A series of insights: location sharing

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ABSTRACT

People share potentially sensitive information with others on a daily basis. This makes it necessary to find a balance between sharing information and protecting private data. We studied location sharing and weighed different factors that impact people's decisions on sharing their location. We present our findings from conducting 12 interviews on the topic of location sharing. The most important findings from our research are qualitative findings based on the quantitative analysis of the interviews. Some of our findings are supported by previous work; other findings are not found in existing literature and provide interesting avenues for further investigation. In addition to general insights, we present some design suggestions for future location sharing systems. One of these suggestions is the automation of certain rules and the inclusion of humans to solve ambiguous situations where existing systems fail. While our insights are able to stand for themselves, further exploration and verification of our insights in real-world scenarios would be valuable.

Keywords

Privacy, location aware systems, data sharing, locations

INTRODUCTION

People share potentially sensitive information with others on a daily basis, even through media that are perceived insecure, such as the Internet. In fact a wide variety of services exist that facilitate sharing of personal information with only a set of trusted friends and colleagues. Examples for these networks are Twitter or Facebook.

This makes it necessary to find a balance between sharing information and protecting the private data that you are about to share. Certain people whom you do not want to grant access to sensitive data should not be able to gain access to that data, while others should be able to access it. This becomes more and more important as the sensitivity and dependency of information increases.

One example of sensitive data is your current location. As technology advances, we see new location-aware technologies emerge that need to protect their users' privacy. One fast growing area in the realm of location-aware technologies is their integration with social networks.

At any given time, your location can give away a great deal of information. Are you at work or at home? Are you in a nightclub in the early morning hours? Some of this information might be acceptable to be shared with some people, but not with others. We are interested in finding out how people decide if their location needs to be protected or can be revealed when a person is requesting it.

We studied how people weigh different factors that impact their decision whether or not to share their current location with others. Our hypothesis was that location, time, data-consumers and awareness of consumers are the core influencers in the process of deciding if you want to share your current location (and at which granularity) or not.

Which factors are the most prominent ones? Is there a difference in your decisions when deciding for your own location and for someone else's location? We conducted interviews and identified the patterns that started to emerge from the data. The next sections are organized as follows: background and previous work, our methodology and then our results. We follow this

up with a discussion section where we draw conclusions.

There has been a significant amount of work on privacy in ubiquitous and location-based systems. We exemplify some previous results of user-perceived privacy that were gathered from diary studies[3], interviews[4,5], observation of use either in a lab or field scenarios [1,2,7,8, 9] as well as a survey [6].

Barkhuus cautions [3] that many users might be privacy-insensitive and concludes that "users need guidance to determine if the service is acceptable or not, they often find services to be neat and do not realize what data they are revealing." He goes on to say: "One girl from the second case study explained that she had been very distressed when one of her not-so-close acquaintances had asked if she had enjoyed her trip to the gym the previous day."

Norman Sadeh et al. [2] concur with this statement, saying that "despite the time and effort spent specifying and refining their policies, participants were generally unable to achieve high levels of accuracy." They also provide a more refined perspective on this issue. When setting up general rules that control the sharing behavior of a location-aware system, the average "subjects required a little over 5 min to specify their initial rules and nearly 8 min if one includes the time spent refining their rules as they were confronted with new situations."

We can conclude from this that when there is sufficient feedback to assess the kind of information that a user is sharing and the implications that his or her sharing preferences may entail, users try to adjust their sharing rules to address these issues. Unfortunately, these efforts were not met by a great deal of success, as Sadeh et al. point out: "In fact, there is relatively little correlation between policy accuracy and the number of rules specified by participants. Similarly, there is little correlation between policy accuracy and the time spent by participants defining and refining their rules." They concluded

that "Instead, it seems that users reach a plateau and are often unable to articulate highly accurate policies."

This issue is further complicated by the fact that the users' perception of privacy changes over time, as Barkhuus [3] and Kelly et al. [1] agree. In our research we found that there are several hints or automated rules that can be applied, also certain considerations to take into account when asking people to build rules that may trigger better formulation of these. In addition, we discuss the possibility of delegating tough decisions to other users in the system.

Lederer et al. [6] conducted a questionnaire-based study to determine relative importance of the inquirer's identity and the user's situation at the time of the inquiry in determining the preferred accuracy of personal information disclosed to an inquirer through a ubiquitous computing system. They conclude that "individuals were more likely to apply the same privacy preferences to the same inquirer in different situations than to apply the same privacy preferences to different inquirers in the same situation." They further note that a participant in their survey wrote "The recipient is more important than the context, because the information will likely outlive the circumstances."

The data that Consolvo et al. [7] gathered supports this. The authors state that "both the qualitative and quantitative data suggest that who the requester was had the strongest influence on participants' willingness to disclose."

Kaasinen [5] states that "Location-aware information was expected to be especially useful in special situations, e.g. in unfamiliar environments, when looking for a specific service or in emergency situations". Hong and Landay [4] support this statement: "people expressed the desire for special exceptions for emergencies. In crisis situations, safety far outweighs privacy needs. This sentiment was universal across all of our interviewees.

There have been interesting results with regard to obfuscating or denying location requests. In their

research, Kelley et al. [1] state that "In follow-up interviews, participants indicated that their decisions about disclosing location included thinking about the reaction other users would have if denied (e.g hiding from your parents, boss, or spouse). A variation of the [application] that obfuscates the reason why a particular request is denied, or embodies notions of plausible deniability, might significantly help and allow for simpler privacy rules."

The authors of [2] took this aspect into consideration and made a design decision that has important implications for us: "When a request for a target user's location cannot be satisfied, the system displays an ambiguous message that does not allow the requester to determine whether the request was denied by the target user's policy or whether the target user's device (laptop or cell phone) could not be found. This provides a basic level of plausible deniability, in that a target user could claim to have forgotten to run the application, had her laptop off, or was simply out of range even if she actually had a rule in place blocking disclosure in this particular instance."

Hong and Linday [4] verify the necessity of plausible deniability: "people expressed a strong desire for plausible deniability. Our survey and interviews, as well previous work on ubicomp in the home, have suggested a social need to avoid potentially embarrassing situations, undesired intrusions, and unwanted social obligations."

Tsai et al. [9] say that "participants were much more comfortable, in general, with friends finding their locations as compared to acquaintances, and acquaintances as compared to strangers." This is complemented by the results of Khalil and Connelly [8] who state that "more privacy is desired when at home than at work."

The authors of [9] further found that "Users said they were less likely to use proximity, making one's location available to people within 1 mile of you, and granularity-based rules, displaying only the city or state of their current location."

Barkhuus [3] encountered some skepticism with regard to usefulness of the service. A participant stated that he could "just call [his friends] up and say 'hey, where are you'." This is backed up by the results of Kaasinen [5] who writes that "almost all interviewees commented that these kinds of systems might be useful for 'some businessmen' but not for them."

Barkhuus [3] found that "participants were willing to give up large amounts of information about their location to a preselected but also broad group". However, he goes on to emphasize the importance of control: "Most of the participants from the first case study mentioned that the potential location-tracking service should provide the user the possibility to turn it off." Hong and Linday [4] iterate on this point, saying that "people want simple control over and feedback about who can see what information about them".

With regard to the level of granularity that participants would share, Consolvo et al. [7] have interesting results: "Participants typically disclosed the most useful detail about their location (which is not necessarily the most detailed) or did not disclose their location at all." The results of Khalil and Connelly [8], albeit coming from observations with a context-aware telephony application, which is not directly related with location-based services, confirm this: "In most cases, participants opted to either reveal all context information or none at all."

Consolvo et al. [7] go on to say that their "data suggest that blurring location to protect one's privacy from social relations is not necessary, or at least is not something participants thought to use. […] if participants were not willing to disclose their location at a level they thought would be useful to the requester, they chose to not disclose location at all."

They further stated that "Participants chose to not disclose their location rather than merely blurring, which suggests that they were using the response to reinforce or communicate social boundaries."

METHODOLOGY

Our study involved the following methods: problem and hypothesis framing, data gathering and finally data analysis.

Problem and hypothesis framing

Literature reviews and in-group discussions drew general concepts from location-aware data sharing. The primary source for thoughts were two papers on "Locaccino", a Facebook application that lets users build lists of friends and point out places, and then decide if they want to share their location in a rule based system. Therefore, we took the direction of studying how these rules are set, what factors are weighted to support a decision, and how they are weighted against each other. Additionally, we took users' perception of their own privacy against their perception of others.

Data gathering

We conducted 12 interviews that combined both qualitative and quantitative data inquiry. The interview was broken into three parts:

Collecting Personal Information. In this session the participants were asked to formulate a list of people they relate to, grouping them if it is logical (for example, family, work colleagues, etc.). Then, the participants were asked to formulate a list of places starting from the countries they have visited, the cities, to their most frequent places and then specific rooms within the places they visited. The data was collected and helped to explore the second session of the interview.

Sharing your personal location. In this section of the interview, the participant was asked to answer if he would or would not share his location in a number of realistic scenarios that were created from the data collected in the previous part of the interview. A time variable was included in the scenario evaluation, for example sharing your location in the morning against sharing your location in the afternoon. Besides getting quantitative data from participant's direct answers, we were able to get additional qualitative data and ask additional questions according to the participant's verbal and non-verbal cues. Some participants expanded answers by speculating around the different situations.

Sharing third party location. This session had a total of ten proposed scenarios with fictional characters where participants had to decide if the location was to be disclosed or not. To complete this task, they were given some information about the context and relationship between the person asking for and the person sharing the location, as well as the specific location and in some cases date and time. Participants also expanded their answers by giving examples that would make exceptions to their answer.

Data analysis

Quantitative data analysis was made from a matrix of yes/no answers for the most common groups of people identified to the type of information they would provide when asked about sharing their location at home, at work and at a non-work based location (such as a bar). Qualitative analysis was made by studying thoughts that participants voiced, personal opinions, non-verbal cues and any relevant information that was noted by the interviewer. We went through all interviews, found related quotes and information and condensed our interpretation into seven insights. These insights were refined after a second iteration of interviews. You can find our insights after the results section.

RESULTS

The following results concerning self-location sharing in real time illustrate the consolidation of all the deployed surveys during all the performed interviews with 15 different subjects.

	Exact (%)	Broad (%)	No (%)	Lie (%)
Boss	36	18	36	10
Subordinate	-	40	60	-
Co-worker	100	-	-	-
Friends	92	-	-	-
Family	100	-	-	-
Partner	100	-	-	-
Strangers	25	-	75	0
Aquaintances	25	-	75	-

Table 1 – Location sharing if at home. Frequency by data-consumer and granularity.

	Exact (%)	Broad (%)	No (%)	Lie (%)
Boss	100	0	0	0
Subordinate	80	20	0	0
Co-worker	100	0	0	0
Friends	92	8	0	0
Family	83	17	0	0
Partner	100	0	0	0
Strangers	25	0	75	0
Aquaintances	25	0	75	0

Table 2 –Location sharing if at work. Frequency by data-consumer and granularity.

	Exact (%)	Broad (%)	No (%)	Lie (%)
Boss	18	36	36	10
Subordinate	20	20	60	0
Co-worker	92	8	0	0
Friends	75	25	0	0
Family	58	25	9	8
Partner	78	11	0	11
Strangers	0	25	75	0
Aquaintances	25	75	0	0

Table 3 –Location sharing if at a location which is neither home nor work. Frequency by data-consumer and granularity.

	Exact (%)	Broad (%)	No (%)	Lie (%)
Boss	13	25	49	0
Co-worker	37	38	25	0

Table 5 – Third-person location sharing if at a location which is neither home nor work. Frequency by data-consumer and granularity.

	Exact (%)	Broad (%)	No (%)	Lie (%)	
Boss	43	26	31	0	23
Co-worker	74	13	13	0	8
Friends	52	24	19	5	42
Family	33	28	37	2	49

Table 5 – Third-person location sharing if at a location which is neither home nor work. Frequency by data-consumer and granularity.

These results were analyzed and coupled with our interviews notes that are discussed in the next section of this document.

INSIGHTS

The following section discusses the insights that we gathered from our interviews. Some of these insights come directly from quantifying the answers to the questions that we asked, others take a more qualitative response and attempt to explain the hesitations or statements that were made during these interviews. When possible we also include design suggestions with regard to the insight that can be included in new systems or incorporated in existing ones.

1. People like sharing information on a need to know basis, not divulging it.

This statement entitles two things. First of all most people seem to be biased against sharing their location at all times, without explicit consent each time their location is requested. This is backed up by the results of Kelly et al., who state that "most of their participants' settings were set up to not reveal anything by default", a very restrictive setting.

"If they ask me specifically I don't have a problem, but having the information available, no."

This sense of propriety about location sharing is tightly coupled with the fact that most people believe in only sharing a location when there is a perceived, clear and definite objective to sharing. The concept of sharing where you are, just for the sake of sharing where you are is not common.

"I'd share my location so that people can meet me."

"Yes, if he wants to find me, [it's] because he has something to tell me"

"Only because if she knows I'm there [close by] we could have a coffee"

This assumption is important to keep in mind as it could gear future location aware practices to allow the data consumer to justify their need for requesting a location. It is also important to note that this particular finding could justify the importance of proximity based rules with people that are close to the user; this differs from the findings of Tsai et al [9]. On the other hand, it means that people are cautious about sharing their location and need to be reassured that their private information is only being disclosed when necessary and not readily available to everybody. Although, giving explicit consent every time a users location is requested seems to have the overload problem, people don't want to be bothered each time, therefore there should be other alternatives that can give the same (or

close) level of reassurance. Another consideration that might be taken into account is that people might be inclined to share their location with certain people if it was an emergency. This would go hand in hand with the insights of Hong and Landay [4] where they say that their interviewees were unanimous that "in crisis situations, safety far outweighs privacy needs."

2. People are more cautious about sharing a third person's location than their own.

The survey we performed, as we mentioned before, has a section where the participant is asked to decide whether to share a third person's location. In general people thought longer and considered intensely the ramifications of disclosing a person's information. This does not mean that all the people interviewed, although a significant amount did, chose what they perceived to be the best answer for the person whose location they were sharing. But it does show a significant increase in awareness about location sharing.

"I don't think a system should make a decision like this that could deteriorate his marriage."

"if they are asking it's because she wouldn't tell them. So, no ..."

This assumption could be useful in techniques for educating people about the implications of sharing their location. If people become aware when confronted by a third person scenario then maybe they can translate it into their everyday lives and understand the ramifications of disclosing their location. Refer also to the insights that Barkhuus [3] published.

Another implication that this assumption could have is a design implication for location aware systems. What we propose would be interesting is to have the ability to delegate the decision in ambiguous situations to a third party. The system would allow users the ability of selecting and ranking strangers, or maybe even close friends, for making decisions in situations that have not been specified. Although this is an interesting venue, it must first be validated and studied for

providing users with assurance about others deciding whether to share their location or not.

"I always tell my friends where I am"

Whether it is a stranger or a very close confident who decides for another person, it would only be in ambiguous situations and if they are available to answer the question. We believe that this would appeal to the user because of the fact that sometimes computers can't make the appropriate assumptions and therefore the appropriate choices and it would provide trust through ranking and/or trust in the person deciding. For the stranger it could also prove to be like a game, puzzling in the clues and figuring out the best scenario. It might also be a solution for the deficiencies in specifying rules mentioned in Norman Sadeh et al. [2].

3. Locations are associated with actions; sometimes this means people want to be able to explain what they are doing, and other times it means they don't want to.

During the course of our interview we often saw people confuse locations and actions. Instead of giving specific locations they would explain what they were doing and other times they would say they would only be comfortable sharing if they could explain. It is important to note this fact; people need the ability to allow the description of where they are to expand beyond a street address or a name (like home, work…). What they are doing is almost as important as where they are, however it is not always the case that people want to share both, so this should always be optional.

"It depends on context, can I explain? It depends..."

"I'd be comfortable sharing my location there, but not necessarily what I am doing (laughs)"

"If I could explain I'm working at home"

Sharing your location is not always straightforward. The ability to elaborate about the why and what a person is doing at a location could make people more comfortable about sharing their location. For example, saying you are at home has actions implied, this usually means you are enjoying personal time, but if you

were able to explain that you are working, the concept of being home takes new meaning.

4. People perceive disclosing only city level location the same as not disclosing anything.

As we mentioned before one of our foci for studying was granularity, so people were given the option to disclose only city level or even country level information, they were also given the opportunity to lie. Although we saw great differences in how people would handle not wanting to disclose information, from lying, to giving very little information to bluntly refusing to share, we did encounter amongst the majority of our users that granularity for city level and above is perceived as giving away the same amount of information, nothing at all.

"Saying that I am in [the city] is good for nothing."

This is an interesting and disturbing phenomenon at the same time. There might be ramifications to you privacy concerning which city or even which country you are in. People generally get used to thinking about their every day lives and when setting rules or preferences in a system they will think the same. If people are always in the same city there is no apparent information being disclosed, but it is important to consider what happens when they do change cities or countries.

Another interesting factor is that since city-level is not perceived as something that changes, one might consider sharing city-level information as a valid option when users were reluctant to share their location. However, previous work by Consolvo et al. [7] mentioned that participants would prefer not to disclose their location, provided that there is plausible deniability. However, throughout the interviews we found conflicting answers and are therefore not able to give a confident answer. Further research might address this issue.

"I'd rather lie and tell him that I am at home than [just] saying 'in [the city]'."

"City level would be suspicious when others are used to getting more information."

"Being general might reveal that I am hiding something. But on the other hand, if I am lying it might be easy to verify if I was there."

Some people were comfortable with disclosing only city level information when they did not want their location to be disclosed. However, many users perceived sharing only city level as an evident deception mechanism that would only raise alerts and require explanations. Other users even weighed the cons of lying versus the suspicion it would create to only state the city they were in.

When designing an application it is important to keep this information at hand. Sometimes the system might not be able to locate the person beyond city level because of technical difficulties, but the ramification of not disclosing their location might be harmful, if not handled properly, therefore when the system is down there should plausible deniability like discussed in [4] and supported in [2], which provides users with reassurance and not suspicion.

5. People only give more detailed, higher granularity of information if there is a perceived need

When inquired most people that are willing to share their location, consider stating the address enough. When inquired whether they would be comfortable with sharing more information, for example sharing the specific room number and floor at university or the store at the mall. The answers were very similar, only if disclosing that information would be of value to the person asking. For example, if a colleague desired to know the person's location and they were at university, they would share the room number, however if their parents asked they would only share they were at university. This implies that the level of detail with which you share is only up to providing sufficient information for the person asking. If their parents inquire the location, university level is enough. If a colleague inquires the location, university level might not be enough.

"There is no need to tell people where exactly I am when they don't know the place!"

"They wouldn't know details about university. I'd just say "university" rather than the specific room."

"In the evening I would disclose the location more specifically. People worry and they would like to know."

An interesting assumption that could be studied further is higher detail of granularity disclosure should only occur with people that have visited a location with you, or more specifically the regularly frequent the location with you. So for example, disclosing which office you are at university would only happen for colleagues or professors. Allowing users to disclose such detailed level of information only when it is perceived as necessary.

6. People are associated with locations. If people have visited the place together they are generally inclined to disclose their location again.

Locations in which we spend a lot of time usually have the same people associated to them. For example, disclosing your location to people that would generally be in that place, the professors or boss when the user is at university is perceived not only as acceptable, but also as unavoidable and in some cases even advantageous. 100 % of our users would disclose their location always in this type of situation. It might show that the user is working hard in spite of it being late.

"Sure, the professors could know whenever I am at university. […] Especially at night!"

Although most locations that are frequented often have associated people, in the results we discussed similar behavior for family and boss in work related environments and at home, but there are some that aren't, for example a bar. Table 3 shows the fluctuation of answers in people, whereas Tables 1 and 2 are more uniform. Another example could be a public open space like a park where the users frequent but not with the same people and only on specific locations. Developing rules or specifying when to share these types of locations becomes more difficult.

People have places where it is socially acceptable to meet and others where it is awkward. Meeting your friends at your office might be perceived as unprofessional, but meeting your professor at the bar would also be perceived as inappropriate. Although, the last statement made seems plausible and it was common amongst the users that we interviewed we did find that some people were that would share their location with professors even if they were at a bar. When we inquired deeper as to why this was true, the general answer was that although they wouldn't have normally shared, this professor, boss or colleague was different; they had gone to that place together. In other words circumstance or the different relationship had led this barrier to be overcome.

"if I have been to this place with this person, I would tell them."

"I would be comfortable telling Prof. X I'm at No 2, because I have seen him there. I would not share my location with other professors that I only see at university."

This confirms that rule based systems might be a good option for defining whom to share with at what locations. It might also take into consideration automation of rules; people that go to places with you can see when you are at that location. In fact, it could even be extended to include a more detailed history, for example people that have visited the place with you in a determined time frame can see when you are at that location.

7. People associate disclosing the location with availability. People need to be able to go offline.

When disclosing their location people become reachable, and therefore interruptible. There is a sensed realization that if you can be found, you can be required to take action. This insight correlates with the fact that people would only share their location if they sensed there was a need, therefore being found implies that something was needed of them.

"If Prof. X was looking for me I would like to appear 'unavailable', even though I might have free time."

Having the ability to be tracked all the time, no matter the hour or the place will definitely have its impact. During the interview some users associated sharing their location with being online in chat systems or social networks and then they proceeded to request the ability to disconnect or go offline. This is inline with Barkhuus [3] findings.

"I should be able to go offline."

"I prefer to say honestly that I don't want people to know where I am"

This is an important consideration to take into account when designing a system, there must always be a visible and clear way to stop sharing your location at given points in time to all users. This will allow the user the security that if he does not want to be found or bother he won't be no matter what they have specified beforehand. Barkhuus [3] states that most of the participants mentioned that the "location-tracking service should provide the user the possibility to turn it off."

CONCLUSION

We studied location sharing and weighed different factors that impact people's decisions on sharing their location. We presented our findings from conducting 12 interviews on the topic of location sharing. Our findings supported some of the previous work that was reviewed; some findings were not supported by literature and need to be researched further. The most important findings from our research were qualitative findings based on the quantitative analysis from the questions answered as well as the way our participants reacted, including their hesitation when answering questions and analyzing actual quotes.

We discussed that people are comfortable sharing their location when there is a need; this also applies to disclosing more detailed information about their location. People think longer about whether or not to reveal information when asked to make the decision for a third person and not themselves. When sharing locations, people sometimes feel the need to explain what they are doing. Other times they want to cover their actions. Lower granularity levels when sharing location, such as city-level locations are perceived as if not sharing anything. Visiting a place with a person – even if only once – usually indicates that this location can be shared with that person. Furthermore, participants wanted to be able to turn off the system, to have an easy way to not be available. In addition to these general insights we presented some design suggestions, among these is the automation of certain rules and the inclusion of humans to solve ambiguous situations in which existing systems fail. It would be interesting to explore and verify these findings in real world scenarios, instead of controlled lab-based interviews like the ones we did.

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