GeoNotes: a real-use study of a public location-aware community system

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(work reported here was conducted at SICS)

December 2002

ABSTRACT

Much of context-aware application research has dealt with the technical aspects of context capturing and how to interpret the context of a user. Little effort, however, has been spent on the experience and usage of these systems. This paper describes a real-use study of a location-aware community system - GeoNotes. Over the one-month trial, 78 users published 283 information items connected to indoor and outdoor places. Users found present people, synchronous situations and activities more interesting to 'tag' than physical objects. Chat turned out to be the major activity in the system. In finding new notes at a place, users found the number of comments pivotal. GeoNotes was conceptualized in terms of newsgroup and IM applications. Implications for design are discussed.

Keywords

Location-aware computing, community system

SICS Technical Report T2002:27

ISSN 1100-3154

ISRN:SICS-T—2002/27-SE

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INTRODUCTION

The basic idea of location-aware information systems is to connect information pieces to positions in outdoor or indoor space, with the help of Global Positioning System (GPS), GSM-positioning, Wireless LAN positioning or Bluetooth positioning. Via handhelds, users are pushed or granted access to the information, entering a given location. By now, quite a few systems have been built around this idea. Several projects focused on campus and city tourist guides [1, 6] as well as electronic guidebook for museums and galleries [10, 13]. Others have focused on archeological and other types of fieldwork [11], context-sensitive conference guides [13] in addition to connecting web information with location [5, 16]. Nearly all location-aware information systems, however, have focused on end-users *access* of information (locating the user correctly and presenting appropriate information to that place). The information content is thought to be created by semi-professional content providers such as museums and tourist organizations. Users are considered to be *recipients* rather than *producers* of information, thereby de-emphasizing the interactive and social potential of these systems.

The primary focus of GeoNotes (http://geonotes.sics.se/) was different. Although connected to a location, information should – we reasoned - primarily be authored by end-users. Our system ought to provide users the ability to express opinions, preferences, recommendations, questions, jokes, criticism and identity markers – all connected to a specific place. In doing this, we hoped that content would be less formal and serious, and more expressive, fun and subversive [12]. Thus, the system would attract not only museum visitants and tourists, but a broader group of mobile users including café enthusiasts, restaurant goers, bar hoppers, shoppers and street people. We aimed for a system with more 'everyday' location-based information, reflecting the lives, concerns and social reality of the users, rather than the views of some organization or authority, cf. [8]. Rather than creating a location-aware *information* system, GeoNotes should be a location aware *community* system, similar to graffiti, post-it notes, toilet scribble, public note boards and posters. To our knowledge, only the *E-graffiti* system - developed at Cornell University shared this approach [3, 4]. The system and its evaluation influenced our work. In describing the design of GeoNotes, it therefore makes sense to juxtapose it with the design of E-Graffiti.

GEONOTES AND ITS DESIGN-RATIONALES

First, *endorsing an open information space* was highly prioritized in designing GeoNotes: at a given location, all users should be allowed to author infinite number of notes and all of those notes should be visible to all other users. Allowing users to 'direct' notes to certain users was discarded. The evaluation of E-graffiti demonstrated that this functionality tended to be experienced as an inferior e-mail system: users felt they had to go to a location to pick up their "message". The interface style of E-graffiti ("to-", "from-", "subject-" and "body-fields" of each note) enhanced this impression. By opening up information space, we aimed not for a personal *messaging* system but rather a *publishing* system, tapping into metaphors of public note boards and newsgroups, rather than e-mail. At the same time, *the location-based aspects had to be emphasized*. In contrast to E-graffiti, which allowed remote authoring but not remote reading, GeoNotes permitted neither. If users were allowed to read and author notes from remote positions - we reasoned - the connection between the note and its spatial context would be endangered (and thereby the whole concept). Although a public-note-board-kind-of system was striven for, authors and readers should be able to clearly relate note content to space.

Second, whereas E-graffiti simply allowed users to sign notes with their username (often recognized by fellow users), *GeoNotes allowed a much broader range of play with identity and anonymity*. Since motivation for authoring was a real problem in E-graffiti, nameless notes – we reasoned – would perhaps encourage some 'shy' users to contribute with content [14]. We also hoped that anonymity would spur more humoristic and subversive content (potentially attracting readers and users). Thus, GeoNotes provided three types of signatures: the username given at registration, self created pseudonyms and anonymous.

Third, since GeoNotes emphasized users' contribution, the system *had to give support for comments on notes*. Comments could only be read and authored from inside the note, ensuring the right context for the comment [7]. Multiple comments were displayed in temporal order, similar to chat and virtual community systems. The comments feature differentiated GeoNotes from E-graffiti, which assigned equal status to all content being authored at a location, making it virtually impossible to comment on other' s notes in a meaningful way.

Fourth, allowing mass-annotations of locations will eventually cause genuine problems of information navigation and access [4]. *How to find, access and be notified about relevant and timely information at a location with thousands of notes*? Whereas E-graffiti left these questions unanswered, the GeoNotes user was provided with a battery of tools. Content could be searched with a

traditional word-based search engine. In addition, meta-data attached to each note were made available to users: number of comments, number of readings (popular) and the age of the note – similar to web-based community systems [8]. By inviting other users to become GeoNote friends, users could easily find notes that this friend had authored or read. In addition to this information access modes may shift for different situations. Sometimes search and retrieval is the default ('pull'), sometimes user wants to be 'pushed' (relevant) information via some form of notification. In GeoNotes the search engine supported pull access mode. These search questions could then be saved as *queries*, constantly and continuously performing the search as users move through space. Wherever a note matched the query, users would be notified with a sound ('pushing' notes to the user). These filters tried to minimize the distraction of location-based notifications [4]. The main window (Figure 1), tried to mix push and pull. This interface not only acted as portal to reading, writing, searching and profile functionalities, but also provided the user with an at-a-glance overview of all notes at the location. This list was automatically displayed as soon as users entered a location (E-graffiti users had had to log on at each location and click 'check new notes' for updates). Due to its expected length, buttons at the top of the window sorted the list according to *place* (place labels in alphabetical order), *recency* (newest notes listed first), *friends* (notes written by friends first) and *popularity* (most read notes first).

Fifth, location was perhaps the most vital aspect of GeoNotes design rationales. Here was the problem: how would authors and readers know to what building, room or object a particular note is attached? This problem was far from merely technical: even if we had a millimeter accurate positioning system, some authors would perhaps prefer to place notes on large buildings. Without a verbal description of the position, the note would still be incomprehensible to its readers (cf. discussion in [12 and 4]). E-graffiti solved this problem by naming each location (=a W-LAN access point), e.g., "Kennedy 210 lecture hall" and attaching a photo of the general building. This, unfortunately, promulgated the system administrators' view of space rather than the users'. In contrast, GeoNotes users were free to define the position. This was done by creating a so-called *place label* (Figure 1). These place-labels could then be re-used by next authors (at that location). To promote useful place labels in the system, the next authors were only presented with the most popular labels. This place-label system allowed authors to be quite creative in connecting notes with space, potentially giving another motivation for authoring. At the same time, we hoped place labels would enable readers to bridge the gap between digital and physical space.

RESEARCH QUESTIONS

Our four research questions focused not so much on traditional usability issues (e.g., interface navigation, menus or ease-of-use), but rather on the experience of the system. First, since E-graffiti seemed to have problems with motivating users authoring notes, we wanted to know why users authored notes (or not), and if our design triggered more or different motivation. Second, since the system was a location-based application it was natural for us to see how GeoNotes information space related to physical space. This included both how notes and place labels were anchored in space, but also investigating why some locations attracted users. Third, how did users access, find and navigate notes, taking advantage of the various tools provided. Also, did place labels enable readers to locate notes at a location? Finally, how did users conceptualize this new kind of system? What metaphors did they use in order to make sense of the system and judge its merits? Did we manage to avoid metaphors of e-mail and web? Did we make people adopt our location-based newsgroup metaphor?

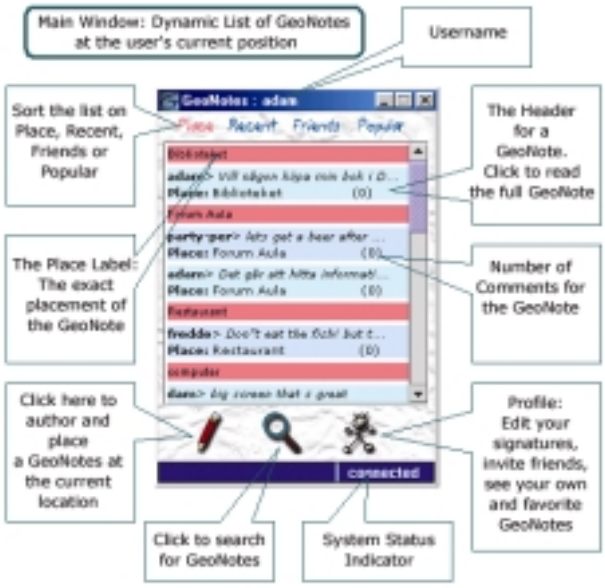

Figure 1. GeoNotes main window. For details, see [12].

METHOD AND PROCEDURE

GeoNotes – like any other community system – required a large number of mobile users that could author, read and comment information. Although GeoNotes ran on handhelds such as iPAQs, equipping large amount of users with this kind of terminals was economically and practically unfeasible. The study had to rely on existing infrastructure. Collaboration with the open access W-LAN StockholmOpen network (www.stockholmopen.net) provided us with 400 potential users (students and faculty of Royal Institute of Technology) with semi-mobile terminals (W-LAN enabled laptops). At the time of the study, this network contained approximately 50 access points located in three buildings in Kista Science City and in two scattered downtown Stockholm areas. Since GeoNotes was offered as a local service in StockholmOpen, non-authorized 'passing-by' network users could also use it.

As to positioning, each access point in the network acted as a GeoNotes location. The GeoNotes client captured the mac-address of the access point and sent it to a server, which returned the list of notes connected to that location/mac-address. In case the mac-address was not recognized, the server created a new entry for that address. In this way, GeoNotes could be used at any W-LAN access point in the world (provided user had Internet access). The crudeness of this positioning method was obvious: the coverage area of each access point was not only quite far-reaching, but also substantially varied due to physical conditions on the site (e.g. walls) and the features of the antenna. In spite of this, we hoped this accuracy would be sufficient for GeoNotes. In particular, we hoped that the place label system, described above, would - if not erase - at least decrease the drawbacks to an acceptable level.

Although we did not expect users to move around in space with their laptops, we hoped they would use their computers (and GeoNote) in various places around the network (lecturing, lunching, drinking coffee, or studying). For sure, the collaboration with StockholmOpen also affected the composition of the user group. Engineer students are not only highly computer skilled and early IT adopters. They may also have different social, ethical and habitual preferences than the average user. In addition, there was a serious gender slant. Considering the technical complexity and the large-scale ambitions of the study, we had to accept these deficiencies.

In order to measure more or less 'real' and voluntary usage, we sought to avoid 'forced' test settings (cf. E-graffiti users who participated in exchange for course points [3]). All we did was to encourage students to download, install and use GeoNotes, e.g., by arranging a evening reception at the commencement of the test period. Except for a subset of users (see below), there was no direct reward for using the system other than the system experience itself. During the test period - April 15th to May 15th 2002 – we collected two types of data. First, we logged usage of the system. Logs included the time clients were connected to the server (=running the application), how often the sorting and searching functions were used, how many notes each user authored/read, access points at which notes were placed and when they were placed, how many times notes were read and number of friends for each user. In the GeoNotes installation software, users were informed about these logging activities and that they participated in a study. Second, all notes, comments, signatures and place labels of the system were captured and later analyzed by the authors of this paper. We also had an external categorizer, but since the information snippets were short and heavily depended on the context in which they were authored (e.g., the space in which it was placed, the comments attached to it, the author and the author's relation to other authors), we discarded this 'second-opinion' categorization.

In addition to this, a subset of 14 students was enrolled for a more in-depth study. These subjects were drafted through posters on campus. Before they downloaded and installed GeoNotes, they filled out a pre-questionnaire about their network habits (http://geonotes.sics.se/web/preQ.php). They also stated their GeoNotes login names. In this way, we could recognize them in the log files. After approximately three weeks of usage, subject underwent a 40-minute individual interview (at SICS' office). Finally, at the end of the evaluation period they filled out a web-questionnaire with about 40 questions (http://geonotes.sics.se/web/largeweb.php). Subjects were given 3 movie tickets for their participation.

Subjects in the subset were between 20 and 35 years of age, 13 men and 1 woman. All had good command of English (which was the language of the menus and buttons in the application). Three subjects had no or little command of Swedish (which became the default content language in the system). As with most other users, the subset was computer science students with extensive experience of applications, operating systems and network technologies. According to their own estimation, they were connected to the Internet via the network in average 22 hours a week. When asked to indicate the ratio between usage of fun and serious applications, the average figure was 41% for fun and 59 % for serious. In terms of mobility, 10 subjects reported to use the network in several places around campus, and 4 alleged to have a favorite place. Most popular place seemed to be lecture rooms (14 subjects), corridors (13), lab-rooms (12) and library (9).

RESULTS – GENERAL

The logs collected general usage data (Figure 1).

General Stats	All Users	Subset
Registered GeoNote users	78	14
Total hours of usage (=logged-on)	242.5 h	166 h
# of Notes	182 (by 49 users)	95 (by 14 users)
# of comments	101 (by 24 users)	50 (by 12 users)
# of place labels	84 (by 40 users)	43 (by 12 users)
Signatures of notes and comments: - user name - pseudonym - anonymous	 76.6% 20.0% 3.4%	 72.4% 17.3% 10.2%
# of note readings	1280 (62 users read at least one note)	540 (14 users read at least one note)
# of comment readings	436 (41 users read at least one comment)	260 (14 users read at least one comment)

Table 1. General results.

The time-based activity logs showed a natural decrease of usage and authoring during weekends, and high activity in connection to the GeoNotes evening presentation April 17th (Figures 3). In the following, results are presented in

relation to each of the four research questions identified above.

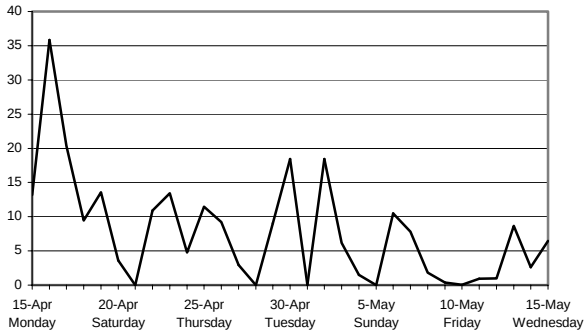

Figure 2. Hours of usage for each day. Usage is defined as the time users were connected to server.

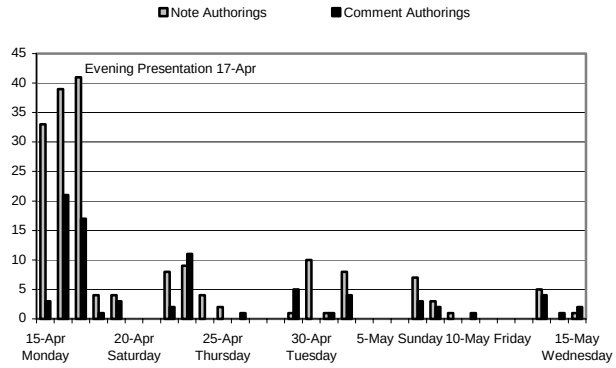

Figure 3. Number of authorings for each day.

Results – Motivation for authoring

One good source for finding out the motivations for authoring was the notes themselves. The analysis of the 182 notes written, found a number of categories (comments were not included in this analysis):

Test. 10 notes (5.5%) seemed to be motivated out of an urge to test the operability of the system. These notes contained nonsense characters or a sentence around the word "test". In spite of the fact that 58% of all users registered the first 3 days, the percentage of test messages kept fairly constant across the four weeks of the study.

Meta-notes. 20 notes (11.0%) expressed views about the system itself e.g., "what is this software good for?" and "mmm, not so good positioning in the c3-corridor...".[1] Some of the notes came close to the test-category.

Expressiveness. In 45 notes (24.7%), authors' apparently wanted to be noted, seen and remembered by others. Expressive notes contained jokes, but also graffiti-style tags such as "I was here" and "I placed the first GeoNote here".

Information. The motivation behind this category (11 notes, 6.0%) was to inform others about something related to the location, e.g., the opening hours of a restaurant or upcoming presentations outside a lecture hall ("There is a lecture given by Ericsson UAB"). Unlike object chat (see below), these authors did not seem to call for a reply.

Commenting notes. Some authors initially failed to differentiate between notes proper and comments. Thus, some notes (10, 5.5%) were clearly created with the intention of commenting one or several notes at a given location. All notes in this category originated from first week of usage (16-23 April), which suggests that users eventually switched to using the comments function.

Drama. Some notes (11, 6.0%) deliberately played with signatures, trying to ascribe a note to another person. By authoring notes in the name of a lecturer or a buddy, practical jokes could be played out, e.g., "Hi, Crille speaking... I just wanted to announce that those of you who have wondered about me have been right all along: I do have a serious problem!"

Chat. By far the largest category of notes seemed to be motivated by a desire to chat with others (74 notes 40.1%). We differentiated between 3 sorts of chat: ***Object chat*** (15 notes, 8.2%) tried to initiate a chat with others related to an object or physical aspect of the locale, e.g. "why are the curtains always down here?" or "Who put up a Markoolio [a Swedish music artist] poster here? Talk about bad taste! Put up an image of Buffy Tyler instead =)". Object related chat was mostly asynchronous: if these notes received a comment, the author had probably already left the place. ***Situation chat***, on the other hand, seemed to be motivated by an urge to synchronously speak with co-present users. These notes (42, 23.1%) related less to physical objects and more to ongoing activities and situations in which several users took part, e.g., lectures or studying in the study area on the 6th floor of the Forum building. An illustrative example would be a note placed during the GeoNotes evening presentation when a toddler at the back of the hall disturbed the presentation:

SIGNATURE: Charlie DATE AND TIME: April 17, 2002, 18:45 PLACE LABEL: nearby the screaming kid MESSAGE: Now you have to be quiet! COMMENTS BOARD: Wed Apr 17 18:56:24, 2002 Anonymous> A really load SHUT UP usually works for me.

Talk-to-me chat. 17 notes (9.3%) were motivated by an urge to chat with others independently of time and place, e.g., "PLACE LABEL: Kitchen, MESSAGE: Hello everybody!" Typically, content did not relate to objects or situations in the location. In contrast to test notes, however, talk-to-me notes had a clear communicatory objective.

Discussion – Motivations for Authoring

It is fair to say that our marketing activities attracted a substantial number of users that managed to download and register GeoNotes. At the same time, 182 notes plus 101 comments attached to 28 access points were below our expectations. It is possible that we had too few users at our

[1]Translated from Swedish by the authors (like all notes and comments presented in this paper).

disposal and too little time to heave the vicious circle of all community system: little data, activity and presence in the system scares away users who might have contributed [8]. In fact, several subjects in the subset mentioned this as a reason why their usage and interest decreased.

Taking the set of notes at face value, however, the analysis of content indicated a wide set of motivations that operated during the trial. Considering our technically curious and skilful user group, it was not surprising to find test and meta notes. For some subjects, technical experimentation seem to have been more or less the only motivation. The creativity with which users employed signatures in the drama category surprised us (finding no equivalents in E-graffiti). GeoNotes' playful signature system (absent in E-graffiti) seems to have tapped into these humorous and somewhat subversive motivations. We expected (and designed for) chat, but were surprised to find situation-related chat outnumbering object chat (and information notes). It seems like triggers of authoring were not primarily *physical* objects or infrastructure, but rather the ongoing social *activities* and *situations* in that physical space. Expressed by one subset subjects in the interview:

Q: When you authored a note, what was the trigger?
A: It doesn't really matter how the lecture room looks like, but it is more related to the fact **that it is a lecture room, sort of.**
Q: And that there is a particular lecture at the time?
Q: Yes, maybe that too, but...I mean it is a **place where many people gather and there is always a special kind of communication.**

The emphasis on activity and situations in GeoNotes concur with the findings in similar systems (cf. the 'snapshot' notes of [4]). It is possible that the official and non-stimulating architectural space of StockholmOpen network area contributed top this effect.

The fact that both GeoNotes and E-Graffiti contained substantial amount of chat initially seems a bit puzzling: why would anyone want to chat *digitally* with people that are *physically* present in the same vicinity or connected to the same access point? Our study suggested several answers to this: first it depends on the architecture of the space. One access point in GeoNotes covered a hallway of many small study rooms in which subjects spent much of their between-lecture time ("the 6th floor"). Walls prevented visual contact, but GeoNotes allowed users to communicate by authoring and commenting notes. The system functioned more or less as instant messaging (IM). Secondly, chat between co-present users (with GeoNotes, IM applications or SMS messaging) creates a parallel world, which may or may not relate to the actual situation in which it takes place (similar to sending secret notes in a classroom):

A: But the interesting thing is that you can sit and talk about something and study, and then have a **completely different discussion over the network**. There you can write about something completely different.
Q: So it is separate from the things happening in the room?
A: Yes, that is pretty interesting. Unless, of course, **someone writes something that makes everybody laugh, then the situation may go out of hand**.

Location-based chat may also have been attractive to users since it enabled chat with people *outside* the normal circle of ICQ friends (yet with people in the same public gathering). Here is how one subject put it, primarily describing his experience in the 6th floor study rooms:

Q: What was the major reason for you to author notes?
A: Well, first it was only testing, but then perhaps there was a question to others, if someone else were doing similar things, if they knew anything about this and that, if someone knew about upcoming events or where lectures were going to be held. **You could also get a question from outside and not only from them you talk to every day**.

Moreover, with GeoNotes signature system those discussions with 'outsiders' could be anonymous. In the interviews, we were told incidents in which this had happened. All in all, it seems like the design of GeoNotes - information openness (no directed notes), the possibility of play with signatures and anonymity as well as the structured commenting functionality – sparked off motivations and usage modes that E-graffiti overleaped.

Results - GeoNotes and space

Since place labels acted as anchorage points between notes and space, an analysis of all 84 labels provided a good indication of users' perception of space. 6 labels (7%) related to larger-than-rooms places such as "Kista IP [sport field]", "Barrvägen [a street address]" and "Lappis [a Stockholm neighborhood]". Most of these were attached to access points outside the core of the StockholmOpen network. 35 labels (42 %) described rooms or corridors, e.g., "library", "lecture hall", "kitchen", "c33", "Electrum C1 corridor" and "the room with the bad tables". 10 labels (12%) referred to aspects of larger rooms and areas, e.g., "sitting area in entrance hall", "lecture hall left", "aisle" and "fireplace". 12 labels (14%) described objects, e.g., "printer", "soda machine", "fifth chair" and "the table in the corner in Forum restaurant". 11 labels (13%) denoted ephemeral objects in a situation or social activity, e.g., "the forehead of the lecturer", "nearby the screaming kid", "Marcus" or "the crowd in c33". Although not confirmed, 2 labels appeared to be faked ("England" and "centralen" [normally designating a metro station far from Kista]). 3 labels functioned more as message field (e.g., "we are waiting for food" and "sick humor"). Finally, 4 labels placed on different access points around the network referred to "floor 41, VIP Room". Initially, these labels puzzled us, especially considering that no building in the network had more than 7 floors. One of our interviewees, however, happened to be the creator of these labels and explained their rationale. He and his friends collectively decided on a name. Whenever they arrived at a new access point, they would create this label. Since this group mostly used GeoNotes for chat, the place label turned into an "IRC-channel" [Internet Related Chat] (expressed by one of the friends). Although readers were unable to read all VIP-room notes – only the ones attached to the current access point - the 4 persons involved found this approach valuable to quickly sort and find each other's notes and comments.

In total, 32 notes were sorted under the VIP-room label on 4 different access points. Unsurprisingly, all but one of these notes fell into the category of chat.

Of the 28 access points taken into use by GeoNotes participants, 3 attracted over 20 notes each (in total 50% of all notes in the system). The access point in the 6th floor study area attracted 39 notes, the lecture hall 24 and a corridor with large lecture rooms attracted 28 notes. According to the log files, these access points also accounted for most number of readings, indicating that the system in general attracted most usage at these places.

Discussion – GeoNotes and Space

In general, the place label system seems to have stimulated spatial creativity of authors. The defined spaces became *their* view of space, not *ours*. The heavy dominance of room and corridor labels was a bit surprising since the freedom of the place label system enables quite particular descriptions (for instance relating to objects). Even in the interviews, subjects referred to place labels as "rooms". One explanation for this, again, can be found in the architectural space of the 6th floor, where the small study rooms all connected to a long corridor. Since this space was quite empty of objects, furniture and interior artifacts, it was natural to categorize this space in term of 'rooms'. As 6th floor attracted major shares of notes and usage, it is fair to conclude that labels created here influenced how users thought labels should be formulated at other locations, propagating this practice in the system. Another explanation of the dominance of 'rooms' could be that users may have perceived GeoNotes in terms of chat-systems, in which 'room' is the prevailing metaphor to separate discussions.

The three most popular access points suggest that GeoNotes users, again, were attracted to spaces with many people and activities (studying and lecturing) – rather the physical space per se. It is, however, equally true that these places also attracted most network activity in general.

Results – Accessing and finding notes

As to access modes, the mix of 'push' and 'pull' in GeoNotes main window (Figure 1) seemed to have greatest appeal. While only 115 searches and 20 queries were created during the test period, the sorting functions were used in the thousands (Place: 1884; Recent: 1674; Friends: 1198; Popular: 920). Over the test period, sorting activity coincided with general activity (Figures 2 and 3). When notes were listed in the main window (independent of sorting), users were attracted by the number of comments a note had received. We asked the subset subjects: "When notes were listed as headers, how did you determine what notes to open and read?" They were asked to grade 4 statements on a scale from 1 (never) to 7 (always): "By looking at signature / By looking at the first letters in the message / By looking at the place label / By looking at the number of comments of the note". By allocating 1 to 7 points of their responses, "comments" received the highest average score with 5.8, followed by "first letters" (5.4), "signature" (4.2) and "place label" (3.6). Feedback on own notes was considered interesting by all interviewees, and 12 out of 14 subjects in the subset checked their own notes regularly for comments and reading stats.

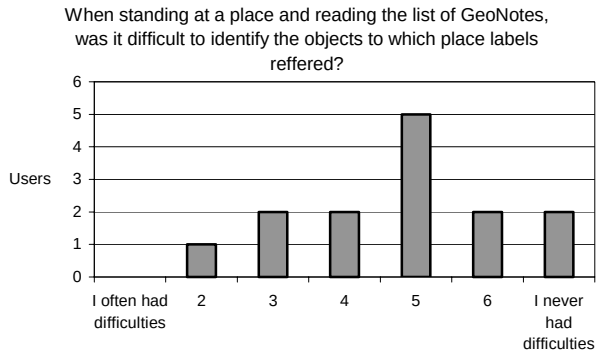

Figure 4. From questionnaire for the subset subjects.

As to identifying the place of notes via place labels, users (in the subset) responded fairly positive (Figure 4). The interviews gave more in-depth information about their experience. Although no one outright complained or felt totally confused, just about all had a story to tell about 'awry' place labels. First, some labels did not seem to relate to the room at all, e.g., labels related to situations that had already passed ('nearby the kid that is screaming' or 'floor 41 VIP room'). In most cases, however, subjects seemed to understand the context in which those labels were created. Second, subjects reported on labels they had recognized but which they knew referred to locations 'far away':

A: we sat on floor 6 and saw a room called centralen [a metro station in Stockholm city] and one room called lecture hall. Then we started to wonder how they ended up there, did someone create them? I mean, we are two floors above the lecture hall and eight metro stations from centralen, what are they doing here?

Discussion – Accessing and finding notes

The low appeal for queries - which notify about interesting notes when users move around in space – is probably due to the laptops: there is no real incentive to create queries when using clumsy and nearly non-mobile terminals. Equally unsurprising, the search function is needed only when there is a *substantially* amount of notes at a location (which did not happen in the test).

Instead, the main window list and its sorting functions appeared to be the major navigation tool. The popularity of 'place' may be due to the fact that users used place labels to know that they were correctly positioned. Moreover, considering the popularity of chat, perhaps people kept close watch over specific place labels (for instance "floor 41, VIP-room"). In this way, place label sorting may have been experienced as quite useful. The high percentage of chat may also explain the relative popularity of 'recency' sorting, since it allows the user to always get new and fresh notes at the top of the list. As an extension of this, several interviewees - without a direct question - suggested a notification pop-up whenever a new note was added to the

access point, or when there was an unread note at a given location. The statistics for 'friends' sorting was a bit surprising since only 19 users had GeoNotes friends (and among them, in average 2 friends).

As with all community systems, the number of comments a note had received proved to be quite pivotal. One interviewee expressed this very bluntly when asked why he thought number of comments was important when he browsed the list for interesting notes:

A: Well, if it [number of comments] says 0 I do not have to click on it.
Q: But if it says one?
A: Then I know that at least someone was interested enough to reply. Then it could be somewhat interesting.
Q: Why?
A: Well, if someone found it interesting enough to reply, the chance is greater that I will find it interesting, **so it is like uh... more information**.

Again, reading and general usage of the system seem to have been driven by the level of activity in the system.

As to understanding place labels, users seem to have been fairly positive overall. One interviewee suggested that each location ought to have a basic set of labels (provided by the system administrators) before users' own labels are allowed into the system. Another proposed administrators to occasionally clear locations of nonsense labels. No one, however, explicitly rejected the system as such. In this way, the place label system practically eliminated the confusion experienced by users of [3 and 4].

Results - Conceptual Metaphors

On a direct request to describe the core of the system, 4 users in the subset employed the metaphor of a (location-based) 'forum' or a 'bulletin board system'. The forum metaphor also showed up in the expressions used in the interviews. What we called *comments* were often referred to as *replies* (Swedish: *svar*). 6 users circled around the notion of a note/message/graffiti board on which you attach messages. 1 user associated the system with 'post-its for your laptop'. Yet another described it in terms of 'the wisdoms left on bar toilets'. (Due to the open interview format not all subjects provided a clear metaphor.) Throughout the interviews, however, ICQ was often employed as a ruler to talk about GeoNotes:

A: Yes, a....virtual messages connected to a geographical place. **Like an ICQ but you put notes on things**.

In contrast to E-graffiti, GeoNotes thus seemed to succeed avoiding the e-mail metaphor. On the other hand, would not the newsgroup and forum metaphors frustrate the users when they found out that messages/notes could only be accessed and authored locally (similar to E-graffiti users)? In the interviews, one subject deliberately brought up the subject of wanting to read remotely. 2 subjects wanted to be able to read own notes and their comments remotely (not realizing that this functionality already existed in the system under 'own' notes). Only one subject thought remote writing would be nice. The majority of subjects, however, on a direct question, did not report frustration. Moreover, most subjects raised concerns about allowing remote authoring and reading in future versions of GeoNotes. Typical objections included: it would "go against the whole concept"; "it will blur with something else"; "then the whole idea disappears".

Discussion – Conceptual Metaphors

The fact that no subject compared GeoNotes with e-mail, suggests that the open information space of GeoNotes (no directed notes) was successful. Instead, GeoNotes' emphasis on comments and the comments board seems to have been interpreted in terms of threaded discussions in newsgroups and forum system. In addition, in spite of the fact that our subset subjects were used to access their newsgroups, forum and chat systems from any place in the world, remote reading and authoring were generally considered to spoil the system. This indicates that at least some users 'got the feeling' for location-based information and services, understanding its merits vis-à-vis global-access information systems. Accustomed to accessing information from anywhere in the world, these PC/Internet generation users probably had a hard time with the location-based aspects of GeoNotes:

A: ...when you sit in front of a computer **you are not used to being bound to a place in that way**, so you...its **not natural** when you sit in front of a computer.

The reoccurring comparison with ICQ was presumably caused by a number of factors. First, the small GeoNotes main window (Figure 1) looked suspiciously like an instant messaging interface, located "on the side of the screen":

A: It is appropriate to say that it [GeoNotes] reminds of ICQ, but also not in a way. **The interface reminds a lot but** the content is completely different. **By first sight it is very similar to ICQ**, but when you take a closer look so.... its not users but notes instead.

In addition, both GeoNotes and ICQ focus on the notion of 'friends' (the invitation process is in fact quite similar). However, while ICQ friends pop up when they get online, GeoNotes friends only functioned as a way to find interesting GeoNotes (sorting the main window list and to see notes friends had authored and read). This metaphorical confusion surfaced nicely in one of the interviews:

Q: Did you invite friends?
A: Yes I did, but it worked.... but I did not quite understand... **you could see when they went online somehow like ICQ...or how did 'friends' actually work**?

SUMMARY

The results of this study have implications on how location-aware community systems should be designed in the future. Notes in were primarily related to synchronous and non-synchronous *activities* in space, rather than *objects*, indicating that *social* space is more important than *physical*. Location-based chat with acquaintances and strangers emerged as an important motivator, indicating the need to support meaningful comments and threaded discussions, in addition to anonymous signatures. Some form of place label system is indispensable since it performs a number of functions. It allows users to formulate their own notion of

space, not that of the system administrators (in our study 'rooms' seemed to be more important than 'buildings' and 'objects'). Equally important, labels help readers identify the position of the note, thus making content and system more meaningful. System and UI have to be designed in a way to trigger the right conceptual metaphors for these kinds of never-seen applications. The terminal's size-weight factor and network coverage inhibited the mobility and heavily influenced the usage practice of GeoNotes. In order to get the final answer about the real value of location-aware community systems, small terminals with city-wide coverage area needs to be emphasized in future evaluations.

ACKNOWLEDGMENTS

Funding for GeoNotes was provided by the Swedish Research Institute for Information Technology. Fredrik Espinoza, Rickard Cöster and Anna Sandin provided invaluable help in implementation. Damien Bailly, Joanna Drapella, Tommy Gunnarsson, Tobias Larsson, Adam Lindström and Pawel Wiatr assisted with GeoNotes in StockholmOpen.net. The authors also would like to express the gratitude to Elenor Cacciatore, Martin Svensson, Hanna Nyström, Markus Bylund and Kristina Höök, Jim Youll, Kåre Synnes and Mikael Nehlsen.

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