Disposable Maps: Ad hoc Location Sharing

Jan Seeburger
Institute for Creative Industries and Innovation
Queensland University of Technology
Victoria Park Rd, Brisbane QLD 4059 Australia
j.seeburger@qut.edu.au

Ronald Schroeter
Institute for Creative Industries and Innovation
Queensland University of Technology
Victoria Park Rd, Brisbane QLD 4059 Australia
r.schroeter@qut.edu.au

ABSTRACT
The gathering of people in everyday life is intertwined with travelling to negotiated locations. As a result, mobile phones are often used to rearrange meetings when one or more participants are late or cannot make it on time. Our research is based on the hypothesis that the provision of location data can enhance the experience of people who are meeting each other in different locations. This paper presents work-in-progress on a novel approach to share one's location data in real-time which is visualised on a web-based map in a privacy conscious way. *Disposable Maps* allows users to select contacts from their phone's address book who then receive up-to-date location data. The utilisation of peer-to-peer notifications and the application of unique URLs for location storage and presentation enable location sharing whilst ensuring users' location privacy. In contrast to other location sharing services like *Google Latitude*, *Disposable Maps* enables ad hoc location sharing to actively selected location receivers for a fixed period of time in a specific given situation. We present first insights from an initial application user test and show future work on the approach of disposable information allocation.

Author Keywords
Context Sharing, Location-based Services, Location Sharing, Location Tracking, Privacy, Urban Informatics

ACM Classification Keywords
H5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous.

INTRODUCTION
People often meet others for various purposes (e.g., business meeting, socialising, shopping) in different locations (e.g., office, restaurants, public places, street corners). Usually one or more participants of the proposed meeting have to travel to the negotiated location. Travelling can lead to delays. Therefore it is a common practice that people renegotiate meeting arrangements (Townsend, 2000) and share their current context via phone calls or text messages (Bentley & Metcalf, 2008). Recent improvements in mobile phone technology, e.g. Internet access and integrated sensor technology such as GPS, as well as the emerging research area of context aware computing enable new ways of communicating the context of a user to others. "Context-aware technology should […] be designed to consider not only one person's doings, but also the doings of other relevant people" (Tamminen et al., 2004). This research is based on the hypothesis that providing meeting participants with location-based information of each other can enhance the above-described process of meeting people in different locations. The following scenario describes the proposed approach:

Peter and Ralph want to see a new movie at their local cinema in Brisbane. They both live in different suburbs and arranged to meet at the cinema 15 minutes before the movie. Peter arrives on time. Ralph, who has been caught up in traffic, starts the *Disposable Maps* application on his iPhone. He selects Peter from his contact list for location sharing. Peter receives an email: "Hi Peter, Ralph wants to share his location with you! *Click Here* to see where he is!" He clicks on the unique link and the phone's web browser shows a map with Ralph's up-to-date location coordinates. As Peter sees his location and thinks that Ralph will at least need 10 more minutes, he decides to buy the tickets and a few drinks so that they can enter the cinema straight away without further delays. After buying the tickets and drinks, Peter clicks on the link again and notices that Ralph is just around the corner. As Ralph arrives at the cinema, he presses the "Dispose of your location" button in the mobile application's user interface. Both enter the cinema on time and enjoy the movie.

The novel approach of *Disposable Maps* is, that users are given the opportunity to send their geographic location data to selected receivers using anonymous and unique URLs protecting their location privacy. Location privacy can be defined "as the claim of individuals to determine for themselves when, how, and to what extend information about their geographic location is communicated to others" (Duckham, 2009). The obfuscation of the geographic location through reduced visualisation on a web-based user interface and the anonymisation through peer-to-peer location broadcasting like email or text messages in combination with unique URLs enable *Disposable Maps* to disclose sensitive data in a privacy conscious way. Peer-to-peer messaging combined with the concept of unique URLs result in the fact that the location-tracking data is only meaningful to the receiver of the message, which contains the unique URL. The identity of the tracked person is only deducible for the location-sharing participants and has no value for other people. Privacy of user identity, control of the distribution, and lifetime of location information is provided. Furthermore we argue that seeing where other participants of a proposed gathering are can reduce and improve idle time for the person waiting.

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The remainder of this paper is structured as follows. The next section reviews relevant literature in the field of location-based services, location tracking, privacy issues, and context sharing. We then present the *Disposable Maps* architecture, which enables the described scenario in this section. We discuss first empirical research data and explore some of the issues that came up during an initial application user test. Suggestions for future work on the *Disposable Maps* application conclude the paper.

RELATED WORK

Context-aware applications utilise context data to deliver more personalised content and services, which are relevant for the users' current situation (Dey, 2001). Thereby, context data can be separated into information about human factors like user interests and goals, as well as information about the physical environment like time and location (Schmidt et al., 1999).

Utilising location data in software applications coined the term location-based services. According to Junglas & Watson, "Location-based services are any services that take into account the geographic location of an entity" (Junglas & Watson, 2008). They further state the importance of differentiating location-based services into location-tracking and location-aware applications. Location-tracking services send the geographical position of an entity to a receiver whereas location-aware applications provide content and services according to an entity's geographical position (Barkhuus & Dey, 2003).

The perceived privacy of a location-based application influences users' intention towards using such a service (Chang et al., 2007; Barkhuus, 2004). Especially location tracking services raise privacy issues by users (Barkhuus & Dey, 2003).

Various investigations on context data sharing have been conducted.

A study carried out by Bentley & Metcalf (2008) has shown that context and location sharing are common human communication practices during mobile phone calls. Barkhuus et al. (2008) developed a system, which constantly shares and monitors the location and additional information with others in an always-visible extended contact list. Consolvo et al. (2005) studied which factors influence the willingness to reveal private location data and at what granularity the data will be provided. They found out that who, why, and what level of information is requested influences the willingness to share. If people are willing to share their location data, "blurring services" like e.g. only sharing the suburb are not needed. Bentley et al. (2006) described a system, which only shares small amounts of context data, e.g. if a user is currently moving or which song they are currently listen to. The aim of Bentley et al. (2006) is to provide mobile applications, which act as a tool for social awareness and presence.

Google introduced the location sharing service Latitude in 2009, enabling users to share their location on Google Maps. Users can send and receive location-sharing requests to add friends to their personalised *Google Map,* displaying their location. *Google Latitude* provides privacy levels for each added friend: (1) share best available location, (2) share only city level location, and (3) hide location from this friend. Furthermore, *Google Latitude* allows users to set different location-sharing settings for all of their friends: (1) automatically detect your location, (2) manually set your location (enables lying), and (3) hide your location. This approach adds a social component to *Google Maps*, enabling users to see where their friends are and communicate their own location in an always-on environment. Page & Kobsa (2009) state that people use *Google Latitude* for social planning and social connectedness, but a critical mass is needed to connect with others.

In contrast to *Google Latitude* and the above-mentioned applications, *Disposable Maps* enables ad hoc location sharing to actively selected location receivers for a fixed period of time in a specific given situation, for example being late for a meeting. Location receivers only need an email address and an Internet enabled device to see location data of others. This approach enables peer-to-peer location sharing without the need of user subscriptions or accounts.

ARCHITECTURE

To enable *Disposable Maps* and ad hoc location sharing, we designed and implemented a software architecture as visualised in Figure 1. Thereby, the three main components involved are the mobile *Disposable Maps* application, the online location sharing processing server, and the web-based front-end for location receivers.

Mobile Client

Disposable Maps has been developed as a native application for the Apple iPhone using the Software Development Kit (SDK) for the iPhone 3.0 operating system. The SDK offers comfortable functionality to access user's locational data and send them to a processing server.

The left side of Figure 1 shows the mobile application's main screen. Mobile phone users can add contacts from their contact list through clicking the + button in the applications navigation bar. Furthermore, possibilities are given to add, change, and remove contact details belonging to a selected contact. After selecting the desired location receivers, the user presses the "Publish your Location" button. The phone receives a unique URL from the server application and opens the iPhone's email sheet to notify the selected receivers. The phone now constantly sends location updates in conjunction with a timestamp to the server application. The frequency of location updates can be changed in the application's options tab, ranging from updating the location every 5m to 1km of location change. When the user decides to stop sharing their location, they simply press the "Dispose of your Location" button and the data is immediately deleted on the server. If the user switches off the application without manually deleting their location, the server deletes the data according to the specified time in the options tab, ranging from 10 to 99 minutes after the last received location update.

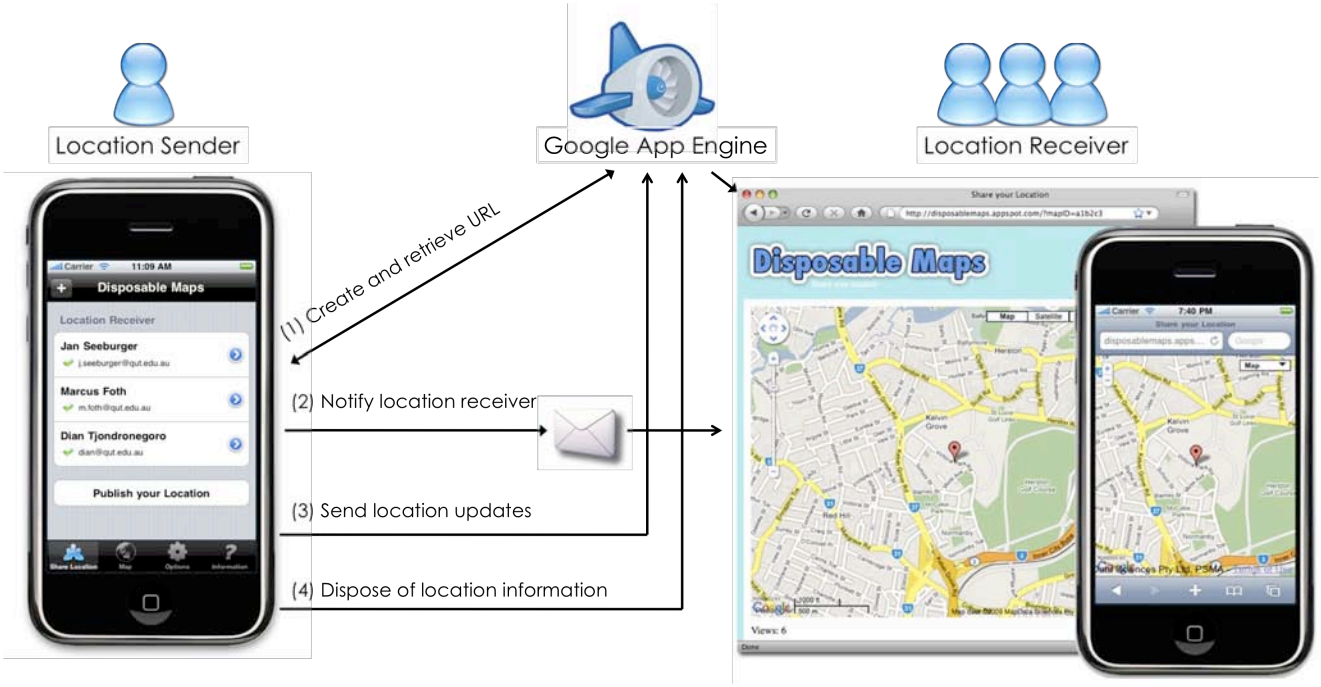

Figure 1: Disposable Maps Architecture

Disposable Maps Server

We developed web services using J2EE hosted on the *Google App Engine* servers. The main task of the server is the unique URL generation, location data storage, delivery, and URL deletion.

The first request of the mobile client instantiates a new location sharing session. Therefore, a unique URL is generated and sent back to the mobile device. The server is now ready to receive data packets containing URL, longitude, latitude, and timestamp. A public server method for the deletion of a location sharing session has been developed, which is called by the mobile client or the server itself, if the set time period in the mobile application's options has been exceeded. Furthermore, a location sharing lookup method has been implemented, which is called by the mobile client at application start. This method has been implemented because of the iPhone's current inability to run applications in the background. The location sharing lookup enables the mobile application to be switched off and restarted without the need to create a new location sharing session.

This generic and lightweight server-side approach enables the management of locational data belonging to objects and prepares the visualisation of these objects for visualisation on a map.

Location Receiver Front-End

For the visualisation of the user's current location, *Disposable Maps* utilises *Google Maps* and the provided JavaScript Application Programming Interface (API).

Location receivers can open the unique URL contained in the email with their device's web browser. The web-based front-end queries the server's data storage for the given URL. If data could be found to the given URL, a map containing a pin marking the sender's position will be returned. To update the position on the map, an AJAX script has been utilised to re-position the pin according to the up-to-date locational data.

Using standard Internet technologies allows us to deliver the shared location to a wide range of mobile phones, which support Internet browsing as well as basic desktop computers. On the right side of Figure 1 are two examples of the location receivers front-end visualised: (1) a standard website for browsers based on desktop-computers and (2) a Safari iPhone compatible site.

APPLICATION USAGE

We conducted a first application user test in a real world setting with 30 iPhone users who were provided with the application for three weeks to gather usage data. Furthermore, we were interested in testing the functionality of the application. We used a mailing list for Apple related topics and iBetaTest.com, a web 2.0 service pooling developers and application testers, for participant recruitment. The only given incentive for users to participate, was to test a new application on their iPhone. Users were asked to use the application on their private phones whenever they feel like sharing their location. The *Disposable Maps* server recorded the single location sharing sessions of the users.

Through this approach we recorded 38 location-sharing sessions from 12 application users. The remaining 18 application testers did not install or use the mobile application at all. One reason could be the remote organisation and allocation of the user test via email and web-based services.

Application testers, who used *Disposable Maps*, selected on average 1.2 location receivers, sending 16.9 location updates to the *Disposable Maps* server. Location receivers visited the generated unique URL twice as a

mean value, whereas the time spent on the website and the amount of AJAX updates received from the server has not been recorded. Fifteen of the 38 location sharing sessions were deleted manually through the application's user interface whereas the remaining sessions were deleted after the specified time in the mobile application's option tab, which was set to 60 minutes as default value. Only two users changed it to the maximal value of 99 minutes after receiving the last location update.

FUTURE WORK AND CONCLUSION

The application user test has shown that not many location sharing sessions have been recorded. This is due to the fact that *Disposable Maps* is a mobile application used in specific situations. There are only certain reasons to share the location with others such as being late for a business meeting or a social gathering with friends. Furthermore, tradesmen or delivery services, who usually only provide time estimates to their customers, could enhance their service through location sharing. We assume that *Disposable Maps* will mostly be used when the location sender's position is dynamically changing while travelling to the location receiver's geographical position, which is mostly static. At this stage of the research, we are not able to generate further predications about application usage and how the sharing of location enhances the experience of the users. However, to gain further insights into application usage and location sharing behaviour, we aim to distribute *Disposable Maps* via Apple's App Store as a free application. Through this approach we hope to rapidly expand the user base to conduct subsequent investigations and collect more insightful data about location sharing. The question still remains if the allocation of location data enhances the process of meeting people in different locations and the idle time they spend while waiting for others.

We aim to port the *Disposable Maps* application to other mobile clients, which allow us to run background processes. Through informal user feedback we noticed that users tend to switch off the iPhone after they initiated a location sharing session. This has the result that no further updates will be sent to the processing server. Additionally we are interested in the opportunities of enabling interaction between location sender and receiver via the *Disposable Maps* mobile client and the web-based front end.

In addition to feedback gathered from the initial application user test, we aim to integrate different web 2.0 services like Facebook status messages, Twitter posts, or Skype status messages for location sharing. It would be interesting to observe if users publish their location more often to semi-public web 2.0 services using *Disposable Maps* as a tool for social identity and comparison, or if they prefer the current approach of peer-to-peer location sharing. How sensitive are people about their location data and in what kind of situations will they make their locations public to their friends and colleagues?

The concept of unique URLs could also be applied for different privacy sensitive data sharing applications, e.g. revealing parts or a whole Facebook.com user profile for ad hoc mobile dating applications.

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