Using Mobile Social Media for Emergency Management – A Design Science Approach

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ABSTRACT

Over the last couple of years social networks have become very popular and part of our daily lives. With the emergence of powerful smartphones and cheap data rates social media can now be accessed anytime and anywhere. Obviously, it makes sense to also facilitate social media for crisis management and response. In this contribution we present a system design for emergency support based on mobile social media with an emphasis on increasing security during large public events. We follow the design science approach as we provide an artifact design along with a description of its implementation and evaluate our artifact using the simulation study methodology. As a result of this study we gained valuable insight into how the users interact with our system and obtained information on how to improve it. Overall the users were quite satisfied with the perceived usefulness and the perceived ease of use of our system.

Keywords

Social media, design science, simulation study, large public events.

INTRODUCTION

In the last couple of years social networks have become increasingly popular and the providers of these networks have become multi-billion dollar corporations. According to their website, Facebook has more than 500 Million active users and more than one million websites, who have integrated with the Facebook Platform (Facebook, 2010). Similar statistics exist for Twitter with over 100 Million users who send over 55 Million tweets each day (The Huffington Post, 2010). As social network progress from simple collections of contact information towards fully integrated communication platforms, they are also becoming an integral part of our daily lives. For example Facebook has a lot to offer as a platform from the get-go, and managed to expand its mechanism from a platform-internal enabler for browser games and other profile plug-ins to a full-fledged federated identity management system offering additional services (such as “like” buttons) to its users.

Furthermore, with the emergence of powerful mobile phones and flat rate cost models for the mobile internet, mobile usage of social media has become very popular. There are more than 200 million active users currently accessing Facebook through their mobile devices (Facebook, 2010) and of Twitter's active users, 37 percent use their phone to tweet (The Huffington Post 2010). This leads to a situation where social media can be accessed and used anytime and anywhere. It makes sense to also facilitate social media for crisis management and response and several authors have advocated the use social media for disaster relief (Kapucu, 2008; Liu et al., 2008; Sutton et al., 2008) and emergency management systems based on mobile communication infrastructures (Yuan and Detlor, 2005; Valtonen et al., 2004; Underwood, 2010).

When confronted with emergency situations and the need for prompt communication, people tend to use the communication channels they are used to and direct, firsthand reports from a disaster can provide a realistic picture, helping to avoid the confusion that can result from widespread, and not always accurate, television broadcasts (Underwood, 2010). It also enables the involvement of ordinary individuals or groups of people in emergency response, which can be a critical contribution to large-scale disaster relief, especially at the beginning of a crisis (Sebastian and Bui, 2009). Some examples where social media has been used for disaster relief are Hurricane Katrina (Palen et al., 2007), the Southern California wildfires (Sutton et al., 2008), and the Virginia Tech shooting (Vieweg et al., 2008).

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In this contribution we present a system design for emergency support based on mobile social media that was developed in the German national funded research project VeRSiert with an emphasis on increasing security during large public events, where even rather small incidents can have severe consequences, because of the mass and high concentration of visitors. In the past there have been several disasters during large public events such as the Heysel Stadium disaster, the Hillsborough disaster, the Niamiha disaster and most recently the 2010 Love Parade and the Water-Festival in Phnom Penh. We follow the design science approach as we provide an artifact design along with a description of its implementation and evaluate our artifact using the simulation study methodology.

SYSTEM DESIGN

We employed a scenario-based approach for our system design, as mandated by Carroll (Carroll, 2000) and others. This approach shares the advantage of aiding in analyzing benefits and challenges of emerging information systems architectures (Carroll, 2000). In addition, an agreement on relevant scenarios was one of the coherent results of initial stakeholder interviews, offering a solid empirical basis for this approach. The scenario-based approach also is very appropriate for complex multi-stakeholder requirements, as it is useful when design moves have multiple effects, and external factors constrain design (Carroll, 2000). Since large public events can differ quite substantially and often have very different requirements, we have picked three exemplary events that cover a very broad spectrum of those dimensions. Those events are a football match, the “Kölner Lichter” (an outdoor event with fireworks) and “Church Day” (grassroots religious event). From the scenarios we derived a layered architecture. Its main benefit lies in reuse and composability of services, in the spirit of service-oriented computing (Papazoglou, 2003). Based on the underlying infrastructure, we implemented several basic services reflecting essential capabilities. Those are integrated into more complex services with direct application character, which may be both commercial and disaster management services, in the next layer. In the final layer, the services are integrated into scenario-specific application packages. The platform communicates with mobile network operators and provides basic services for service providers from the event management industry and the emergency manager via standardized service interfaces. The basic services include localization of mobile subscribers, message delivery via SMS and Cell Broadcast Service (CBS), multilateral data transfer, access to information databases, support for mobile communities and billing services for mobile payment and mobile ticketing.

IMPLEMENTATION

We have implemented a system prototype, based on customized Open Source components for the server side, and using Google’s Android platform for implementation of the client application. The service platform provides a centralized access point to the mobile communication infrastructure, which can be utilized for emergency management and commercial mobile value-adding service as described in the previous section. For our demonstrator we have set up our own micro-blogging service, to be able to test emergency messages without running the risk of endangering innocent witnesses, which would have been a big risk when using the commercial Twitter platform. Additionally, we can meet confidentiality requirements of e.g. relief units or law enforcement. In order to integrate real messages of selected commercial services in our application, we implemented an interface to the commercial Twitter service. In addition to the micro-blogging service, we also offered the possibility for real-time chat to attendees of the event.

On the client, components like routing, chat client, micro-blogging connector and friend finder have been implemented. In addition, the demonstrator also offers functionality allowing sending SMS-based messages to event participants and/or relief units (individually or via cell-based broadcast). This functionality is provided especially with notifications of visitors in case of a disaster in mind, providing warning and evacuation information. Further (low-level) implementation details may be found in (Braun et al., 2010). Figure 1 presents screenshots of the current mobile client system.

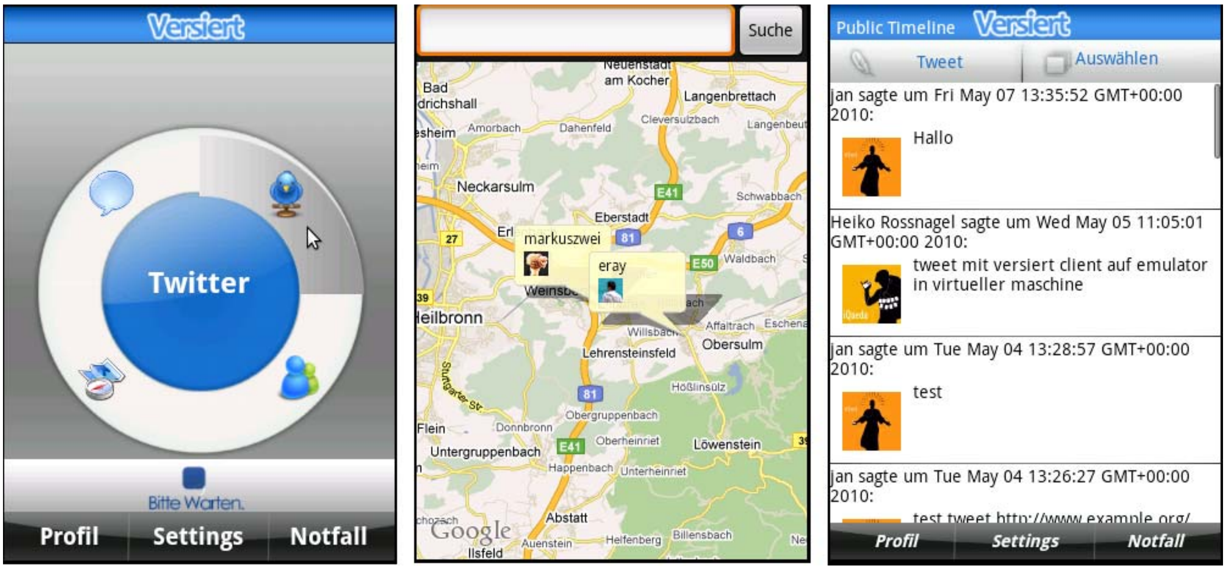

Figure 1. Demonstrator Screens

EVALUATION

Simulation Studies

Simulation studies allow the testing of prototypical software in a real environment and in realistic scenarios as they combine elements from observational and experimental evaluation approaches. The goal is to provide a situation that is as realistic as possible and at the same time to avoid any danger of incurring real damages.

In simulation studies real users will be observed while they intensively experiment with prototype technology in realistic situations in a real environment over a fixed time frame. During this time, the researchers can get an insight into specific research questions by manipulating the boundary conditions and user tasks. Simulation studies require:

- real technology, albeit in a prototype status,
- real users, who act in a real environment,
- realistic problems, that are based on real cases but are simulated during the study,
- realistic working material, that is prepared for the study,
- realistic attacks or emergencies, whose impact is only simulated.

Simulation studies can be used to systematically collect operating experience before technology, users, infrastructure and legal frameworks are set up for the deployment. Therefore, experiences can be made without risking irreversible unjustifiable and harmful decisions.

Since the users accumulate a lot of insight in form of hands-on experience, they should be included in the analysis of the study results. This can be achieved by combination of several methods such as direct observations, surveys, protocol analyses and personal or group interviews.

In contrast to field tests simulation studies allow the possibility to examine different, complex and extreme usage scenarios during a short but highly intensive testing phase. Simulation studies induce less costs and provide results faster than field test, which allows for an easy integration into technology development and deployment processes. A more detailed description on simulation studies as an evaluation method is given in (Roßnagel, 2007).

Study Setup

For our study we used three independent test persons who are not associated with the project and who would have attended the event even if they had not participated in our simulation study. We equipped all three subjects with an HTC-Desire Smartphone with our prototypical software already installed. None of the subjects had seen the software before the start of the study. After a short introduction on how to use the technology, each subject received a personalized list of tasks (that was not visible to the other subjects) and a different starting location. Each subject was accompanied by an observer, who recorded all user interactions on videotape.

One of the researchers acted as the simulation study coordinator. He also acted in several different roles such as the city council, the local transport provider and the event organizer and in these roles provided useful information to the subjects, such as event specific information, train schedules and delays. He also fulfilled the role of the emergency manager. The simulation study lasted for six hours and the subjects were questioned after the study in form of a short survey.

Empirical Results

Simulation studies do not provide representative quantitative data. They are a helpful tool to explore the scope of different design options and to gather hands-on experience without endangering anyone before the actual deployment of the technology. They provide the means for “trial and error”-testing of risky or experience needy technologies. In this regard they are a very good fit for the design science approach where IT artifacts are developed and then evaluated, as a promising vector for research that contributes both to the scientific knowledge base (the research is rigorous) and to practice (it is also relevant).

Consequently, most of our results are of qualitative nature. User interactions were videotaped by the observers and all tweets that were sent during the study were recorded. Figure 2 provides a screenshot of the public timeline during our simulation study.

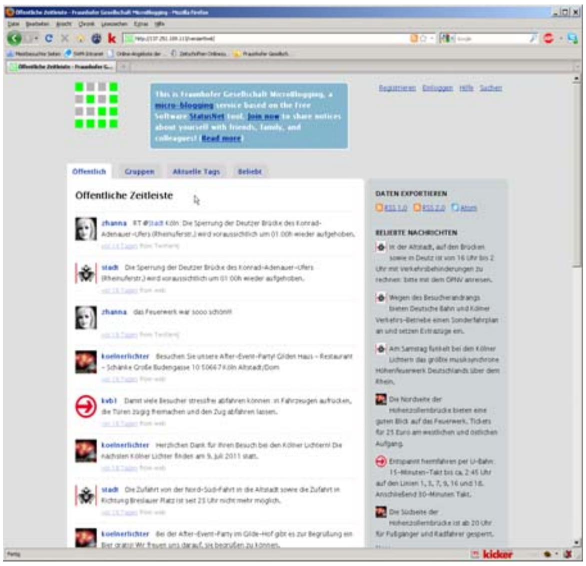

Figure 2. Overview of public timeline during the study

During the study 112 tweets including 31 pictures were made by the subjects and the additional roles. The subjects interacted heavily with each other. They used and acted on the information given by the roles performed by the simulation coordinator but did not interact with these roles.

The videotapes provided valuable evidence on how the subjects interacted with our software and we were able to identify some usability shortcomings that we eliminated in the next version of our software.

We also tracked the location of all subjects during the whole course of the study. This enabled us to see if and how the subjects performed their tasks and how they reacted to different situations. One of the main tasks of the subjects was to find each other by using our friend finder service. The subjects accomplished this task at 21:15 when they met at the Rhine river bank.

After the closing fireworks the subjects filled out a survey based on (Davis, 1989) on their assessment on the perceived usefulness and perceived ease of use of our software. The results of this survey are very encouraging as all subjects stated that the ease of use is very high and the usefulness is also considered to be high. However, due to the small number of participants these results are by no means a reliable data pool for quantitative analysis. They can only serve as a first qualitative assessment.

CONCLUSION

We presented a system for emergency support based on mobile social media with an emphasis on increasing security during large public events. We followed the design science approach, providing an artifact design along with a description of its implementation as proof-of-concept, and evaluated our artifact using the simulation study methodology. As a result of this study we gained valuable insight into how the users interact with our system and obtained information on how to improve it. In a survey performed after the simulation study users stated their satisfaction with the system, supporting encouraging results we already obtained using a purely simulation-based evaluation approach.

REFERENCES

1. Braun, M., Khan, D., Özmü, E., Roßnagel, H. and Zibuschka, J. (2010) - Gemeinsam unterwegs: Android-Unterstützung für mobile Communitys, *Android 360 - Mobile Technology Sonderheft*, 1, 55-58.
2. Carroll, J. (2000) Five reasons for scenario-based design, *Interacting with Computers*, 13, 43-60.
3. Davis, F. D. (1989) - Perceived Usefulness, Perceived Ease of Use, and User Acceptance of Information Technology, *MIS Quaterly*, 13, 3, 319-340.
4. Facebook (2010) Statistics, *http://www.facebook.com/press/info.php?statistics*, accessed 2010-11-30.
5. Kapucu, N. (2008) - Collaborative emergency management: better community organising, better public preparedness and response, *Disasters*, 32, 2, 239-262.
6. Liu, S., Palen, L., Sutton, J., Hughes, A. and Vieweg, S. (2008) - In Search of the Bigger Picture: The Emergent Role of On-Line Photo-Sharing in Times of Disaster, *Proceedings of the Information Systems for Crisis Response and Management Conference (ISCRAM 2008)*.
7. Palen, L., Hiltz, S. R. and Liu, S. B. (2007) - Online Forums Supporting Grassroots Participation in Emergency Preparedness and Response, *Communications of the ACM*, 50, 3, 54-58.
8. Papazoglou, M. P. (2003) - Service -Oriented Computing: Concepts, Characteristics and Directions, *Proceedings of the Fourth International Conference on Web Information Systems Engineering*.
9. Roßnagel, A. (2007) Simulationsstudie als Praxistest und Gestaltungsmittel, in R. Gitter, V. Lotz, U. Pinsdorf and A. Roßnagel (Eds.), *Sicherheit und Rechtsverbindlichkeit mobiler Agenten*, Gabler, Wiesbaden, 59-69.
10. Sebastian, I. M. and Bui, T. X. (2009) - Emergent Groups for Emergency Response: Theoretical Foundations and Information Design Implications, *Proceedings of the Fifteenth Americas Conference on Information Systems*, August 6th - 9th, San Francisco, CA, USA.
11. Sutton, J., Palen, L. and Shklovski, I. (2008) - Backchannels on the Front Lines: Emergent Uses of Social Media in the 2007 Southern California Wildfires, inF. Fiedrich and B. Van de Walle (Eds.), *Proceedings of the 5th International ISCRAM Conference*, May, Washington D.C, USA.
12. The Huffington Post (2010) - Twitter User Statistics REVEALED, *http://www.huffingtonpost.com/2010/04/14/twitter-user-statistics-r_n_537992.html*, accessed 2010-11-30.
13. Underwood, S. (2010) Improving Disaster Management, *Communications of the ACM*, 53, 2, 18-20.
14. Valtonen, E., Addams-Moring, R., Virtanen, T., Jrvinen, A. and Moring, M. (2004) - Emergency Announcements to Mobile User Devices in Geographically Defined Areas, *Proceedings of Information Systems for Crisis Response and Management (ISCRAM)*, 3-4 May, Brussels, Belgium, 151-156.
15. Vieweg, S., Palen, L., Liu, S., Hughes, A. and Sutton, J. (2008) - Collective Intelligence in Disaster: Examination of the Phenomenon in the Aftermath of the 2007 Virginia Tech Shooting, inF. Fiedrich and B. van de Walle (Eds.), *Proceedings of the 5th International ISCRAM Conference*, Washington, D.C.
16. Yuan, Y. and Detlor, B. (2005) - Intelligent Mobile Crisis Response Systems: Systems to help coordinate responder communication and response efforts in order to minimize the threat to human life and damage to property., *Communications of the ACM*, 48, 2, 95-98.