Enhancing the Experience and Efficiency at a Conference with Mobile Social Networking: Case Study with Find & Connect

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Abstract. With mobile devices and wireless technology becoming pervasive at conferences, conference attendees can use location-based mobile social networking applications such as Foursquare and Gowalla to share their location and content with others. How to use the mobile devices and the indoor positioning technology to help the conference participants enhance the real-world interactions of people and improve efficiency during the conference? In this paper, we report our work in Nokia Find & Connect (NF&C) to solve this problem where we use location and encounters, together with the conference basic services, all through a mobile UI. To demonstrate the usefulness of the NF&C system, we conducted a field trial at the 7th International Conference on Ubiquitous Intelligence and Computing and Autonomic and Trusted Computing (UIC/ATC 2010). Results show that NF&C can help the conference participants enhance the real-world interactions of people and improve efficiency at a conference effectively.

Keywords: mobile social networking, indoor positioning, conference-assisted system, case study

1 Introduction

The number of mobile devices is growing at an explosive rate. Worldwide mobile device sales to end users totaled 1.6 billion units in 2010, a 31.8 percent increase from 2009. Smart phone sales to end users were up 72.1 percent from 2009 and accounted for 19 percent of total mobile communications device sales in 2010 [1]. With mobile phones having Internet and web capability, users can easily access and update their online social networks in real time and with real location using applications such as Foursquare and Gowalla. There are many applications that use GPS for location, but few that use indoor location positioning technologies.

However, Wi-Fi wireless networks are becoming increasingly pervasive in many of the indoor places like hotels, schools and offices. Wi-Fi can be used as indoor

positioning technology for location tracking and navigation. Today, for example, Ekahau Real Time Location System [2] is one system that uses Wi-Fi to track tens of thousands of mobile objects, assets or people, in real time with only a few second update intervals, with down to 1-3 meter accuracy. Wi-Fi is becoming a necessity at conferences and conference programs are readily available to read on mobile devices, however few conferences support a real-time location-based conference system.

Much of the work on conference-based support systems can be divided into two parts: network and proximity-based systems and conference content-based systems. Network and proximity-based systems only focus on the interplay of networking and social contact at a conference, but do not provide other conference-supported services and are always dependent on specific device and network support. Conference content-based systems only provide services for the conference participants based on the conference content, but do not consider about the effect of user locations on enhancing the real-world interactions of people.

Considering the shortages of these two kinds of conference-based support systems, we designed Nokia Find & Connect that uses location as the basis for integration with the network and proximity-based system using encounters, together with the conference content-based services, all driven by a mobile UI. Our contribution is that we designed a system for enabling opportunistic social networking, that is, helping to connect with other people in the conference at specific opportunities based on recording encounters and social interactions, as well as providing a richer, enhanced social networking and conference experience.

To demonstrate the usefulness of our system, we conducted a field trial at the 7th International Conference on Ubiquitous Intelligence and Computing and Autonomic and Trusted Computing (UIC/ATC 2010) [3]. Through performing a user study with user behavior analysis and surveys, we show that NF&C can help the conference participants enhance the real-world interactions of people and improve efficiency at a conference.

Our paper is organized as follows. Section II summarizes related work. A full description of Nokia Find & Connect is given in Section III. Section IV covers the trial and outcomes of the application deployment at UIC/ATC 2010. Finally, we conclude the paper and provide avenues for future work in Section V.

2 Related Work

Much of the work on conference-based support systems can be divided into two parts: network and proximity-based systems and conference content-based systems. Network and proximity-based systems such as [4, 5, 6, 7, 8] only focus on the interplay of networking and social contact at a conference, but do not provide other conference-supported services. For example, memetic spreading [4], opportunistic networking for mobile devices [5] and the live social semantics application [6] can only obtain the encounters of people, but not the user's position. IBM's RFID system [7] and Yuusuke's system [8], on the other hand, are only concerned about whether a person is in a session room, and also suffers from not being able to get the exact location of the user. All of these systems only focus on characterizing the statistical

properties of human mobility and contact, such as reachability to connect indirectly with others. They lack other conference-supported services, such as building your schedule, and seeing a map of what's happening and how to get there. In addition, these systems are all dependent on specific device and network support, so they are complex to deploy.

On the other hand, there are conference content-based systems that provide services for the conference participants based on the conference content. For example, "Ask the Author" [9] helps audiences ask questions during a conference using mobile devices, such as a notebook and PDA. A conference information system in [10] allows users to query the progress of the conference and the current state of papers anytime and anywhere using a mobile client on a mobile phone and web server. Many conferences now provide their own conference applications such as SXSW GO [11] which was used for SXSW 2011. The application allows you to build your schedule, see a map of what's happening and how to get there, navigate the tradeshow and stay connected to the online social world like Twitter and Facebook. However, systems like [9, 10] only focus on one special service for the conference and do not consider about the interplay of networking and social contact at a conference, especially encounters. SXSW GO [11] and others do not consider about the locations of users or the social network in the real world.

Our Nokia Find & Connect system differs from previous work in that we combine and integrate user location with a network and proximity-based system using encounters together with the conference schedule using a mobile UI. We do this by using readily available and popular technologies. We use mobile phones (instead of special hardware sensors), use the indoor Wi-Fi network, and specifically use the indoor location to record where attendees are, to provide location-based services such as finding where people are at the conference, where sessions are held, creating a personal conference schedule, and for establishing social networking connections such as exchanging personal information and communicating with others based on your encounters and similarity with others. In this way, we provide a much richer, integrated and social experience that provides opportunities for users to meet and connect with others.

3 Nokia Find & Connect

3.1 System Architecture

Nokia Find & Connect (NF&C) is a location proximity-based conference-supported system for conference participants to social network. The system architecture is a three-tier architecture, which includes the presentation layer, session layer and database layer as shown in Figure 1.

There are two kinds of clients in the presentation layer. One is a mobile client for the conference participants which contains the Positioning Client and the Browser Client. The other one is a PC Client which shows the social network visualization and position in real time.

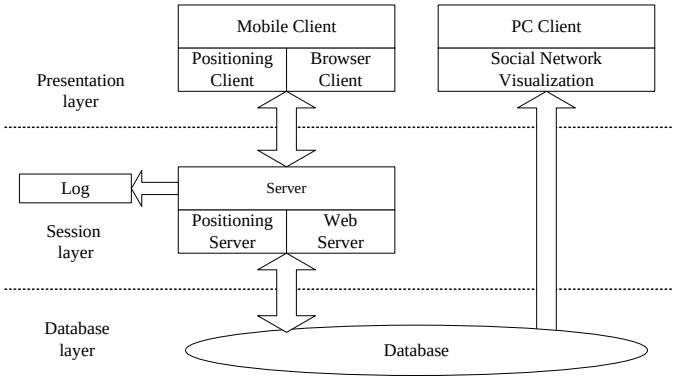


Fig. 1. System Architecture of NF&C

The Positioning Client and the Positioning Server compose the positioning subsystem. The Positioning Client collects Wi-Fi signal strengths from nearby WLAN access points at a user-specified interval, and sends them to the Positioning Server through the User Datagram Protocol. After the Positioning Server receives the Wi-Fi signal data, the Positioning Engine uses the Positioning Model and machine learning algorithms to approximate the positioning of the user. The Positioning Model is created by performing a site survey that involves recording the Wi-Fi signal strengths and access points of the conference place. For our implementation, we used an off-the-shelf commercial Wi-Fi positioning system, called the Ekahau Real Time Location System [2].

The Browser Client sends requests to and receives responses from the Web Server in JSON format through TCP. Then the server reparses the JSON message, and sends the result back to the Browser Client. The internal implementation of the Positioning Client, the Positioning Server, the mobile Browser Client and the Web Server is shown in Figure 2.

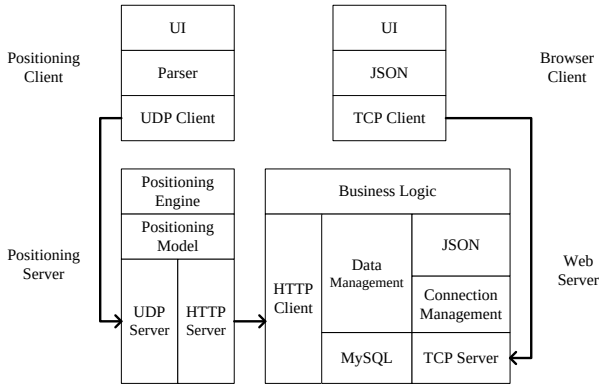


Fig. 2. Internal Implementation of the Mobile Client and the Server

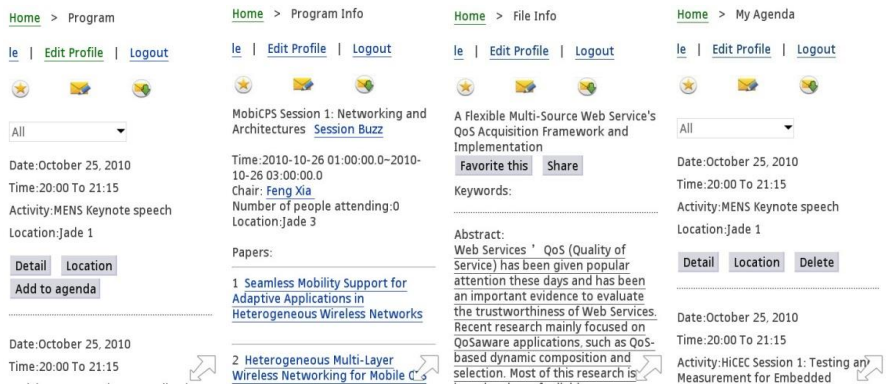
The information stored in the database includes activity content, paper content, user content and message content. Activity content includes topic, time, location and chair of each session, papers in that session and comments that users make during the conference. Paper content is title, keywords, abstract and author lists of all accepted papers. User content includes user profile, friends, friends recommended, agenda, favorite paper and encounter information of each user.

The server logs record every request from the clients including time, username and specific page accessed, parameters and location for further data analysis.

3.2 Features

Five functional modules are in the home screen: My Agenda, Program, Map, Social Network and Buzz.

My Agenda and Program. In Program (Figure 3 a), you can see all the activities happening in the conference and the time, location and the detail of them. You only need to select the button to add it to your agenda. Figure 3(b) shows the activity detail of a session, and all the papers in that session are listed. It will help you to find your favorite session. Paper Info is shown in Figure 3(c). You can send a SMS to others to share your favorite paper easily, as shown in Figure 6(a).



(a) Program (b) Program Info (c) Paper Info (d) My Agenda

Fig. 3. Program & My Agenda

Map. In the Map module you can see the locations of people who are using this system in the conference. The users' locations are shown on the map as in Figure 4. Search Online People can help you find the location of the people you want to meet. You will never worry about missing the academic stars during the conference.

People on the map can be filtered by: all people, friends, sessions and only yourself. You can then select the link of the person to see his/her profile. If you select a specific user in the user list, you will see only that person on the map.

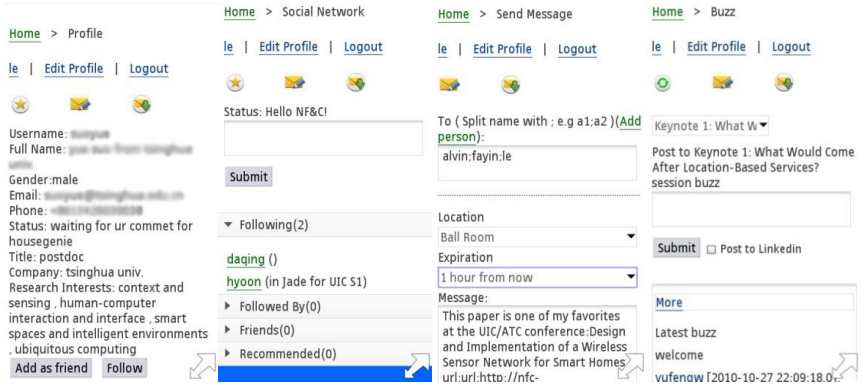
Fig. 4. Map

Profile & Social Network. The user's profile is similar to other social networking sites as shown in Figure 5(a). Users can manage their friends by adding and removing friends, and obtain the friend's details. When the user selects a friend or a contact that is nearby, that user can look at the contact details. These include downloading the contact's business card to the phone, and finding out the last encounter time and location.

When someone wants to add you as a friend, you will receive a SMS. You can choose whether or not to make friends with him/her by reading the friend request and deciding whether to accept. You can also choose to follow the person whom you are interested in.

In the Recommended part of the Social Network page, there is a list of people that are recommended to be added as friends based on common friends, common people that both are following, same favorite session, same favorite paper and encounters.

Communication. There are three different means to communicate in Nokia Find & Connect. In Figure 6 (a), we see the screen for sending a message. First, you can send a standard message to one or many users. Second, you can send a location message, if you choose the Location, then you can select the Expiration Time as to when that message will continue to be sent until. The location shows a list of all rooms in the conference. Whenever the users go into the room they can receive that message within the expiration time. In Figure 6 (b), you can also discuss about the various sessions in the conference such as the Keynote 1 by posting a message and viewing other people's posts. We call this Session Buzz. We allow users to post the buzz also to the LinkedIn social network for others to view.



(a) Profile (b) Social Network (a)Send Message (b)Buzz

Fig. 5. Profile & Social Network

Fig. 6. Communication

Visualization. To promote Nokia Find & Connect, we create a visualization of where all people are on the conference map and show the relationships among the people as a social graph in real time. We discover that this provides a hub of activity for participants and non-participants to see where they are and where their other friends are. The system uses the username to designate the user and if two users are friends then there will be a red line between them and a green line to indicate a follow. The visualization client can help the social scientists get the structure of the social network visually. Figure 7 shows one snapshot of the social network visualization captured at the conference.

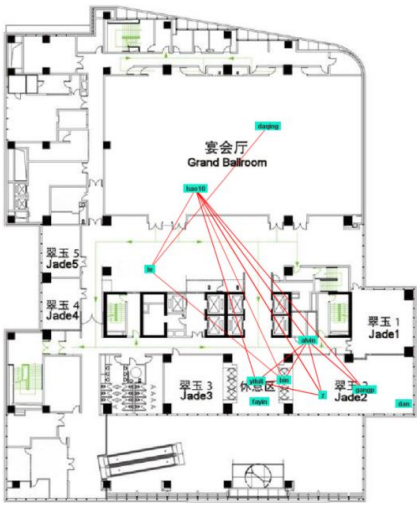


Fig. 7. Snapshot of the visualization of users at the conference and social graph in real time

Privacy. Privacy protection is an important part of the NF&C system. Permission was sought from all participants for collecting and using their data. A standard ethics participation agreement explained what the data was and how it was going to be used. We anonymized all the data in our analysis. Users can set whether to share location information to others or to friends or just private in their Profile.

4 Trial of Nokia Find & Connect system in UIC/ATC 2010

Nokia Find & Connect was developed and piloted in the UIC/ATC 2010 conference for four days during October 2010. During the trial, we provided 50 Nokia X6 and 50 Nokia 5800 phones for the participants. A big display was placed in the hall to show the location of participants and social network visualization as shown in Figure 7, in real time.

4.1 User Behavior Analysis

A total of 112 people registered for the trial, of which 62 users were authors of a paper in the conference and 50 users were non-authors. In our database and log, we recorded the profile, friends, followers, friends recommended, agenda, favorite papers, encounter information and so on for each user. From this data, we analyze the various social networks formed from the social interactions of friend and follow relationships arising in NF&C. We also analyze the location distribution of the users.

Friend Network. From the acceptance of friend requests, we discover 59 users in total who have at least one friend in the friend network and 221 friend links generated. Each user has an average of 7.49 friends and 59% (257/436) of all friend requests are accepted.

A total of 2829 friend recommendations are generated during the whole trial, and 274 of them are added as a friend request by 35 unique users. This means that about 10% of total friend recommendations are converted into friend requests.

We perform a network analysis of the friend network for all registered users and report the results in Table 1. Authors significantly dominate the friend network with 55 users.

Figure 8 shows the visualization of the friend network. In this figure, we have chosen the red dot as the selected person and the yellow dots are that person's friends.

Follow Network. A second form of social interaction network is the follow network which comprises of all users that follow others and others that follow that user.

A total of 62 users are in the follow network with 184 follow links generated, 57 unique users follow others and 37 unique users are followed. The reciprocal percentage is 0.1739, making it highly asymmetrical which makes sense because follow is a unidirectional relationship that does not require a response. Average degree is 2.96774 which means a user follows around 3 people. The comparison of

social network properties of the friend network and the follow network is shown in Table 1.

Figure 9 shows the visualization of the follow network. In this figure, we have chosen the red dot as the selected person and the yellow dots as the people that that person follows.

The numbers of people who are involved in the friend network and the follow network are almost the same. The number of links in the follow network is less than that of the friend network. The friend network is much denser than the follow network, has a smaller diameter, is more highly clustered with a larger clustering coefficient, and has similar average shortest path length. This means that the friend network is a tighter and intimate network than the follow network due to the reciprocity of friend requests and its social connotation, which is not a surprise.

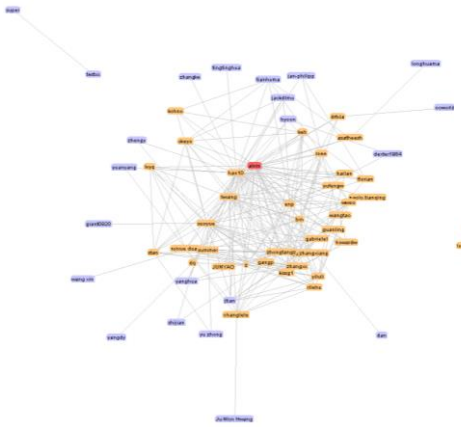


Fig. 8. Friend Network Visualization

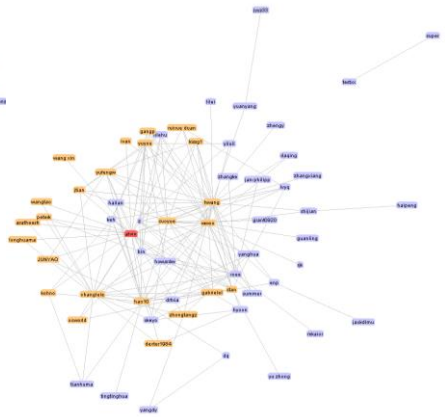


Fig. 9. Follow Network Visualization

Table 1. Comparison of Friend Network and Follow Network

	Friend network	Follow network
# of users	59	62
# of links	221	184
Average # of friends/followers	7.49	2.97
Network density	0.129	0.04865
Network diameter	4	6
Average clustering coefficient	0.462	0.387
Average shortest path length	2.120	2.679

Location Updates. From the trial, a total of 83 users uploaded 1,430,121 locations. Figure 10 shows the distribution of the location updates by every user which appears to follow an exponentially decreasing distribution. Aggregated positioning of users over the 4 days is shown in Figure 11 and we can clearly see that by overlaying the scattered patterns to the conference map, we can clearly see which rooms in the conference had the most activity presence of users.

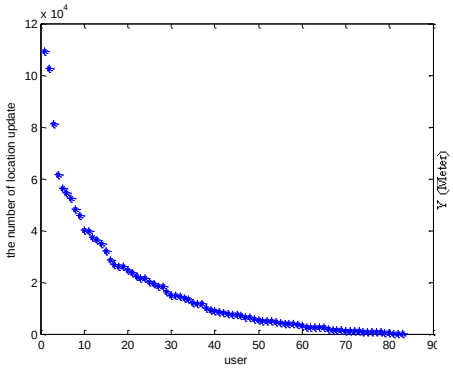


Fig. 10. Location Updates by Every User

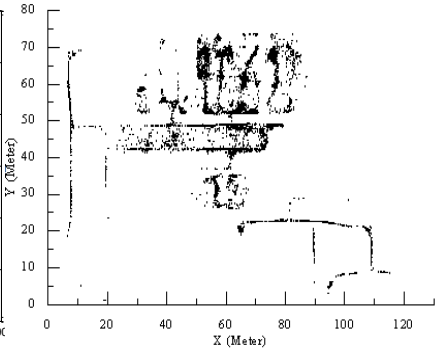


Fig. 11. Aggregated Positioning of Users

4.2 Survey Results

We released two surveys in the conference. The pre-trial survey is the Social Network and Conference Survey which was provided to participants before the beginning of the conference. This was designed to get background knowledge of the social network behavior of the participants. The exit survey is the User Experience and Feedback Survey which was provided to participants at the end of the conference to obtain their feedback from using the software. We received 86 completed pre-trial surveys and 83 completed exit surveys. 49% of the participants were aged 25-35 years old, 79% were male and 91% were from academia.

User and Social Network Behavior Summary. From the Social Network and Conference Survey, we can reach the following conclusion. Most of the users use QQ as their online social network (OSN) and they use OSN at least once a day, and average 15 min to half an hour each session to keep in touch with friends. Some users use QQ on the phone at least once a day, while others never use OSN on phone. Most users never use proximity-based or LBS apps, some have used Google Latitude. All users have never used an indoor social networking application. Most do not use OSN for conferences, some have used Facebook and LinkedIn and over half of the users add people from the conference to Facebook. All users have never used a conference system designed for mobile devices.

Therefore, these users are prime to try out Nokia Find & Connect because they do have social networking experience, but not on the mobile and have not used any proximity-based location applications.

Usage and Usability. From the User Experience and Feedback Survey, we can reach the following conclusion. The user interface was average as to what they expected (62%), usable (easy to navigate) but difficult at times (67%), and overall ease of use was usable but difficult at times (60%). Location accuracy showed that they were in room when they entered the room. Social network visualization on the big display was also helpful. Most of the users made 0-5 new contacts.

Comments and Problems. Participants found the UI on the mobile phone was a little hard to use, and the interface was a little complex to get a message. Many SMS messages were received during the sessions for the location-based posts thus interrupting them, so we need to figure out a way to reduce the number and only send when appropriate. In addition, some information was not well organized in the pages.

The results from the user behavior analysis and the survey analysis prove that NF&C appears to be useful at a conference and is generally well accepted by users. However, there are improvements that can be made as shown from the comments. The feedback shows that for building a mobile social networking application, we need to simplify the user interface and avoid overloading all information to the user, by only presenting the relevant information at that time, especially with scrolling and interruptions (in the case of SMS messages).

5 CONCLUSION

In this paper, we presented a system called Nokia Find & Connect which is a location-based proximity system using encounters and integrates with the conference basic services using a mobile UI. We use mobile phones, indoor Wi-Fi network, and specifically use the indoor location to record where attendees are, to provide location-based services such as finding where people are at the conference, where sessions are held, creating a personal conference schedule, and for establishing social networking connections such as exchanging personal information and communicating with others based on your encounters and similarity with others. In this way, we provide a much richer, integrated and social experience that provides opportunities for users to meet and connect with others.

The system was deployed in the UIC/ATC 2010 conference. The results demonstrate that NF&C can help the conference participants enhance the real-world interactions of people and improve efficiency at a conference.

In the future we will improve the NF&C UI and build a better robust system to give users a better user experience. We would like to perform user studies in other conferences to improve the performance of NF&C, as well as gather more data for our research. Finally, we would like to deploy NF&C to other indoor environments like an office environment [12].

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