vHike – A Dynamic Ride-sharing Service for Smartphones

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***Abstract*—In times of lacking natural resources and increasing environmental pollution at the same time, modern resource efficient kinds of personal transportation have to be considered. Ride-sharing is maybe one of the most economical ways to avouch permanent mobility without losing too much comfort. However, especially dynamic ride-sharing is laden with many resistances including a lack of security and a heavy scheduling and coordinating burden. Hence this paper introduces an implementation of a system for dynamic ride-sharing called *vHike* which should eliminate these barriers. With our demonstrator every interested participant may test whether or not such a system can be viable and effective.**

1. Introduction

Various realistic estimations assume that in 2010 more than $600,000,000$ passenger cars travel the streets of the world today while every year $50+$ Million cars are produced additionally. This is a ratio of nearly 0.09 cars per capita. $50+$ Millions of them are in Germany which means that there is one car per 1.6 capita. Thereby, the German average yearly passenger car mileage is 13.600 km per year [1]. Most of the streets not to mention the environment are overloaded by these masses.

As the extent of transportation-related problems can be noticed every day (air-pollution, traffic jams or increasing resource prices just to name a few) both industry [2] and academia [3] have spotted these problems as a new research area. One solution for these problems consist of forming carpool for permanent repeating needs for a ride (e.g. commuting) or in sharing a ride for long-term planed journeys (e.g. going on vacation). With on-line services such as Pendlernetz or Mitfahrzentrale.com there exist some tools for managing and organizing these tasks already. Though the success of these platforms is limited by some factors: Firstly, even if the system provides support for some tasks, a high organizational effort still remains by the User himself. Secondly, people are used to arrange their lives completely flexible, while this way to arrange a trip is not really ad-hoc. Thirdly, Users are not encouraged enough to share their vehicle with a randomly selected person. But without their voluntary participation such a project cannot have any success. Finally, most people have some security issues and a feeling of discomfort against sharing a ride with a stranger in general.

This is primarily because these tools do not exploit the potential of today's hardware - especially in the mobile sector - sufficiently. Modern Smartphones are equipped with high performance CPU - nearly comparative with the ones in personal computers - and many additional features such as Bluetooth or GPS already today. With these devices it is almost guaranteed that a User is always traceable and has a permanent connectivity and reachability. Also the days of mainly static Web-pages are over as highly dynamic services can be provided in real-time by any half-way current server. As an important third pillar, social networks have shown that a User accepts to give up some of his or her privacy, when the service provided in return satisfies a certain quality level [4]. Therefore, the registration and rating technologies used in those networks can be a huge contribution towards feeling secured and comfortable, as they are accepted to maintain trust among strangers in the Internet already.

Innovative solutions satisfying these requirements and specifications are needed in order to provide a promising and accepted service. For this reason our paper introduces *vHike* [5], a dynamic ride-sharing service for Smartphones using these technologies and methods. Our service ranges from establishing the first contacts between driver and rider to finding fitting partners up to ensuring that any arrangement which has been made will be met in the end. Additionally, we keep an eye on issues of flexibility, security, trust and privacy all of the time.

With our early prototype a User can experience how such a secure dynamic ride-sharing service might look like. Each step, from the creation of an offer and the request for a ride, respectively, to the establishment of contacts and finally its (hopefully) successful ending, will be shown in our demonstration. The remainder of the paper is organized as follows. In Section 2 we will present some work already published in this research area and we will deduce special requirements of these systems in Section 3. We will confront these approaches with our implementation of *vHike* in Section 4. A concrete scenario for *vHike*, which we are

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going to demonstrate in the demo session, is the topic of Section 5. Finally, desirable but missing functions are the topic of Section 6.

2. Related Work

As shown in Section 1 there are some examples for traditional carpooling tools in use but for the so-called *dynamic ride-sharing* there are theoretical approaches, mostly. We will give a rough overview of the most important representatives in the following.

Awareness, *inconvenience*, *trust* and *availability* are key factors for the success of a dynamic ride-sharing system, according to a survey by Chaube et al. [6]. Kelley [7] presents a recommendation how to design a dynamic ride-sharing system that does all scheduling task completely automatically by localizing all Users over RFID tags. Thereby, security is guaranteed by monitoring each ride and User rating mainly based on the quantity of accomplished rides. In *Smart Jitney* [8] all applied vehicles are equipped with mobile phones. To drive such a car a special license is needed. Then, riders can cab-like call a car and order a ride. The scheduling is done fully automatically, also. *SRSS* [9] divide all registered Users in homogeneous interest groups. The driver / rider arrangement is done by algorithms on base of these Social Networks. *SafeRide* [10] combines existing and accepted Web services (e.g. Google Transit) to realize User interaction.

RideRemedy [11] is one of the few examples for a dynamic ride-sharing project which is actual working and currently running. This application is available through Apple's iTunes App Store [12] since April 2010 free of charge. While the download and the use are free for the first three month, *RideRemedy* is still a commercial product, since it claims an annual subscription fee after this trial period. Though this approach assures the User's privacy, it disregards trust measures, completely. Therefore, it hardly differs from common hitchhiking and needs some revision concerning this aspect, according to our researches.

3. Requirements

Considering the outcome of the projects mentioned in Section 2 we managed to identify two technical requirements as well as four strongly needed non-functional requirements towards a dynamic ride-sharing system.

3.1. Technical requirements

Bluetooth: Bluetooth originated of a draft to facilitate a Wireless Personal Area Network free of charge, made by a consortium of companies. Primarily it was used as a cable-replacement technology connecting external data and audio peripherals to mobile devices. By now it defines a standard for short range, low power and low cost wireless communication using radio technology.

Bluetooth devices are capable of locating each other within a short range up to 100 meters, depending on the used power-class and environmental disturbance. Once a device is paired to another Bluetooth device either synchronous traffic (e.g. within a Bluetooth chat) or asynchronous data communication (e.g. exchanging virtual business cards) is possible. Even when connected, Bluetooth devices can switch to a low power state in order to spare battery.

GPS: GPS receivers are able to determine their current position by timing the signals send by satellites. Therefore it is required to receive at least four different signal sources constantly. Herein lies one of the major weaknesses of the system as it will not work indoors, during periods of strong atmospheric disturbances and in densely populated areas. Another problem especially for small mobile devices, such as Smartphones, is its permanent energy consumption.

3.2. Non-functional requirements

Community-based: The *vHike* service is available to closed community of registered Users exclusively. We are confident that, comparable to every other community, most of the User will form their own private *crowds* - small subdivisions within the community consisting of friends and associates - after a certain time. These crowds can be used to prefer certain providers or to exclude others already at a very early stage. The crowd members feel responsible for their fellows and are willing to invest some time, not only using *vHike* to request a ride, but also to offer one. Thus the awareness will be up all the time, even without any refunds for the drivers. Ultimately in the long-run a dynamic ride-sharing service can only be viable when there is a balance between supply and demand.

Smartphone-based: The handling of our service has to be very easy, fast and intuitive in order to reduce the inconveniences to a minimum. If the User has to perform more than a few clicks, he or she is not willing to use *vHike*. Especially the driver would be alienated to offer his or her voluntary services to the other Users.

Furthermore, we need to implement the *vHike* service on devices which are always available and always accessible for any potential User, in order to reach a widespread deployment. According to Gartner [13] Smartphone sales will grew rapidly and will sooner or later represent the gravest device in the sector of mobile phones. In addition Gartner estimates that Android-based mobile devices will be the fastest growing brand in today's Smartphone division. Therefore, our implementation of the *vHike* service is initially available for Android-based mobile devices, exclusively. Thereby, we hope for a wide dissemination of our application which is essential for the viability of such a service. Nevertheless, subsequent releases for other platforms are not excluded.

Trust-based: As any User of a dynamic ride-sharing platform has to put a lot of trust into the other service providers *vHike* has to provide a variety of trust building measures. The first step towards a secured service *vHike* is available to a closed community of registered members only. During the registration process a profile is created for each User. In addition to contact data this profile holds some identifying information about the User. Whenever two Users

agree upon the circumstances of a ride, every ride-related data has to be monitored by the dynamic ride-sharing service. During the ride *vHike* offers an emergency button which triggers an emergency call immediately. After a completed ride both involved parties are encouraged to rate each other. Besides the pure evaluation, well known from services such as eBay, this serves the confirmation that both of them have arrived safely at the agreed destination.

In order to improve the safety of *vHike* even further, the course of a ride is tracked. It is intended to include features to show this data on a map. Thereby, selected persons could overview the whereabouts of a certain User almost in real-time. In this way, unexpected deviations from the agreed route can be noticed fast and in case of major violations against guaranteed agreements security authorities can be informed.

Web-based: *vHike* has to guarantee a permanent availability and manage plenty of User data at the same time. The best way to achieve this is to implement the service as a classical three tier architecture including a small client (mobile phone), a main server and a database in the back-end.

Based on these considerations and demands towards such a system *vHike* has been implemented as part of a Software Development Course. In the following Section we will describe the operating mode in detail.

4. *vHike*

Before the *vHike* service can be accessed a User has to log into the system. Therefore, a valid account is required. While such an account can be created with any given system for which a web browser is available the actual *vHike* service, as depicted in Figure 1a, supports Android-based devices, exclusively. Initially, a registered User selects whether he or she wants to place an offer for a ride or if he or she is looking for a free seat. The two different interfaces for drivers and riders are shown in Figure 1b.

An offer for a ride is defined by its place and time of departure, the destination and the number of free seats. These parameters are broadcasted to all accessible devices in the surrounding via Bluetooth. The short range of Bluetooth is not a disadvantage for *vHike*, because thereby only Users close to the driver are informed. They represent our target audience since a driver is not willing to make a detour just to pick up a hitchhiker, usually. For input process the User is support in two ways. On the one hand *vHike* predicts the place of departure depending on the current User location and on the other hand a possible destination is suggested when the driver has stored additional information in his or her profile. Afterwards riders can apply for the free seats until it is time to leave.

A request for a ride cannot be placed directly lest not to flood the server with spam. The rider interface features a list of available offers. If one of them is eligible all available rating of the corresponding driver can be accessed. Afterwards a rider can either start a Bluetooth chat with the driver to clarify open points or apply for a free seat. Following an application the driver is informed. Then the driver can also obtain rating information about the rider or accept or decline the application.

When an agreement has been reached all key figures are monitored by *vHike*. Besides from the ride information made by the driver the affiliated driver and rider(s) are forwarded to the system server and stored in the record created for this ride, also. When the time of departure has come the driver and rider(s) meet and confirm it. On the *vHike* display appears a huge emergency button, then. This button sends an alarm signal to the responsible authority. In addition to this call all available information about the incident is recorded in the *vHike* database in order to facilitate investigations afterwards.

We distinguish two possible outcomes of a ride: A successful ending means both parties reach the expected location and reports this to the *vHike* service. When the ride ends prematurely or at least one involved person does not confirm the arrival, we speak of an unsuccessful ride. The latter kind of rides needs to be investigated further to decide whether this occurred accidentally or if an agreement has actually been breached. The confirmation, which attests an unharmed arrival, is done automatically when one participant rates his or her counterpart.

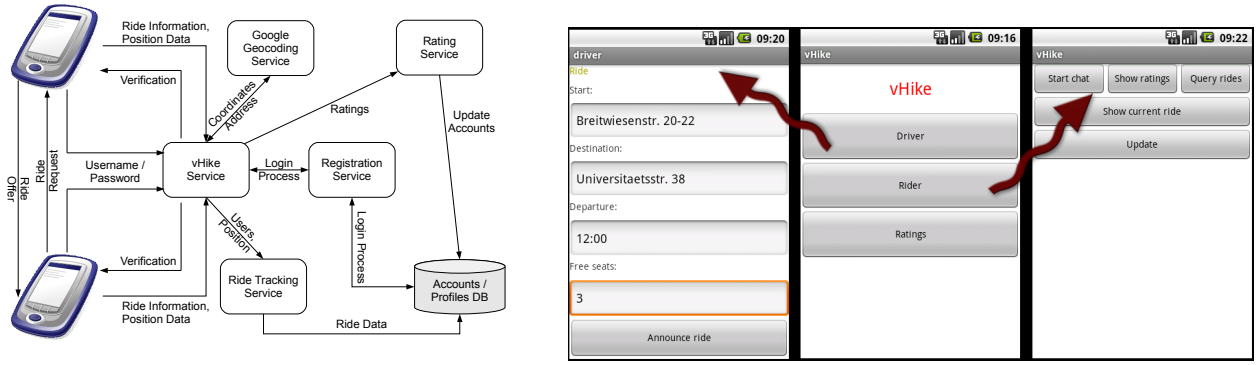
The *vHike* rating system is similar to the common rating systems used in Web 2.0 services such as Amazon Marketplace. User may award between zero (an awful ride) and five stars (a fantastic ride) and justify their decision with a short description of characteristic details of the ride. Following the rating process the record for the ride is closed and a new ride can be started.

Apart from this dynamic ride-sharing mode *vHike* also provides a mode to arrange long-term planed or periodic rides. Therefore, each User can announce a ride intention in our Web-based forum accessible by our registration page. Admittedly, such a ride-sharing cannot be supported by *vHike* in any way apart from the announcing opportunity.

5. Demonstrator

To run a *vHike* demo session two mobile phones with the Android-OS "Eclair" each equipped with a working Sim-card are needed. Additionally, a running PHP-enabled Web server and a prearranged SQLite-Database will be required. In order to present the stored data to visitors either a laptop or a desktop PC with an Internet connection is needed.

In the interactive *vHike* demonstrator a visitor can test the complete functions of the *vHike* service. After a short registration he or she is able to play either the role of the driver or the rider. As a driver the User may plan and offer a new ride. Hereafter, the User can take a look at his or her potential passengers and decide whether to pick one of them up or not. As a rider, however, he or she can stretch out his or her virtual thumb to draw attention and look for a willing driver. After a successful arrangement phase via Bluetooth Chat either a successfully completed ride (final destination corresponds to the arranged goal) or a deviation from the expected destination can be simulated. Finally, both Users



(a) Architectural design of *vHike*

(b) *vHike*GUIs

Figure 1. Services and System Components of *vHike*

may rate each other. After *vHike* has come to an end it is possible to get an insight into the server protocols.

6. Future Work

Future Work is planned along several directions. In upcoming releases of *vHike* we are working on minor improvements of the driver-rider-matching process to reduce the result set of possible candidates further. The user interface and the operability will be embellished and improved, too.

Our main focus is to expand the functionality of two aspects: On the one hand we would like to include a possibility to share the location of a User with his or her friends within the *vHike*-community. Thereby, they will not only be able to meet each other and stay in contact but also to provide a ride offer to selected members over a larger distance than it would be possible via Bluetooth. Google already offers such a service called Google Latitude, which will have to be adapted for our application.

On the other hand we will include the Google Maps service into *vHike*. This will help us to calculate directions and suggest a time- or distance-optimal route to any given destination. Additionally, we will be able to offer the full functionality of a common navigation system to the driver. But not only the driver can benefit of such a feature but also worried parents. They will be able to track the location of their children and "follow" their trace on a map in real-time via Web access.

When these features are fully included, we are looking forward to release a test version of *vHike* in the Android Market in order to attract a huge number of voluntary '*guinea pigs*'. With their help we will be able to evaluate how well our system runs under real conditions and we will collect measurement date to determine the success of *vHike*.

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