KnoWhere: User's Attitudes towards and Experiences with an Experimental Location Based Service

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Abstract. Users' attitudes towards the use of an experimental location based service running on a mobile phone using Wi-Fi beacons as a locator are reported. Twenty one users took part in the trial and sixteen went on to be active users. Detailed results based on logging and user interviews are reported exploring usage, perceptions and experiences. The attitudes reported to a service of this type were generally positive.

Keywords: location based services. Wi-Fi, mobile.

1 Introduction

Context enriched services are recognised as a key growth area for mobile based services [Jones, 2010], and these are expected to emerge from the simple and ubiquitous location based services enabled by the fact that all mobile phones are able to offer some level of location information, using cellular, Wi-Fi or satellite technologies. In parallel there is a growing interest in understanding how to offer services that work with users' social networks, providing services that augment or depend upon services such as Facebook[1]. This work explores user's attitudes towards a prototype location application, called KnoWhere. KnoWhere is a mobile phone application that automatically shares a small amount of information about your geographic location. In this work we have investigated the use of, and attitudes towards this application, when used between a group of self selected close friends, colleagues or family members in trials that lasted up to ten weeks. KnoWhere is not an overtly commercial advertising or incentive based application; rather it invites users to gain comfort and utility from knowing the location of close friends.

Participants' use of the application was monitored through logs and their attitudes towards it were recorded through interviews and questionnaires. Twenty one people were engaged in testing the application in six groups. The tests took place over a period of six months. The authors anticipated a degree of suspicion towards and wariness of the application, believing that users would feel uncomfortable using an application that revealed their location.

[1] Facebook (link checked May 2010) www.facebook.com

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Not surprisingly, use of the application varied from user to user, but the log results tend to show that, for those that used the application, after an initial flurry of activity, usage tapered down to a residual constant level. In interviews no users reported feeling uncomfortable about the way the software recorded and published their location data. Five of the six groups reported a real or anticipated benefit from using the application. For some this benefit was based on the ability to better orchestrate specific events, like meeting a friend. For others it was a "warm feeling" of having an awareness of another's activity.

The main criticisms were related to the phone and not the application; users tended towards demanding more from the application, wanting more control and wanting it to reveal more rather than less about their location.

We conclude that, when designed to give users control over the way they reveal and tag locations, services that automatically reveal an individual's location could be popular with some users.

2 Background

Location based services are not new. A range of different technologies can be used to help ascertain location. Perhaps most successful is the Global Positioning System, the technology behind satellite navigation systems, which provides positioning information accurate to within a few metres calculated from the difference in time stamps received from (ideally) at least 4 visible satellites. GPS work best outside when there is an unobstructed view of the sky and hence the satellites.

For cell phones, cell ID can be used to provide some indication of position, though the accuracy of such systems will depend upon the separation of the mobile phone masts and the accuracy to which the location of a given mast is known. Chen et al. [Chen, M., et al., 2006] report a (best) median error of 94m based on tests in Seattle. In general, errors will vary from a few tens of metres to a few kilometers.

Locating based on proximity to the known locations of Wi-Fi access points can give an accuracy of a few tens of metres [LaMarca et al. 2005]. Here, the access point locations are determined by a process known as wardriving (searching for Wi-Fi access points in a car and cross correlating the WI-Fi identifiers with a known GPS location). While the database coverage of such systems in urban areas is now very good, rural areas still lack both Wi-Fi availability and the database mapping, and as a result, this approach will not provide universal positioning.

Services such a Google's Latitude and in car navigation systems often use a hybrid positioning approach where the position is derived primarily from GPS but also, in instances when the GPS signal may be weak or absent, through other means such as Wi-Fi or Cell ID positioning, or using dead reckoning to extrapolate your position in a moving vehicle based on a knowledge of your last know location, trajectory and your speed.

These technologies are used in the provision of location based services that allow users to share their location with the world or with their friends through commercial

services such as FourSquare[2], Brightkite[3], Latitude[4] (from Google), and experimental applications such as Locaccino[5] and Locyoution [Tsai et al., 2009].

Brightkite, Locaccino and Locyoution all emphasise the social networking aspects of the service. Brightkite allows users to post a message along with their location (which provides some context to accompany the location information). Locaccino and Locyoution are Facebook applications and are thus implicitly linked with social networking. FourSquare has a business model based around advertising and enables commercial premises to make incentivized offers to individuals using their location. Alternatively Skyhook[6] makes available a location engine which can provide location information for use in other applications or devices.

Experimental research has been published on location based services. This includes assessments of concern about privacy [Barkhuus and Dey, 2003] and about methods for overcoming such issues [Toch et al., '09]. Locaccino, which is designed with knowledge of the perceived privacy concerns sets out to offer people tight control over the user groups with whom they share their information.

3 The KnoWhere Application

KnoWhere is a software application that runs on a mobile phone. KnoWhere uses Wi-Fi access points to identify locations and builds on previous work of Johnson, [Johnson, 2007]. The application allows users to tag particular locations with whatever name-label they like. In the naming process KnoWhere will offer up, as a possible location tag, the location scraped from the user's Microsoft Outlook calendar, though users can ignore or change this if they wish.

HTC 620

HTC 710

HTC HD2

Fig. 1. The phone types used within the trial were all variants of HTC windows mobile devices

[2] FourSquare (link tested May 2010) `http://foursquare.com`
[3] Brightkite (link tested May 2010) `http://brightkite.com`
[4] Latitude (link tested May 2010) `www.google.com/latitude`
[5] Locaccino (link tested May 2010) `http://locaccino.org`

Skyhook, (link tested May 2010) :
[6] `http://skyhookwireless.com`

In normal operation, the application will wake up every 10 minutes (this periodicity can be changed), turn on the phone's Wi-Fi connectivity if it is not currently on and "sniff" for Wi-Fi access points. If the Wi-Fi fingerprint detected matches the fingerprint of a labeled Wi-Fi signature, then that label is published to a presence server. If the Wi-Fi signature is not recognized the user's location is published as 'unknown'. If no Wi-Fi connectivity is detected the location will be uploaded as "undefined".

The application was designed to minimize battery usage and so would automatically turn Wi-Fi off after its periodic "sniff". In our work the application worked with a range of HTC Windows mobile devices including the HTC 620, The HTC 710 and the HTC HD2 phone which are all shown in Figure 1.

The application presented a user's published location on the home screen of the phone so they could easily see, and if necessary adjust, the location they published to the presence server. The location of others could be seen by clicking on the KnoWhere application shown on the home screen. This action polled the KnoWhere presence server and presented the results as a simple textual table.

KnoWhere was designed for use by closed user groups and is targeted in our trials at groups of close friends or family members.

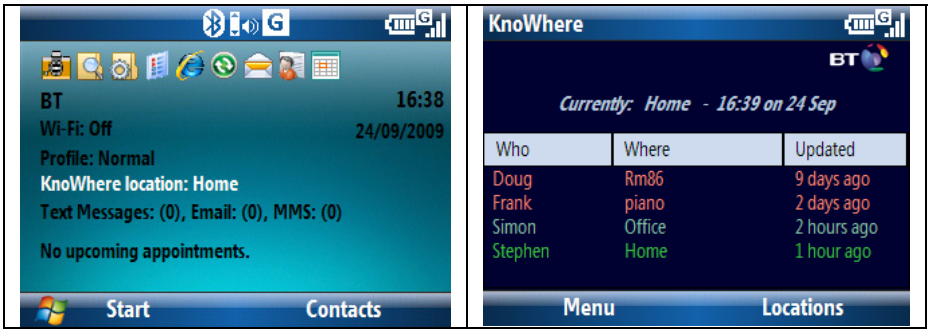

Fig. 2. The mobile phone home screen (which shows the location the user was publishing) and the KnoWhere page, which displays the locations of the user's close friends/family

4 Experimental

In order to learn more about a sample of potential users' attitudes to, and use of the KnoWhere application, we conducted a number of user trials in which groups of people were invited to use the KnoWhere application for between six and fourteen weeks. A condition for participation was that users must use one of the eligible HTC smart phones as their main phone for the duration of the trial. We had available four HTC 620s and two HTC 710 variants.

The application either came pre-loaded on the loan phones, or could be downloaded and installed on the phone by the users. Clear written and verbal instructions were offered as was personal help in order to get the application up and running. Once the

trial had started the researchers made no interventions unless they suspected from log results that there had been a system malfunction.

Usage was recorded in logs, which were triggered every time users activated the KnoWhere application on the phone or tagged a new location. At the end of the trial users were invited to take part in a short on-line questionnaire and to take part in a closing interview.

When the phone scanned its environment in order to create a location tag, a local log was stored on the phone. By default, the scanning periodicity was 10 minutes though this was a user adjustable setting. When the phone had stored 20 instances of such scans (if there was a data plan in place) it attempted to upload this file to the server, for which it needed some kind of data connection either Wi-Fi or GPRS. If no data plan was in place the data remained on the phone and was collected at the end of the trial.

Data costs users incurred through using the application were covered by the research budget and at the end of the trial the user returned the loan phones.

The data collected included a user ID, the time, the tag name and whether the application had been accessed. This data allowed us to build pictures of the number of tags that people identified, the names they gave the tags and the number of times the application was accessed by the user. Together these enabled us to develop a picture of the usage by each individual.

Towards the end of the trial users were invited to fill in a simple form based on nine statements/questions. Eight of these were multiple choices, the ninth asked for a free text response.

Armed with the questionnaire responses we invited the trialists to take part in short interviews. These allowed us to go over the answers to the on-line questionnaire and to receive more elaborate and qualitative feedback. The interviews lasted about 30 minutes and where possible were held with as many members of the groups as possible in order to elicit more qualitative data on how such location based systems could serve the needs of groups.

5 Results

The trial took place in three phases because of the limited availability of the loan phones. The initial recruiting email was sent to about 150 people; this ultimately yielded six user groups including 11 people from the company. Other users were friends and family. The make-up of the groups is described in Table 1.

Table 1. Outline description of the six user groups

Group ID	*No of participants*	*Constitution*	*Days persistent usage*
G1	4	Mum, Dad, friend who helped with childcare, teenage boy	67, 70, 61, 53
G2	5	Group of friends	22, 18, 47, 2, 0
G3	4	Mum, Dad and late teenage daughter, son	141, 93, 98, 0
G4	4	Mum, Dad, daughter, son	5, 46, 2, 0
G5	2	Couple	40, 2
G6	2	Couple	57, 35

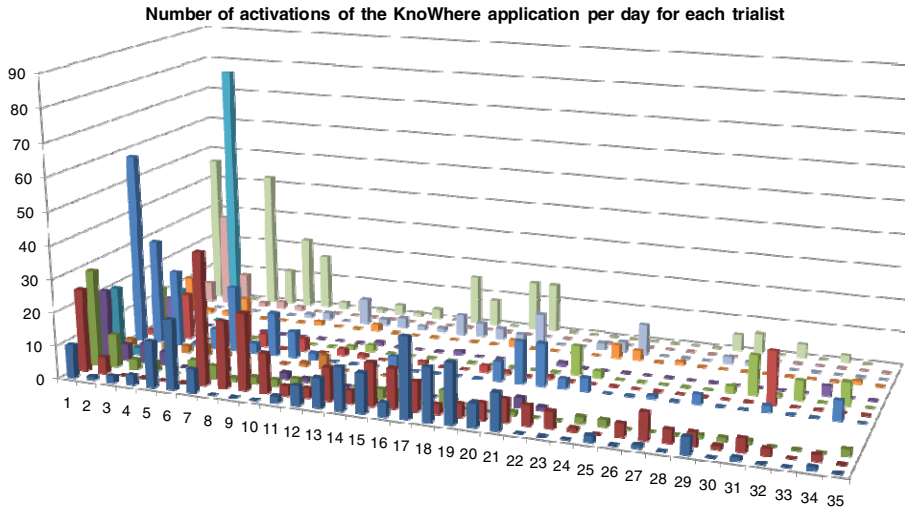

Fig. 3. The graph shows the number of daily activations of the KnoWhere application

A number of onerous practical complications had to be overcome during the set-up stage. One user for example whilst having a data plan in place, had a system that did not allow XMPP traffic used to communicate with the presence server and so their location data could not be transferred. This situation was eventually changed following communication with the service provider. Other issues including making sure that the phones were unlocked for the network used by each participant's service provider. Another hassle was negotiating the data plan (as far as possible) so that the cost of data traffic (primarily the log data only needed for the trial) could be covered by the research group. It was our intention that the triallists could take part in the trial at zero financial cost to themselves. All of these issues proved tractable but were time consuming.

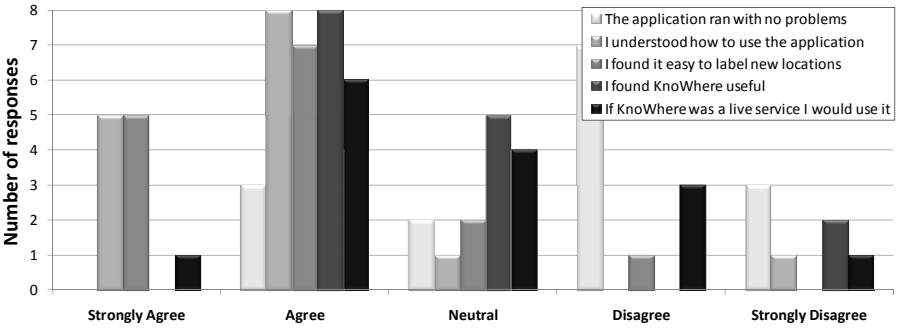

Fig. 4. On line questionnaire responses

Of the 21 triallists recruited only 15 became active beyond day 4 of their trial. Data were collected from these 15 triallists. The users tended to use the application more during the first few days but usage declined steadily towards the end of the trial.

Nevertheless users reported in interview, and the logs confirm, that usage continued at a low level with users checking the application "once or twice a week".

Questionnaire feedback forms were completed by 16 of the original 21 recruits and included one set of responses from a participant who was not active beyond day 4 of their trial. One questionnaire was substantially incomplete. The results from the on-line questionnaires are summarized below.

Users who persevered with the application for more than four days labelled between 3 and 28 different locations each. Overall 128 different name labels were recorded. Some tags were common such as 'Home'. The mean number of tags identified was about 8.5 and the mode was between 4 and 6.

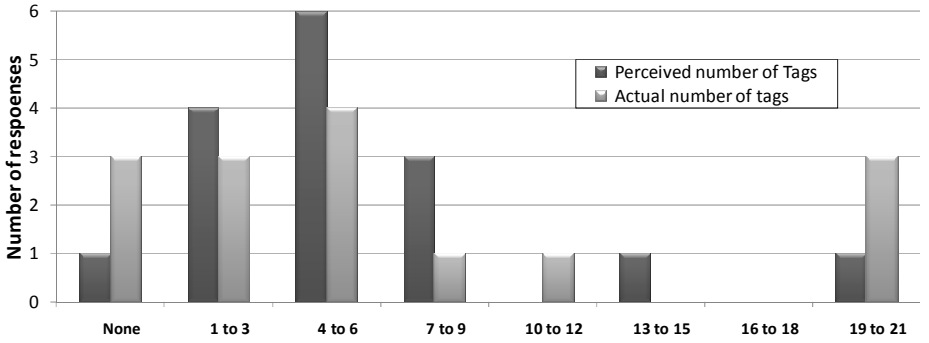

Fig. 5. The number of labels created (actuals and user reported)

Location tags included address-like titles such as a town name, building name, shop name, or room number, but also included descriptions which would mean little to someone who was not a member of the group, such as Gym, Nana's, Town or Hair. As reported elsewhere [Barkhaus et al., 2008] some of the labels were deliberately playful including affectionate names for users' homes and labels such as 'not running'.

Interviews were conducted with 10 of the 15 active users. In the interview users described choosing labels with a particular audience in mind. One user said "I chose labels that <child's name> would understand". The same user also identified not only that they were in a coffee area at work, but which side of that room they were in; this made chance meetings over lunch or a cup of coffee more likely.

The most common frequency of checking the application (measured over the last fourteen days of each user's trial) was between 1 and 3 times per day.

6 Discussion

As with many trials of this type, it was not easy to recruit users. The reasons for this were often related to user's reluctance to change their mobile phone. The phone and its behaviour were also the cause of criticism within the trial; one user reported "For me the main problem was the battery life. It was significantly shorter <than my old

phone.>". Whilst relevant overall to the user experience these criticisms should not be associated with the application, which for the most part was accepted warmly and appreciated by the users.

Groups used the application to different extents and in different ways. One group, who were highly purposeful in the way they sought to use location information, wanted to use it to aid in the picking up and dropping off of a child for whom they all shared some child care responsibility. Others were less intentional in their use but found their behaviour changing in small ways because of the application. One of Group two commented: "<friend's name> lives next door to me. When going to visit him instead of calling I would check his location." And another user similarly reported "When calling <Friend> I found myself checking if her mobile was at home first <using the KnoWhere application> then calling on the landline rather than the mobile phone." A third user said: "I noticed <friend's name> location changing from 'undefined' to 'home' and rang her right away. She said "I have just got in" and I said "I know" and laughed." Another user also reported using the application to try and engineer meeting a colleague so they could travel home together by checking whether said colleague was working in the head office building.

Whilst the groups did find utility from the application they also reported some limitations. The group who wanted to use the application to coordinate child care were frustrated that a Scout Hut could not be fingerprinted (because there were no local Wi-Fi access points around) and thus they could not tell whether the child was at Scouts or not and had to revert to SMS exchanges. In the interview they reported that they would have found it useful to include automatic location information from sources such as Cell ID or even GPS as this would let them know when the child was waiting outside the scout hut. They also told us that imagined that "knowing <friend> was in North Ipswich would be useful; at least I would know they had left work and were on their way…".

One of the young professionals was a strong advocate of the system but was frustrated by the fact that so few of their friends were using the system "to really work I'd have to get all my friends on the system that would be really useful. I can imagine deciding to go to particular pub to meet up if I could see where most of my friends were that evening."

One triallist commented that whilst location information was interesting it had limited utility without a context. They felt it would be more useful if information, such as the duration for which a person had been in a particular location, had been included.

One user suggested that alarms or alerts could prompt the user when a person was in the same location as them or when a person had reached a particular location – this would prevent users having to continually monitor the system and provide the utility required.

The KnoWhere application only offered users one group to which they could belong. Users anticipated that they would like to be able to manage several groups and commented that they would like to manage the permissions for different people in different ways so that the same place might be visible in different ways. An office location say, may be labelled quite specifically for work colleagues, but just identified

as 'work' for non-work colleagues for whom the specific address would be meaningless. Similarly they felt that location outside work hours or outside the work location should not be made visible to people in a work group. One user commented "I think there should be a way to create groups to configure this as I might not want all of my contacts to see my location at any time."

One user also suggested they would like an override function so that the user could change the location published by the system temporarily.

Applications such as KnoWhere, which have the potential to disclose information about an individual, in this case their location, can be viewed as raising significant privacy concerns. The authors anticipated these to be issues of some concern to our user group. However, no one mentioned privacy unless prompted. When prompted, users reported that they had no concerns. We interpret this as suggesting that our users were satisfied and comfortable with the notion that their location was being shared within their well understood and controlled friendship group. One user commented "provided that the information is being shard in the way that I have been told it is being shared it is not a concern."

7 Conclusions and Further Work

KnoWhere is a small software client which runs on a mobile device. KnoWhere automatically determines its location and shares it with your chosen peer group. KnoWhere uses Wi-Fi access points as its location points and allows users to each apply a personalised tag to any Wi-Fi enabled location; the device will then publish the tag whenever it returns there. This application provides the basis for a very simple consumer and a corporate whereabouts service that works well indoors unlike other technologies such as GPS.

The results from the study suggest that whilst the application was valued by consumers they would value it more if the coverage it offered was more complete. Value was recognised for practical intentional tasks, like arranging to meet people at a certain location, but also as a way of keeping people who know each other well connected and aware of each other when apart. This leads us to suggest that location based services could be targeted at close friends and families but for appropriate utility they should be based on multiple location technologies and not just Wi-Fi. Future research should be conducted into the impact of publishing greater contextual information about a person's location in order to provide users with a richer picture about the tracked person's intent and action.

The fact that users did not reveal high anxiety levels about privacy issues within the trial suggests to us that some people are happy for devices to automatically disclose information about their location to a group of people that they select.

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