications the following types of information can be identified:

- basic and demographic attributes like “name” or “gender” information about interests: This can be represented by correlations with predefined clusters or stereotypes (e.g. in iFAY (www.ifay.com)), by explicit attribute (e.g. “interest.music = ‘hip hop’”) or by collaborative interest definitions (correlations with other users). The source for all of this can be ratings given by the user to information (implicit by visit or explicit).
- information about relationship networks: colleagues, buddies, etc.

Some of this information can be stored in a standard way using attribute value pairs, but not all of it. Therefore, our approach extends the standard approach by new data types mainly for ratings and for relationships. Additionally, there is the possibility to have multiple values in any place in the hierarchy. This is needed to store sets of values for an attribute (e.g. “personal.spokenLanguages = (‘de’, ‘en’, ‘fr’)) or to provide several data sets (e.g. “personal.address(1).street”, “personal.address(2).street”).

The main features in our approach can be summarized as follows:

- hierarchical attribute space values at any level can be sets (multiple values)
- domain specific standard set and additional application specific attributes
- special types for relationships and ratings
- ontology to define attribute hierarchy, attribute names and data types

Profile information that is stored centrally and that is used by the different platforms at TUM currently is:

- name, email address, address information
- interest categories
- relationship networks (buddy lists)
- personal information manager data (e.g. calendar data)

The main issue with the implementation of the IDRepository has been the generalization of the user profile information. This is necessary to make information usable cross-service. Especially with interest categories we are still experimenting with different possibilities (including automatic ontology matching, see (Lacher & Groh 2001)).

In addition to making the usage of different platforms easier for the user, the separation of service and user profile management provides a higher transparency for the profile owner (knowledge who stores and uses what data from the profile) and offers rich possibilities to specify and enforce privacy constraints (see also (Koch & Wörndl 2001)).

Summary and Outlook

In this article we have given an overview of the different possibilities community support systems offer in the university domain. We have presented some examples from the community platforms currently in use or under development at Technische Universität München and have identified the interoperability among different platforms as major problem in this heterogeneous set-up.

The solution of providing only one central platform for all communities was rejected as not practical in the highly individual (German) university domain. Highly configurable and interoperable platforms and a central identity management have been presented as an alternative solution. In the Cobricks framework we have implemented basic bricks for building such interoperable platforms. These bricks are already used in the TUM systems and have made interoperability possible and easy to configure. Dreh scheibe is completely based on Cobricks, the other systems under development (TUMmelpplatz, studiosity) make use of Cobricks components for item management and for user profile management. Our first experiences from the operation of the interoperability features were that the user profile reuse was highly welcome by users. Several projects already emerged that are trying to make use of the richer user profile content in the single applications. Exchange of content is currently mainly used in communities that span different platforms (e.g. lecturers from the Economics Department that also teach students from the Informatics Department or leisure groups).
In the future we will further extend the interoperability features and study the usage of the systems at TUM. We are also planning to provide personal information agents for accessing different community platforms and will evaluate how this influences community interaction.

The requirement of connecting decentralized community support systems does not only come up in the university domain. The idea of identity management and exchange among different platforms could also be interesting for different knowledge management applications in corporations.

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