Study of Usability of Security and Privacy in Context Aware Mobile Applications

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Abstract. Mobile devices, such as smart phones, are becoming increasingly powerful with more memory, processing capacity and interface to several hard and soft sensors, making it possible to easily develop and use context aware applications on them. Context aware applications make use of context from several sources including location, light, sound, as well social context and users' behavioral patterns to make more informed decisions for the user. Since these applications are indeed aware of all the user's personal information and context, it is important that they be designed with security and privacy in mind. In this paper, we discuss a study conducted to understand user perception of security and privacy features implemented in context aware mobile applications, improvements that can be made and design guidelines that will help improve the usability of these features.

Keywords: Context-aware, mobile applications, security, privacy, usable security, usability.

1 Introduction

Context aware mobile applications are a class of applications that examine and react to an individual's changing context [1]. Although security and privacy are significant factors that need consideration in these applications, one area of research that has not received adequate attention is the usability of these aspects.

We conducted a usability study to understand how users perceive security and privacy features provided by their cell phones and whether or not these features are indeed usable. We used Nokia Friend View [2], a location-based social networking application, as a case study for context aware mobile applications. We also evaluated a paper prototype version that we created, in which security is made explicit and the application gives a clear indication of security and privacy features.

2 Related Work

Chen and Kotz [3] identified two key problems with security and privacy of context-aware systems: 1) ensuring the accuracy of location information and identities, and 2) establishing secret communications. They observed that these problems are not

S. Ystad et al. (Eds.): MobiCASE 2009, LNICST 35, pp. 326–330, 2010.
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satisfactorily addressed by existing context aware mobile applications. We built on their recommendations and made sure that we give the user the ability to share location information with specific friends/ groups of friends in lieu of broadcasting the user's location to the whole buddies' list. Iachello et al.[4] discussed eight design guidelines for enhancing the privacy of social location disclosure applications and services. These papers give useful guidelines on how to design software for context aware mobile applications. They, however, do not perform a quantitative study of the usability of applications designed using these guidelines.

3 Methodology

The study was conducted over a period of seven weeks with 15 participants in the following three phases.

3.1 Pilot Study

The study was conducted using the mental models technique. Participants were asked to use the Nokia Friend View application and discuss how they felt while using the application to share their location and status messages. Each interview lasted for about 20 minutes.

3.2 Paper Prototyping

Based on information gathered from the pilot study, we first designed an initial paper prototype to address some of the issues that came up from the pilot study and then improved it iteratively. To arrive at the final version of the improved prototype, we conducted six iterations with four participants. At the end, we had a prototype with more explicit cues for secure and insecure connections, and for privacy of user's location and status information. These cues are discussed more in section 5, Design Implications.

We used three scenarios for testing: i) The user logs into the application, ii) the user updates his location and iii) the user updates his status message.

3.3 Usability Testing - Comparative Study between Application and Improved Prototype

This phase consisted of performing a comparative study of usability of the original Friend View application and the paper prototype we designed. In this phase, each participant was given both the Friend View application and the improved prototype. They were given about 5-10 minutes to get acquainted with these. Each participant was then handed out a survey to fill in his/her feedback on security and privacy features in both – the original application and the improved prototype. The participants were allowed to use the prototype or original application at any time while answering the survey.

4 Results and Analysis

The survey questions consisted of statements about the user feeling very secure while using the application to perform a certain task, or feeling that the application respected their privacy. Users' responses were recorded on a five-point Likert scale.

4.1 Perception of Security

In general, we observed that participants responded more positively to the prototype when asked whether the application made them feel very secure and respected their privacy.

Security While Logging in. About 62% of the users either disagreed or strongly disagreed that the original Friend View application made them feel secure while submitting their credentials. The rest neither agreed nor disagreed. On the other hand, about 87% users either agreed or strongly agreed that the prototype made them feel secure while logging in, while only 8% remained neutral.

Security While Sharing Location. While testing the user perception for sharing location, we found that all participants either agreed or strongly agreed that the prototype made them feel secure. On the other hand, only one out of 16 participants agreed that Friend View application made them feel secure while sharing their location.

Security While Posting a Status Message. Similar results were observed while testing user perception for security while posting a status message. About 81% participants responded positively to the prototype, while only 6% responded positively for Friend View application.

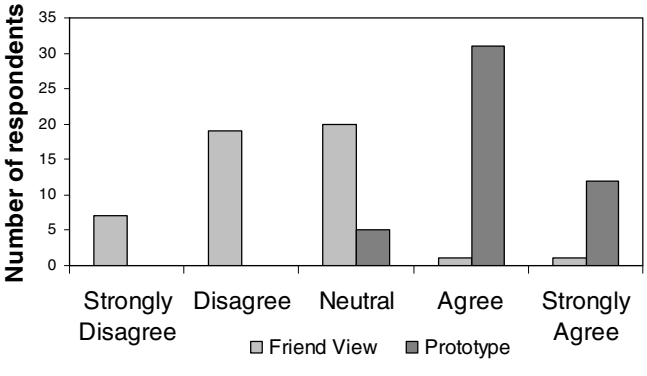

Fig. 1. Average response of participants to security scenarios: (i) while logging in, (ii) while sharing location and (iii) while posting status message to friends in the application

4.2 Perception of Privacy

We observed that the majority of users responded that they either disagreed or were neutral when asked if the original application respected their privacy. For the prototype, over 93% participants either agreed or strongly agreed.

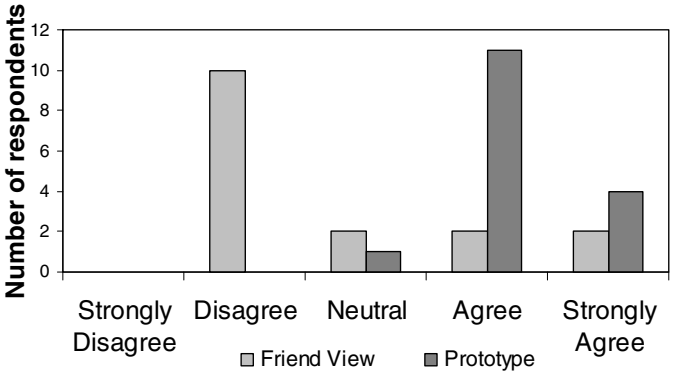

Fig. 2. Response of participants to application respecting user's privacy

5 Design Implications

Through the initial phase of mental model interviews and second phase of prototype design, we were able to understand several important factors that can contribute towards better usability of security and privacy features in context aware mobile applications. We have outlined these factors as design guidelines in this section. This list of guidelines is in no way exhaustive or complete. It is a start in the direction of improving usability of context aware applications and will be worked on for improvement in the future.

5.1 Security Guidelines

1. Security indicator should be part of native interface
2. Security indicator should be more dynamic
3. Indicating secure connection is just as important as indicating insecure connection

5.2 Privacy Guidelines

1. User should be able to see his/her most recent action

If a user is given the option of sharing his location with everyone, a group of contacts or a selected set of contacts, it is important that the application indicate what the user's most recent action was. Users tend to find this information useful to understand the causes for any present actions.

6 Conclusion

In conclusion, we believe that usability of security and privacy aspects in context aware mobile applications is important and needs more attention while designing these applications. In all our tests, we observed that users preferred the improved prototype over the original Friend View application. Indeed, we tested only the Friend View application, which is a relatively safe application to use since it only involves friends and does not consider many dimensions of users' contexts. We therefore assume that these privacy and security aspects will definitely have more gravity in applications which involve sharing more personal and important information with strangers. A best example of it is a ridesharing application.

Acknowledgments. We would like to extend our gratitude towards Dr Cynthia Kuo for her guidance and help in designing and conducting this user study.

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