Enhancing Communities by Social Interactions in Mobile Environments

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Abstract: The progress in www-technologies and the trends toward ubiquitous computing have led to web-based user communities in recent years. Community members meet in virtual space and share information. Member interactions are mainly based on centralised services. This paper introduces Agent Assisted Communities, an approach to enhance member interactions and community forming in mobile environments. Based on domain-specific user-defined profiles held on mobile devices, mobile software agents can look for individuals in the vicinity, who have shared interests. If found, an initial contact can be established via the mobile devices in peer-to-peer mode and then used in real life.

1 Introduction

“Are you always mobile? - If not, you are out, of the community …” Web 2.0 is knocking on your door, but how does it look like in practice? Powerful multimedia handsets support on the fly activities, which were limited to “fixed”/stationary computers, in the past. Pure web consumptions moves into user content creation and sharing, either publicly on the World Wide Web, or in restricted mode by a closed user group – the community (see fig.1). While the past was mostly driven by technology affine applications followed by service offerings, in today’s networks human beings become the most important part of the game.

Online content itself is more diverse. Plain text messages are enriched by audio and video items, photographs are combined with geo-coordinates and discussion forums are established [BE01]. Public projects, like all the Wiki derivates, exceed the critical mass to be simply ignored by established content service providers and publishers.
### 1.1 Application Scenarios

For several of years, our research group in the department of computer science at Friedrich-Schiller-University (FSU) in Jena, Germany, has focused on the development of loosely coupled distributed systems. In May 2005, as a result of ongoing research, the MobiSoft project [Mob] [BKR07] started to investigate future usage scenarios of mobile agent technology [Tra] [BR04] combined with mobile environments. MobiSoft is a joint research project between three partners – GO DYO AG [God], the agent factory GmbH [Taf], and FSU Jena – partly funded by the local government.

Based on the identification of future application scenarios involving mobile users, about three dozen such scenarios were defined, ranked, and finally – if chosen as relevant – clustered into four integrated, more complex scenarios. Additionally, T-Systems provides a profile matching-based personalized mobile recommendation system.

- **Supply chain management**
  - Personal assistants support production workflows
- **Project Assistant**
  - Assistance for project managers
- **Campus.NET**
  - Platform for students and employees
- **Socio-Mobile Assistant**
  - Interaction in ad-hoc networks
- **MediaScout**
  - Recommended application for video contents from several sources

During the project, Campus.NET and Socio-Mobile Assistant have gotten stronger community aspects. Despite the fact that these scenarios have fewer business aspects,
they received more attention during presentation of the project results, especially on the CeBIT Germany 2007.

Campus.NET is intended to be a field-test scenario at FSU and benefits from a sophisticated infrastructure and potentially large number of users interested in new kinds of mobile applications. Information from different administrative areas of the university are ad-hoc integrated into more complex scenarios. So, one can imagine that a student receives on her/his mobile phone a message from his personalised assistant like this (underlined words imply more detailed information):

“Next semester, there is an interesting course on distributed systems. I’ve reserved for you one exemplar of the book at the library which is proposed by the course leader. Do you want to enrol for the course? And by the way, today is your favourite meal available at the student’s cafeteria!”

The information is not picked up from a central point but is collected by mobile software agents migrating through the network in order to collect selected information (see fig. 2). Campus.NET will integrate community functions to form student learning groups or support team networks.

The Socio-Mobile Assistant has a human-centred approach. It connects people sharing the same interests. Again, a personalised mobile software agent on a mobile device visit other mobile devices in the vicinity when reachable. Usually, the communication is done using Bluetooth. Profiles are compared by agent-to-agent communication (see chapter 2.2). In case of matches the device owners are notified. Sample scenarios are to share a cab or to find business partners at a fair.

1.2 Challenges in Mobile Communities

While implementing applications on mobile devices we faced important challenges. The current generation of mobile phones has excellent communication facilities. Unfortunately, the access via APIs does not exploit the full function set, or it is not accessible from Java-based applications. Different display resolutions and different operating systems also acquire additional effort in realisation.
Beside these implementation restrictions, there is a set of general restrictions in using mobile devices as an interface for mobile access to distributed information. These devices have limited resources. CPU performance, available memory and limited battery power demand for optimisations in applications. The most challenging limitations for usage are input and display capabilities of mobile devices. Standard desktop applications – like an internet browser even with software feature extensions like a lens for better readability – are not practically applicable to these small devices. It makes sense to have these applications on a mobile device for basic information retrieval, but they cannot be as sophisticated as their desktop counterparts. As our experiences from MobiSoft indicate, assistant-based applications taking user profiles and the current context into account help to simplify and to improve integrated usage of mobile devices.

2 User-Centred Community Approach

With the new possibilities provided by modern mobile devices and the experiences from MobiSoft, community issues and mobility can be combined more easily. We target a user-centred approach of connecting people sharing similar interests and exchanging information.

The mobile device is used for discovery of (D) and interaction with (I) people in the vicinity. People with overlapping profiles P will get connected and can enlarge or start to form communities C with two or more members M (see fig. 3). A similar approach for information sharing and collaboration without considering profiles can be found in [HKLM03]. There, information Clouds – iClouds – are introduced as the set of people sharing the same communication horizon and providing information on the basis of offer (have)- and search (wish)-lists.
2.1 Profile Handling

Profiles, usually stored in central community systems, have to be carried on mobile devices. A central user profile is just a copy of the user-centred profile. If a user has enabled her/his device to join communities (scan mode) or search for interested people the software works autonomously in the background and communicates with other devices (discovery). For the autonomous communication between these networked devices mobile agents will be used as a preferred solution. Their ability to migrate autonomously, compare profiles with each other and proactively inform people are a very good base for the realisation of such a mobile community – an Agent Assisted Community.

Agent Assisted Communities are defined as user-centred communities where members are supported by personalised substitutes – the mobile agents/assistants – acting as autonomous connectors to form communities including social interactions especially in mobile environments. A mobile agent knows the preferences of its owner using its profile. It acts as an enabler for the real life communication between peoples.

Fig. 3 shows the establishment of communities. Circles around people indicate their vicinity. People sharing the same vicinity may get informed by their agents and may get in touch.

2.2 Profile Vocabulary and Structure

Quite often people search for information or look for a person who shares an interest. Thus, it is necessary to structure personal information and to introduce common terms to have a base for identifying similar interests. Imagine that there is software which helps you to meet people you are interested in. We accept without qualification the use such software for business, for example on a conference. Next time the software scans a new contact it has to check whether you are interested or not. Now it starts a question-and-answer game with intention of finishing the game with a happy ending, namely the discovery of a common interest. During each contact you rerun the game. If you remember the questions for all interviews, there are common topics like personal information, qualifications or interests. Thus, a good approach is to build a database with all kinds of data you are interested in as well what you want to share with each other while protecting your privacy. Now we have a personal profile as a private view of the world.
Let’s start our conference scenario again. The software relies on a profile database and a module to match a profile. It seems to be possible to use an automatic matching process for pairs of profiles. One of the assumptions is that all profiles use the same vocabulary. If there is an update, you have to extend the profile to use the same vocabulary. As a second pre-condition, we assume there is an entire contact profile which covers all topics in the world. Hence, such a profile defines all objects using a well formed vocabulary. A real instance of the profile is filled by the person who owns the profile. A comparison of two profiles could be done based on the same vocabulary. Everything outside the contact profile we have to model as knowledge of the world and requires a world view.

![Fig. 4. Personalization control on a mobile phone for MobiSoft by FSU (a), personal interest selection (b) and MediaScout by T-Systems (c).](image)

Now we have to discuss the question for the border established between knowledge of the world and the private contact profile. Where is the limit? As a second point there is the question how to define knowledge of the world. At the end we are not able to give an answer for the border question. Moreover, we cannot present a definition of knowledge of the world as well as a profile which covers all possible topics.

### 2.3 Domain based Subprofiling

As a next step we want to introduce our approach for profiling as a *domain based profile*. The main idea is to use the origin of each information item. The composition of a profile is a set of different *subprofiles*. Information in a subprofile is assigned according domains. A *domain* represents a group of related items, topics, or subjects belonging to a certain field. The group itself is established by related items with a common origin e.g., a surname is part of the personal information. Personal information as the origin for surname establishes a domain with the same name.

An item can be assigned to different domains. We accept without qualification there is a main topic for an assignment into one domain. Dividing the profile into pieces of domains (subprofiles) we get a distributed approach. Each part is generated by its own area if necessary. The area specific information is left in the domain and we are able to manage or extend the domain in its own context. Hence, we do not need to be proficient.
in each part of the profile. Each domain could be managed by its own experts – mostly the users themselves.

Based on the idea low-dimensional domains the domain vocabulary can be distributed by sharing XML definitions. In cases of different domain vocabulary a second approach establishes the mapping process which is introduced next. Profiling based on domain profiles breaks down the complexity of an entire profile into straightforward small-sized domain profiles (divide and conquer). An entire profile is a set of domain profiles which can be extended or adapted by adding a new domain profile. Each user builds up their own personal profile.

2.4 Interaction and Information Discovery

Following the user-centred approach, a set of domain specific profiles is spanned by mobile users. Via profile matching, contacts between users can be established. Looking at the communication between two participants the first step is to identifying the shared domains and the vocabulary used to perform the matching. As a first approach a common communication protocol for syntactic comparison is applicable.

Once we have found “compatible” domains represented by their subprofiles S in the first step, an in-depth look at the semantics is necessary to check whether used vocabulary terms have the same meaning. In [WR01], the DOGGIE approach enables agents to locate similar semantic concepts. This promising approach can also be helpful to identify homonymous words with different meaning and synonymous words.

After passing these two steps, the matching process can be started in order to identify shared interests. Fig. 5 indicates an overlap of subprofiles S1 and S4. As the timeframe is unknown during which an intercommunication between two mobile devices occurs, information exchange will follow three phases:

1. fast ID tag exchange – for later re-identification
2. chunk exchange – to support re-linking via the community backend
3. information exchange – to support local P2P ad-hoc communication

[KM01] proposes an information-theoretic approach to compare interests of users. The interests are captured in a weighted ontology of keywords.
Every established contact with other users as potential community members is important to form a community and to discover the (shared) interests of others, even if only one compatible domain has found by the contact and the other mentioned steps were not successful. Of course the contact is more interesting when shared interests could be identified.

As a result of this approach, communities are formed in a user-based manner. In contrast to a traditional client-server approach, the user is put into the middle. In addition, this user-centred approach integrates mobile and non-mobile users. Due to characteristics like autonomy, personalisation and adaptability, mobile agents are an adequate connector between users and their communities.

3 Integration of Traditional Community Systems

Mobile communities equipped with functions to involve new partners as proposed in the last section can not live without a stable backbone containing centralized services and knowledge. Typically, an internet community uses community centred services (Wiki, Forum, Blog, etc.) or community supporting services (del.icio.us, digg, slashdot, reddit, studiVZ, etc.) to interact, to exchange information, and to gain benefits.

Beside these content-oriented services there are also meta services: (central) directory of services, community explorer (which communities are available), or member areas. Usually, such services are installed on stable server infrastructures. In spite of the central characteristic of such services, there is no need to have a single central server which limits scalability. In most cases a community maintains their own infrastructures.
A central question is how to combine mobile devices with traditional community software systems. Internet browsers are typically used to participate in a community. As mentioned in chapter 1.2, this method of using community software from mobile devices is not feasible due to strong restrictions in human-device interactions. Extensive content contribution can not be expected from a mobile device.

Fig. 6 gives a schematic overview of the connection between a potential mobile community member and her/his community. With the help of an “intelligent” peer-to-peer middleware (P2P MW) like mobile agent technology, the integration of mobile community members is possible in an efficient manner. Simple tasks can be handed-over to assistants acting autonomously and proactively within a networked environment. The personalised assistant can also act as a proxy for the member and informs her/him on relevant events (see chapter 1.1).

In fig. 7, the combination of mobile devices and traditional community software systems is shown to form a Human-Centered Mobile Community (HCMC). Thereby, mobile clients can also extend the possibilities within the community by creating a virtual pool of services and information distributed on the mobile part of the network.
Fig. 7. Integration of mobile elements and central community services.

4 Summary and Further Work

This paper proposes an Agent Assisted Community to support mobile community members, integrate them into existing community infrastructure, and extend the community by social interaction in mobile environments. The focus of the approach is the mobile user and not centralized community services. Domain specific profiles are held on mobile devices. Mobile agents running on mobile devices are ready to compare these profiles in a 3-step process with profiles of people in the vicinity of the user. Overlapping interests will be fed back to the users to establish a contact. The defined process will be investigated in more detail as part of the research at FSU.

The paper also comes up with challenges for mobile device usage for communities. Experiences from device handling in projects are reflected. From both MobiSoft scenarios and T-System’s trials addressing topics like “Personal Shopping Assistant” or the mobile recommendation application “MediaScout” the following lessons we learned:

1. **Bilateral cross matching** between user offers and search requests is essential.
2. Basic community services could be modelled as offers.
3. A profile could be seen as an instance of an ontology.
4. User profiles constructed of domain specific subprofiles must be easily manageable, namely switchable.
5. Context awareness can efficiently assist the subprofile management.
6. Beside others, the use of any kind of tags e.g., Bluetooth tags, visual codes, or a GPS location can be a profile activation trigger.
More interesting aspects which one might look at are even more in the social area of potential users e.g.,

- Is the usage of mobile devices as a community interface accepted?
- Has usability reached an appropriate level for ad-hoc mobile device usage?
- Is there a correlation between age and gender of potential users and the acceptance of usage?

Consolidated findings in this interdisciplinary area are essential for a successful application of future technologies in the mobile sector. The user is a central element in ubiquitous computing.

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