Connecting People in the Workplace Through Ephemeral Social Networks

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Abstract—**Online social networking has taken off very rapidly over the past few years. Incorporating location in mobile applications such as Foursquare helps to bridge the gap between offline and online. The people that we encounter and connect with around physical resources such as meetings, provide opportunities for extending our social networks which are rarely captured. To circumvent this problem, we use the concept of ephemeral social network to capture opportunistic physical proximity encounters in a workplace environment. We investigate how social connections can be established and integrated with workplace resources using location through our user interface, and we examine the user behavior around the social connections and ephemeral social networks. We developed a mobile social network application called Find & Connect for this purpose in our office. Results show that offline interactions of encounters and meetings do help in creating online friendships, and that the friend network, friend encounter network and meeting friend participant network form small and uniform subgroups which can be used to enhance friend recommendations and social networking.**

Keywords-ephemeral social network; proximity; online social network; mobile social network;workplace management

I. INTRODUCTION

With the ubiquity of mobile devices and network technology, online social networking sites (OSNs) have blossomed over the past few years, however one of the problems is that they are not integrated with real life. In the office, very often people do not remember if they have met the person nearby and miss opportunities to make relevant connections. Adding positioning technologies such as GPS to mobile devices that are combined with the OSN can be a feasible solution to the above problems, as have been implemented by Foursquare and Google Buzz.

According to Jyri Engestrom, "social networks consist of people who are connected by a shared object", which he calls object-centred sociality [15]. For example, in Flickr, the social objects are the photos which users tag, comment and share with others. Therefore, the problem yet to be solved is how to use the resources in the physical environment (like the office) to help facilitate social networking and vice versa. Physical resources are social objects where people connect to each other. In the office, the meeting room is the shared social object because people meet there and can make new friends. Our objective is to bridge the gap between offline and online in the workplace environment to provide opportunities where social networking can occur.

Our research questions are the following. First, how can social connections be established and integrated with workplace resources through positioning technology? Second, what is the user behavior around the social connections and ephemeral social networks, where ephemeral social networks are created based on opportunistic encounters that occur for a short time period during a specific activity? Inspired by the demands of managing office resources and the concept of object-centred sociality, we designed and developed a location-based social networking solution for workplace and office management called Find & Connect that uses the workplace resources such as meeting rooms and desks as social objects.

Our major contributions are two-fold. First, we present Find & Connect as a system and user interface for connecting with others through the location of office resources such as meeting rooms and the location of people and their proximity encounters. Second, we conduct a case study of Find & Connect by deploying it in our office to demonstrate its usability and viability in creating new social connections and ephemeral social networks. Results show that viewing a person's profile is the most popular, followed by adding a friend and finding encounters between you and another person. Encounters and meetings helped to build friendship from our friend recommendation study. Finally, social networks that involved friends (Friend Network, Friend Encounter Network, and Meeting Friend Participant Network) have small and uniform subgroups compared to those that do not involve friends (People Encounter Network and Meeting Participant Network) where they are large, dense, and have well-connected subgroups.

This paper is organized as follows. Section 2 describes background and related work. Section 3 describes the system and user interface for connecting to people through the workplace resources in Find & Connect. Section 4 introduces the concept of ephemeral social network and how it is applied in Find & Connect. In Section 5, we explain our user study and analyze the data collected from our office trial to determine the usage of social features, friend requests and ephemeral social networks associated around encounters and meetings. Finally, Section 6 concludes the paper and discusses areas for future work.

II. Background and Related Work

In this section, we describe the background and related work around location-based services, proximity-based systems and opportunistic networking, and examine the relationship between offline and online from which Find & Connect is based upon. We then outline how Find & Connect differs from previous work.

A. Location-based Services (LBS)

We are seeing an increasing number of commercial LBSes (eg. Foursquare and Google Buzz) as well as research LBSes (Intel's PlaceLab [17] and MIT's iFind [18]). However, most of these efforts have focused on accuracy improvement and ignored their impact on the social network. Barkhuus and her colleagues [4] discussed how the awareness of location people experienced of each other affected their self-presentation, but did not mention about the effect on the social network.

Tsai and his colleagues [23] also described their location-sharing application, but focused more on the impact of feedback. WhozThat [5] builds a system that ties together online social networks with mobile phones, but does not utilize the advantage of location awareness to bring convenience. However, many of the previous systems fail to exploit how mobile social interactions can be recorded and used to create and maintain social networks.

B. Proximity-based Systems and Opportunistic Networking

Many applications of social proximity-sensing software are based on ephemeral social networks and proximity encounters. Eagle and Pentland [12] review some of this work which include LoveGetty, SocialNet and Jabberwocky. The proximity encounters, detected by RF or Bluetooth, can be used for introducing people directly and making inferences about a user's social network like Serendipity [12] or for finding people nearby and suggesting people to add based on frequency of encounters like Aka-Aki [1]. This all relates to the concept of the "familiar stranger" [21] where people often pass by or encounter others but do not know them, which otherwise can be known as opportunistic networking [22]. Mobile social networks can use opportunistic contacts for friend recommendations [8] and for collaborative internet access [9], however according to [19], no killer application exists. Ephemeral groups, related to proximity encounters and opportunistic networking, are ad-hoc and used for collaboration [24] and informal communication [6].

C. Relationship Between Offline and Online

Inferring the presence of friendships among people based on physical proximity, is a very important problem in building the links between online and offline behaviors. People that check in at the same physical location are more likely to become friends compared to people that check in far away. For example, the relationship between geographic proximity of user-supplied address data and friendship in Facebook shows that the probability of friendship is roughly inversely proportional to distance [3]. Friends spend more time together and the self-reported information about the proximity with others and the number of unique physical location can be a predictor of whether there is a friendship between user pairs [13]. In addition, positive correlations exist between the number of a user's online social networking friends and the location diversity and regularity of a user's location trail as in Locaccino [11] which uses GPS, WiFi positioning and IP geolocation for location coordinates. Alani and his colleagues [2] examined the correlation between physical proximity network of face-to-face contacts created from RFID tags to the online network such as Facebook and Twitter. Social ties can also be inferred from geographic coincidences as in [10].

D. How Our Work Differs

Considering the above systems, none take into account the social interactions that occur in the ephemeral social networks and the social context of the environment. Our work differs in that we build the social links between users by utilizing the physical proximity history. Another difference with our work lies in that we use the movement of users as well as people nearby, rather than co-location. The co-location in [11] is defined if two users historically visited the same location, while in our system, we use encounter, which is defined only if two users are within a limited physical proximity at the same time but then move away.

Our work uses WiFi to collect users' positions in indoor environments, rather than RFID or Bluetooth because WiFi is readily available in indoor locations. Not only does our mobile application provide location, but we create a complete user interface that integrates with the workplace resources and the meeting room reservation system, which others have not done. Bluetooth is not used in our locator client since it is not able to provide the determinate position where the physical proximity between users takes place, and thus it lacks the social context of proximity places. We now explain our Find & Connect system for connecting people in the workplace.

III. Find & Connect: Connecting People in the Workplace Through Ephemeral Social Networks

To easily connect with people in the workplace, we build a system that integrates a user's position with the workplace resources, namely meeting rooms. We select meeting rooms because in the workplace, the majority of social interaction and discussion takes place at meetings, from which new people meet. In this section, we first describe the system architecture that enables the connections, followed by the positioning and proximity system that locate individuals and their nearby encounters. Last, we explain how we integrate the social features with the workplace functions in order to connect people through the workplace resources.

A. System Architecture

The system architecture is shown in Fig. 1 which is divided into two parts: (1) positioning subsystem and (2) NF&C subsystem. The positioning subsystem provides the user's location and the NF&C subsystem provides location-based services, resource management, and social networking to users.

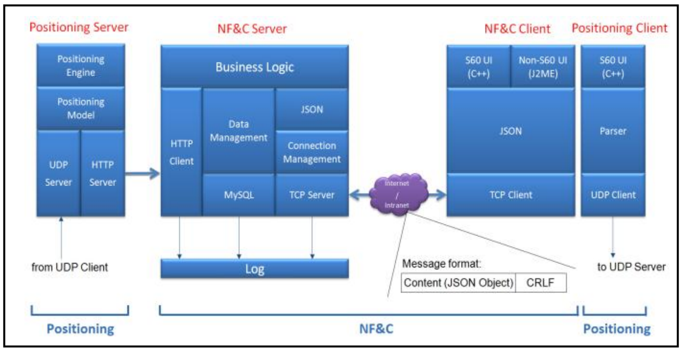

Figure 1. System architecture of Find & Connect

The positioning subsystem consists of the Positioning Client and the Positioning Server. The Positioning Client collects WiFi signal strengths periodically from nearby WLAN access points at a user-specified interval, and sends them to the Positioning Server through UDP (User Datagram Protocol). After the Positioning Server receives the WiFi signal data, the Positioning Engine uses the Positioning Model and machine learning algorithms to approximate the positioning of the user on a floor map. The NF&C subsystem consists of the NF&C Client and NF&C Server. The NF&C Client sends requests to and receives responses from the NF&C server in JSON format through TCP. The business logic layer provides the functionality of resource management and social networking. The JSON message format includes two parts, the content label and the content value. All data is stored in a MySQL database.

B. Positioning and Proximity

The positioning of the user in Find & Connect is computed as follows. Once the strongest WiFi signal strength is discovered and transmitted to the Positioning Server by the Positioning Client, the Positioning Server uses machine learning algorithms to approximate the location in (x, y) in pixels by comparing the collected signal strength with the recorded signal strengths from the Positioning Model. In the Positioning Model, the real actual map dimensions are translated into the image pixel (x, y) coordinates. In Find & Connect, we use an off-the-shelf positioning system for the Positioning Server [14].

To determine potential people that you might want to connect with, we want to infer whether you and another person are talking together, like perhaps in a meeting or engaged in some activity together. We use physical proximity to determine this and specifically, use encounter to denote the physical proximity between two users. If a pair of users are physically near within a certain distance threshold (called the encounter distance threshold) and stay at least for a certain period of time (called the encounter duration threshold) before they move away, we call this an *encounter*. For any pair of users that are on the same floor at a particular point in time, we compute the distance between the pair and if the distance is less than a specified encounter distance threshold, then we record it as an encounter. Then every 5 seconds, we compute the distance again for the same pair of users. If we discover that the pair distance 5 seconds later is also within the encounter distance threshold, then we record it still as an encounter. We repeat this process for all combinations of pairs of users on the same floor. The encounter duration is calculated as the difference in time that the pair distance becomes greater than the encounter distance threshold, and the time that the pair distance is first within the encounter distance threshold. Note, that calculating encounters is a simple, yet crude method for detecting offline activity. We do not advocate that encounters can actually determine if two people are really conversing or performing an activity. Even the positioning of the users may not be exactly accurate. However, the idea of using encounters is to record the possibility that two people may be engaged in an activity and are physically 'encountering' each other, which can thus be used as cues for establishing social contacts and social networking.

C. Connecting People

In Find & Connect, users find a particular workplace resource (such as a meeting room or desk) first and then can connect with people that are associated with that resource.

1) Finding a resource

Often in our workplace, users need to find the location of a particular meeting room for attending a meeting that has either been booked with Find & Connect or synchronized from our meeting room reservation system. In Find & Connect, a user selects "Find room" on the Map, then selects the room name as in Fig. 2 a and the room is highlighted on the floor map as in Fig. 2 b. Users can also find where a desk is if they need to find where a particular person sits as in Fig. 2 a, by selecting "Find desk" on the Map, then selecting the desk number or the person's name.

(a) (b)

Figure 2. Finding a room (a) and showing the rooms on the Map (b).

2) Connecting to people

In Find & Connect, users establish new connections through three methods: add as friend, friend recommendations, and acquaintances. As the premise of Find & Connect is to know more people in the workplace, we record this social connection using friends, similar to online social networks such as Facebook. Specifically, users can add others as friends at different opportunities. For example, you can add a friend from the map. If a person is nearby you or there are similar people nearby you (similar referring to same interests as specified in a user's profile) using the Map (Fig. 3 a) or Contacts (Fig. 3 b), or if you know of a particular person that you can search for that person online (Fig. 3 c), then you can easily add that person as a friend as is shown in Fig. 3 d. The recipient will receive a friend request along with the reason (from which function the friend request was sent) from which she can accept or reject. For example, a friend request could be "Alvin wants to add you as a friend because he is nearby you on the map". If she accepts, then you and the recipient become friends and you can see the friendship in the Contacts screen under Other Friends.

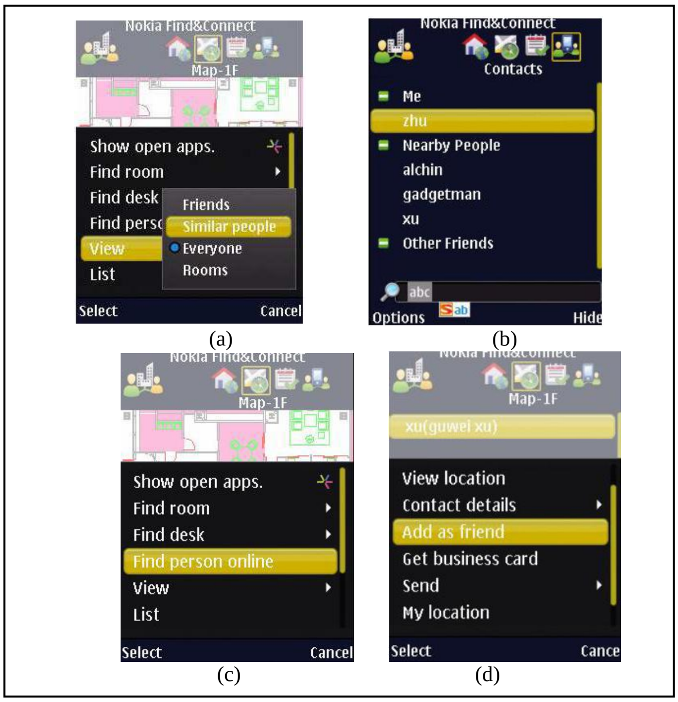

Figure 3. Adding a person as friend from the Map or Contacts screen. If you view people nearby or similar people on the Map (a) or view people nearby in the Contacts screen (b), or find a person online (c), you can select that person and then select "Add as friend" (d).

Even though we provide a simple way to add friends, you may not know who you should add as a friend. Similar to online social networks like Facebook which have "People You May Know", we provide a friend recommendation system to suggest friends you should add. However, our friend recommendation system differs from others in that besides common friends, shared content and similar profile [16], we provide context and social features. We use the following list of features that you and your potential friend have in common: common friends, number of encounters between the two, number of pass by between the two, similar interests, number of messages sent, number of question and answer messages sent, and common meetings. Pass by differs from encounters in that in a pass by, users approach each other from opposite directions and meet for a very short period of time (less than the time for an encounter) before passing each other and going in opposite directions. Our friend recommendation interface is shown in Fig. 4.

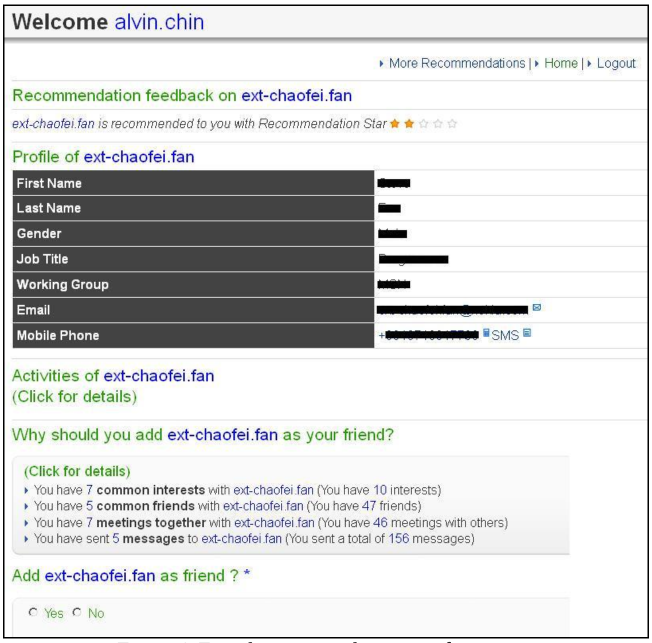

Figure 4. Friend recommendation interface.

We provide up to a list of 10 recommendations, from which you can see the name, profile and activities of the recommended friend to see more about this person. Very often, we receive friend spam where we do not know about the person who wants to add us as a friend. In our friend recommendation interface, we provide a list of reasons as to why you should add this person as a friend similar to Guy and his colleagues [16], then this can help you to decide whether to add this person as a friend. If you select "Add as friend", then a friend request is sent to the appropriate person, similarly to "Add as friend" in Fig. 3 d.

Besides friend recommendations, we also provide acquaintance information if you do not know the particular person, which can be very useful. We use the meeting history and encounter history for this acquaintance information. In Find & Connect, we keep a history of all meetings that both of you have attended (Fig. 5 a). If you have not had any meetings with this person, we can also check to see if your friends have, therefore we exploit the friend-of-a-friend relationship to allow for increased social connection, as shown in Fig. 5 b. In addition, we provide the last time that you have met a specific person and the location as shown in Fig. 5 c. By providing this acquaintance information, we feel this provides good incentive to encourage you to add this person as a friend.

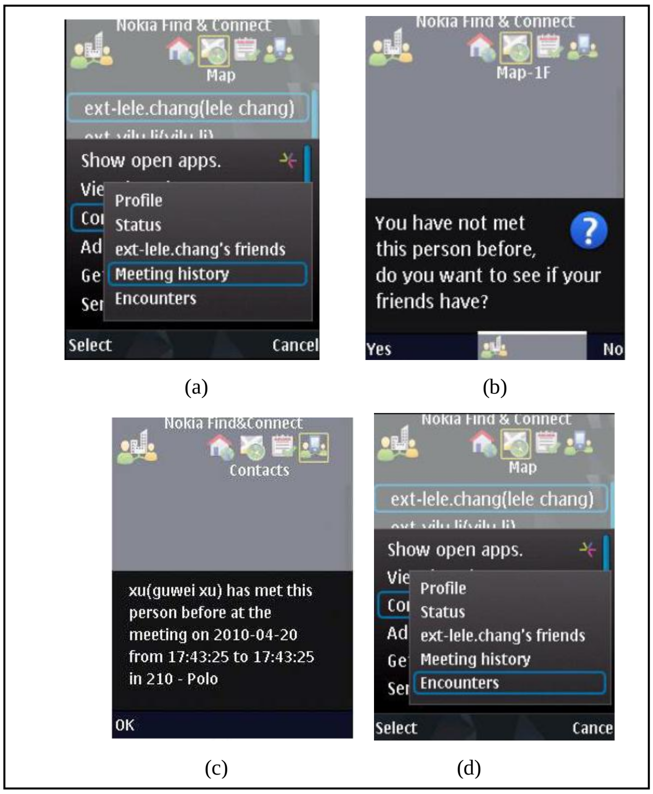

Figure 5. Acquaintance information. A user can determine if she knows this person by viewing the meeting history (a), and if none of her friends has, she can see if her friends have met the user (b), followed by specifying the time and location of the meeting (c). Also, a user can find out if she has encountered another person by selecting Encounters (d) which shows the last encounter time and location.

IV. Ephemeral Social Networking

Current online social networks (OSNs) are inconsistent with physical real social networks because users can randomly send and accept friend requests, therefore prompting the question: How many friends in your online social network are your true friends? [20] Also, many times you come across a person that you seem to know, but you cannot remember who that person is or where you have met. There is no system to record this temporary event to remind you. How can we capture social networks as they happen occasionally in the real world? We solve this problem by introducing the concept of an ephemeral social network, which is related to that of ephemeral groups [24].

The ephemeral social network is defined as a social network created spontaneously in an ad-hoc manner at a specific point in time for a specific purpose and lasting a short time. For example, employees have opportunities to attend a meeting for cooperation of a project. It is possible for some of them to know each other, while others may not. However, the ephemeral social network is created by the interaction among the participants during the meeting marked by meeting topic, meeting time and participants. Thus, it is probable to find out some interesting information, such as who just passed by, who are friends during the meeting and what are their common interests. Ephemeral social networks occur frequently in our daily lives where people opportunistically encounter each other or get together for a special purpose like having lunch in the canteen, attending a lecture, or attending other organized activities.

The ephemeral social networks in Find & Connect are based on encounters and meetings. In Find & Connect, users can find other people nearby. If you are interested in a certain person that just passed by, you can find out who that person is by using the "View People Nearby" function on the Map and then view the contact details. Then, you could get some information about that person and send an instant message to start a meaningful conversation, and add that person as a friend. You can also find out if they or their friends have met a certain person from the meeting.

You can also use Find & Connect to exchange business cards from the participants of the meeting (sent as SMS) and record their contacts on your phone for offline communication. Therefore, you can set up the relationships among the nearby people to provide services to help you build and strengthen the relationships, because Find & Connect has recorded the ephemeral social networks.

V. User Study and Analysis

In this section, we describe about the trial of Find & Connect which was piloted in the Beijing office in late May 2010. We collect and analyze usage data logged for approximately 2 months from May 24 to July 25, 2010. During the nine weeks, 151 active registered users were involved in the service.

For the encounter distance threshold, we used 10 meters because we discovered that a user's position could have a maximum error of 5 meters from the WiFi positioning system. We first discuss the usage of social features, analyze the friend requests, perform a social network analysis to understand the user's social behavior, and analyze the friend recommendations.

A. Usage of Social Features

We analyze the usage of social features in Find & Connect that are used for connecting with people in Fig. 6, namely viewing the profile (Get Profile), adding friends (Make Friend), and finding whether you have encountered this person before (Find Encounter). We find that users are most interested in viewing other people's profiles, followed by making friends with them as can be seen from the figure. (Note: "Make Friend" requests here include adding a new friend, accepting the friend request or rejecting the friend request, and also includes adding friends from the friend recommendation interface).

Recall that Find & Connect also helps people to remember the person they have met before through the "Find Encounter" request. Therefore, Find & Connect makes it easy to connect to people at any time and users will never forget who they have met in meetings or encounters. We do not include

Exchange Contacts as a social feature in the analysis because the business card exchange is just used to establish offline relationship which is independent of online social connections such as friendship.

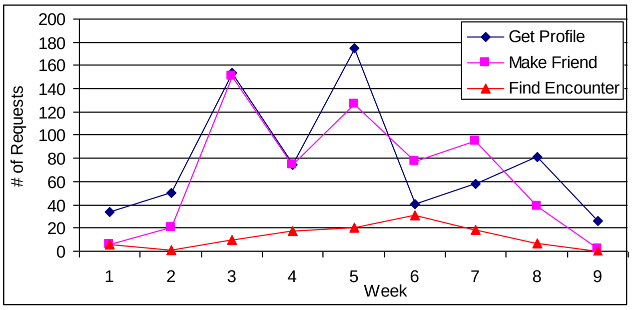

Figure 6. The number of requests related to connecting people: get profile, make friend and find encounter.

We can see in the first 2 weeks that profile requests (Get Profile) are much greater than "Make Friend" and "Find Encounter" requests, demonstrating that users in the beginning were not too familiar with the friend and encounters. However, we see in the third week that "Make Friend" requests are almost the same as "Get Profile" requests, suggesting that users began to familiarize with adding friends. Towards the later weeks of the trial (fifth week and after), the number of "Get Profile" requests are generally higher than the "Make Friend" requests, suggesting that users already have added friends, and so just use the view profile function. We observe that the number of "Find Encounter" requests is the lowest, therefore showing that users did not use much of the "Find Encounter" function either because it was not useful or they did not realize it was there so they never selected it.

B. *Friend Requests*

A total of 41 users are involved out of a total of 181 requests for making friends, from which 53% of friend requests are accepted. We also look at the reason attached in the friend request as shown in Table 1. We can see that with indoor location tracking, friend requests to nearby people are more likely to be accepted. If the friend requests from nearby people with similar interests are included, about 48.6% of the total friend requests are accepted and come from nearby people. From Table 1, 31.5% of friend requests from nearby people are accepted and 17.1% of friend requests from nearby people with similar interests are accepted. We find it surprising to see that very few people use the "Find encounters" function to discover if they have encountered others. We believe the reason for this is because an encounter is perceived as not something meaningful such as nearby or similar interests. Therefore this demonstrates that Find & Connect helps to most easily connect nearby people in the office.

C. *Social Networks*

Three types of social interactions (friends, encounters and meetings) define and construct the different types of social networks. Suppose we have two users A and B. A and B are considered as friends if A adds B as a friend and B confirms this friend request. A and B are considered as encounters if the location of both users satisfies the definition of an encounter as described in the previous subsection. Finally, A and B are considered as having met if both have attended at least one meeting together. This results in a total of 5 types of social networks that are undirected and unweighted, which we describe below. Each social network is constructed as a social graph $G(V, E)$ where V is the set of nodes (v_i | $1 \le i \le N$), N is the number of nodes and E is the set of edges (e_{ij} | $1 \le i \le N$, $1 \le j \le N$, $i \ne j$). The edge semantics for each social network is defined below.

TABLE 1: THE PERCENT OF FRIEND REQUESTS ASSOCIATED WITH EACH REASON

	Accepted (%)	Not Responded or Not Accepted (%)
Nearby	31.5%	16.6%
Similar interests and nearby	17.1%	15.5%
Same meeting	0.6%	6.1%
Found online	3.9%	3.3%
Others	0%	5.5%

1) *Friend network (FN)*

An edge between two users means that the two people are friends, regardless if they have encountered each other or not.

2) *People encounter network(PEN)*

An edge between two users means that both have encountered before according to our definition of encounter.

3) *Friend encounter network(FEN)*

An edge between two users means that both are friends and both have encountered before.

4) *Meeting participants network(MPN)*

An edge between two users means that both have attended the same meeting at least once regardless if they are friends or not.

5) *Meeting friend participants network(MFPN)*

An edge means that the two people are friends and both have attended the same meeting at least once.

Fig. 7 plots the number of nodes and edges for each social network. From Fig. 7 (a), 47.2% of nodes in MPN have friends while 87.1% of nodes in PEN do. From Fig. 7 (b), about 24.3% of the unique edges in MPN and only about 9.3% of the unique edges in PEN become friends in our system. Therefore, it seems helpful and efficient to get more friends from meetings than from encounters. Another observation is that the number of nodes and edges of FEN are similar to that of MFPN. From Fig. 7, there are 59 nodes and 91 unique edges in MFPN while there are 70 nodes and 129 unique edges in FEN. Therefore, the results suggest that ephemeral social networks from meetings have greatly contributed to building the friend network.

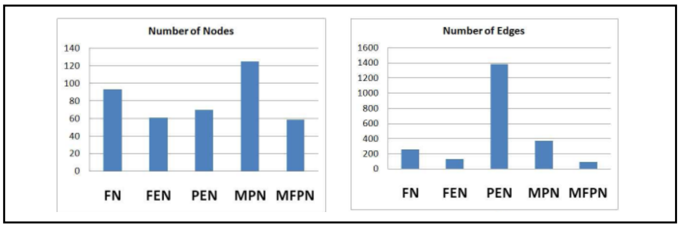

Figure 7. The attributes of the 5 networks using (a) number of nodes and (b) number of unique edges.

For each of the 5 social networks in Find & Connect, we use the following common social network properties [25] as shown in Fig. 8. Density is the proportion of ties in a network relative to the total number possible. Average shortest path (ASP) is defined as the average number of steps along the shortest paths for all possible pairs of network nodes. Diameter is the maximum length of all shortest paths between any two connected nodes. Average clustering coefficient (ACC) is a measure of degree to which nodes in a graph tend to cluster together, which relate to a subgroup's group betweenness centralization (GBC range: $0 < GBC < 1$).

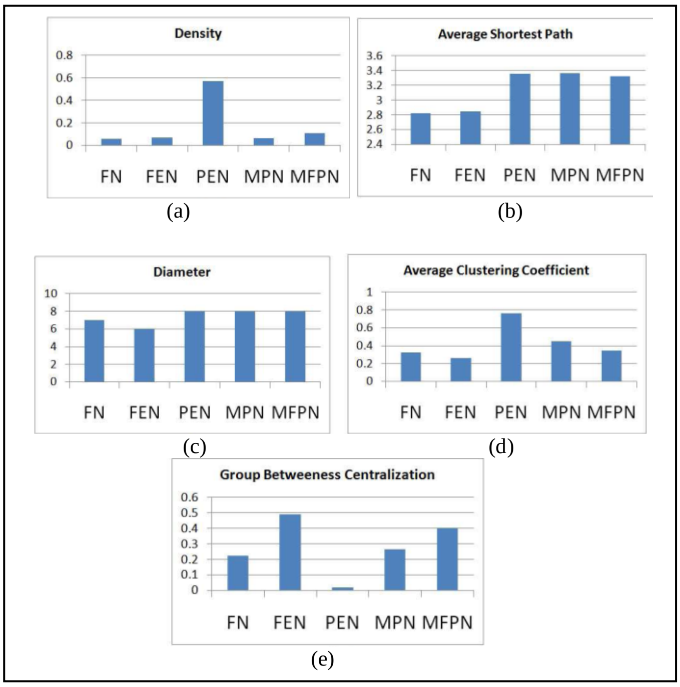

Figure 8. The attributes of the 5 networks: (a)Density, (b)Average shortest path, (c)Diameter, (d)Average clustering coefficient, and (e)Group betweenness centralization.

Fig. 8 (b) shows that the average shortest path of PEN and MPN are 17.9% higher than that of FN, FEN and MFPN, implying that becoming a friend of each other does indeed help in terms of communication efficiency. This is also supported in Fig. 8 (c), where the diameter of PEN and MPN is higher than other networks. Average clustering coefficient of PEN and MPN is higher than that of FN, FEN and MFPN, as shown in Fig. 8 (d). Higher average clustering coefficient of PEN can be explained in that encounters in PEN mainly happened within several well-connected subgroups, which is true for example in that people encounter each other a lot during lunch and at the office building entrance. The spike in density in Fig. 8 (a) supports this explanation. In MPN, people that attend meetings are mainly on the same team and connect a lot whenever a meeting starts, while the possibility of people from different teams attending a meeting is relatively small, therefore resulting in a high average clustering coefficient in MPN. However, average clustering coefficient of FN, FEN and MFPN is small, showing that people in these networks are connected more uniformly.

Therefore, these results show that social networks that involve friends (FN, FEN, and MFPN) have small and uniform subgroups compared to those that do not involve friends (PEN and MPN) where they are large, dense, and have well-connected subgroups.

D. Friend Recommendations

We recruited 10 employees in the office who used Find & Connect frequently for booking meetings and had many position updates in the system. The study took 1 hour to complete and participants were asked to perform two tasks on a phone. The first task was to evaluate up to 10 friend recommendations based on common friends, whereas the second task was to evaluate up to 10 friend recommendations based on physical context using encounters and meetings (EncounterMeet). We then provided a feedback form for each recommendation asking them whether the suggested friend was a good recommendation, was already known, was in the user's phone book, and was already a friend in one of their social network sites. Table 2 shows the results of the feedback.

TABLE 2: RESULTS FROM FEEDBACK OF FRIEND RECOMMENDATIONS

	Common friend	EncounterMeet
# of total recommendations	81	83
Average # of recommendations per user	8.1	8.3
% of good recommendations	32.1	44.6
% of recommended persons already known	24.7	37.3
% of recommended persons in phone book	9.8	13.3
% of recommended persons in SNS	14.8	16.9

From Table 2, for having nearly almost the same number of recommendations presented for both tasks, EncounterMeet overall provided better recommendations to the users than the common friend recommendation. From the EncounterMeet recommendation, users rated a greater number of good recommendations (44.6% vs. 32.1%), knew more of the recommended people (37.3% vs. 24.7%), had a fairly higher number of recommended people already in their phonebook (13.3% vs. 9.8%), had a slightly larger percentage of recommended people in their online SNS (16.9% vs. 14.8%), and accepted a larger percentage of people as friends (50.1% vs. 38.3%), than from the common friend recommendation. Therefore, this suggests that the EncounterMeet friend recommendation performed better than the common friend recommendation. However, since the sample size is small, these results need to be taken with a grain of salt, yet they are promising which is worthy of future work.

VI. CONCLUSIONS

In this paper, we explored how social connections can be established and integrated with workplace resources and we examined the user behavior around the social connections and ephemeral social networks. We presented Find & Connect, a system and application for providing social connection and social networking through workplace resources. From our study of social features for connecting people in the office, viewing a person's profile is the most popular, followed by adding a friend and finding encounters between you and another person. The encounters and meetings were helpful in generating and accepting friend requests as observed in our friend recommendation study. Finally, social networks that involved friends have small and uniform subgroups compared to those that do not involve friends where they are large, dense, and have well-connected subgroups.

For future work, we would like to perform a detailed friend recommendation study with a greater sample of users, and create an algorithm for identifying ephemeral social networks instead of pairwise encounters. We would also like to record more context on the phone to identify activities. We believe that creating an ephemeral social network provides an intuitive method for bridging the gap between offline and online.

ACKNOWLEDGMENT

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