ADDING VALUE TO TRAFFIC ENCOUNTERS: A DESIGN RATIONALE FOR MOBILE AD HOC COMPUTING SERVICES

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Abstract

The roads are places where an extensive amount of everyday meetings among people occur. Two issues make the social interaction meagre. First, when driving, high speed makes these encounters brief. Second, driving often involves being enclosed by a hull of a vehicle. Consequently, this interaction and, in the end, also driving, occasionally becomes tedious. We suggest a design rationale for mobile ad hoc computing services that add value to traffic encounters, yet taking into account safety issues. We argue such services would considerably augment and enrich the highway experience. This rationale, which honours the main features of the prevalent social interaction, is motivated by two prototype services: Hocman and Sound Pryer. The first adds value to biking activities. The latter provides shared music listening experiences during traffic encounters.

Keywords: Design Rationale, Traffic Encounters, Mobile Ad hoc Computing.

1 INTRODUCTION

Highways, city streets, turnpikes, country roads etc. are places were an extensive amount of everyday encounters among people occur. Any road user's journey often coincides with several, sometimes hundreds, and in extreme cases, even thousands of other journeys. The encounters happen as a consequence of sharing a common resource i.e. being temporally and spatially co-located on a particular stretch (Schmidt et al, 1996). The drivers involved in such encounters use the movement of their vehicles to claim and offer others access to it. Their actions are not only governed by legislation, e.g. adhering to speed limits, but also informal conventions, e.g. being too close or an aggressive overtake, may potentially disturb other users (Juhlin, 2001).

Manoeuvring a vehicle in traffic is thus a co-operative activity. However, often drivers handle this perfunctory, which allow them to do many other things. Besides manoeuvring, time spent in traffic also concerns e.g. eating, listening to music, and even work (Laurier, 2002a). Traffic encounters are also pleasant experiences. They are sometimes enjoyed for their own sake. Appleyard and Lynch argue that the encounters are central in the road user's experience of driving:

> *"[m]ost impressive of all is the motion of the accompanying traffic, to which he is forced to be attentive, and which even passengers will watch with subconscious concern (Appleyard et al, 1964)."*

The very brief engagement and the participants being enclosed in the hull of a vehicle characterize the social interaction occurring during encounters. This detachment occasionally makes interaction monotonous and in the end driving becomes lonesome (Laurier, 2002b).

From our experiences gained by developing two prototype services: Hocman (Esbjörnsson, et al, 2002b) and Sound Pryer (Axelsson et al, 2002), we suggest a design rationale for services of mobile ad hoc computing platforms that add value to traffic encounters. We argue that using this rationale such services are able to somewhat bond participants engaging in traffic encounters and thus able to considerably augment the experience of driving. The work comprises empirical studies, prototype implementations, as well as user tests.

The design rationale consists of four items that services must address in order to successfully provide added value in traffic encounters. The first concerns *convenient interaction*, where we argue how the Human-Computer interface of the service must be designed to accommodate driving. *Participator approximation* specifies how one instance of the service should select other instances in a given encounter. In *data exchange* we argue for ad hoc networking technology and peer-to-peer systems architecture fitting services adding value to traffic encounters. Finally, *personal technologies*, is about staging the services on handheld devices rather than vehicle embedded devices.

The disposition of the paper is as follows: immediately below we will specify adding value to the social interaction occurring during traffic encounters. The section following it gives an overview of the Hocman and Sound Pryer prototype services. Next we will present the design rationale. In section five we will present how they fit this rationale.

2 ADDING VALUE TO TRAFFIC ENCOUNTERS

To add value to some practice is to introduce a certain quality that did not exist in it before or articulate a certain behaviour that the participants feel strong about. It is not about rationalising or improving in terms of efficiency. The purpose of adding value is to entertain or at least to deepen the experience of a prevalent situation. However, the goal is not about giving immediate satisfaction, but lead towards a situation in which the person using the service may experience more of some aspect of the practice he or she already appreciates. Our goal is to add value to *traffic encounters*. It is a highly social situation in a public milieu. The interaction occurring among participants engaging in traffic encounters is characterised as follows.

Traffic encounters are an *omni-present* social phenomenon. They occur in great numbers anywhere along the roads and streets of our society.

Specifically, traffic encounters arise when two or more people on the roads are *co-located*. These situations compromise drivers meeting, e.g. in intersections, passing in opposite lanes or when overtaking. Traffic encounters also include drivers meeting people that travel by other means e.g. pedestrians, bikers, and skateboarders.

Social interaction during traffic encounters is *temporally bounded*. In most cases, due to high relative speed, people meet for very short periods of time, sometimes lasting only a fraction of a second. Still, some encounters persist.

Traffic encounters are *co-operative* situations, since a number of actors, i.e. drivers, share a common resource (Schmidt et al, 1996), i.e. the road. They are compelled to show consideration, or at least adapt their activities to each other, in order to avoid accidents and disturbances. The coordination in an encounter requires much work from the participants although provided with a set of formal rules i.e. legislation, to aid the handling. A participant must situate these rules into a contingent context (Suchman, 1987) at the same time also consider informal conventions (Dannefer, 1977).

However, road users show *indecisive commitment* in traffic encounters. Some take place without the participants hardly noticing each other, e.g. two drivers traveling in opposite direction on a highway. However, encounters also involve active communication, or performances, which serves to influence all or some of the other participants in various ways and for various reasons, e.g. using turn signals (Goffman, 1971).

Interaction during traffic encounters is mainly *mediated* by short-range communicative tools e.g. turn signals, headlights and horn. Communication is also conveyed with other, subtler means. Sophisticated vehicle manoeuvrings implements, in a sense, a mediated "body language" (Goffman, 1971).

Traffic encounters are also *seamlessly integrated* into other social activities. For instance, drivers sometimes do work, i.e. making calls with mobile phones on their way home or to their worksite (Laurier, 2002a).

3 PROTOTYPE SERVICES ADDING VALUE TO TRAFFIC ENCOUNTERS

The prototype services, Hocman and Sound Pryer, add value to traffic encounters. However, related concepts promoting social interaction using personal technologies do not. GroupWear (Borovoy et al, 1998a) is designed with the face-to-face social interaction that occurs at big events, i.e. conferences, which is a very different situation than the temporally bounded nature of traffic encounters. MemeTags (Borovoy et al, 1998b) is also designed for similar face-to-face interaction purposes. Hummingbird (Holmquist et al, 1999) is an inter-personal awareness device. Interpersonal awareness is a good candidate for a value adding service, however, the Hummingbird implementation was not adopted for in-car use. Proxy Lady (Dahlberg et al, 2002) is designed with the purpose to initiate face-to-face communication in an office, again, not directly applicable to the traffic domain.

Related in-car leisure and entertainment concepts do not acknowledge traffic encounters. WIRE[3] is a “hands-free” HTML browser for car-drivers (Goose et al, 2002). ShoutCar, is a music application designed for car commuters (Åkesson et al, 2002). Neither of these projects addresses the social interaction in traffic encounters.

3.1 Hocman

The design of Hocman is informed by a field study on motorcyclists (Esbjörnsson et al, 2002a). Biking is a mobile social leisure activity. Bikers take interest in traffic encounters, especially meeting other bikers. However, these stray meetings are very brief and the social interaction is often scant, e.g. a quick nod or wave of the hand. In order to socialize more, biking is often organized e.g. they often travel in groups, or meet other bikers at specific locations. However, setting up such joint rides with bikers met during random encounters, is difficult.

Hocman (Figure 1) is the prototype service designed adding value to biking (Esbjörnsson et al, 2002b). It is a HTTP peer-to-peer application for handheld computers capable of wireless ad hoc networking. The Hocman prototype supports running in two complementary modes. The first is *cruise mode*. It works as an automatic HTTP client to be used in the background of the user's attention. Upon detecting that a new peer entered the ad hoc network it plays a sound icon and downloads the index page of the main directory on the newly discovered peer. The cruise mode also logs the time of the event. The second is *browse mode*, which is a basic HTML browser. This mode lets the user browse the pages of other user's Hocman servers within wireless reach.

HTML is a flexible format that may contain various media formats other than tagged text, such as embedded audio clips, and images. By letting the user be in control of the authoring he or she is in control of both content and format, which allows the service to mediate a personal expression accurately among semi-anonymous users. To encompass flexible descriptions, users are identified by the content of the title tag of his or her index page.

We designed the Hocman concept to be used as in the following scenario. Before heading out on the roads, a biker would activate the cruise mode and then tuck the device away. Whenever encountering another Hocman user he or she would hear the sound telling there is something more to the situation. Additionally, the service would automatically download a page through the background downloading mechanism. When coming home the biker could browse these pages and perhaps take contact through other prevalent media, e.g. phone, or web-chats, to set up future rides with the bikers he or she met.

We have performed a series of tests to prove the technical feasibility of the automatic background downloads taking place on discovery in cruise mode. Each Hocman was also prepared with an index-page containing at least one picture and textual content we think would represent typical usage. We placed two Hocman devices close to each other and drove by at different speeds with the third observing the performance. We were able to drive by in speeds up to 70 km/h before experiencing problems with the downloading mechanism.

Figure 1: The hardware used (left). A typical biker's page (middle). Screenshot of the log (right).

Later in the development phase a refined version of the discovery protocol was tested in a similar fashion. In this test we used the same hardware as above however we disabled downloads and monitored performance of the discovery protocol only. We kept one Hocman stationary next to the road and drove by at various speeds. We went as fast as 160 km/h and experienced no problems with the protocol.

This prototype was later used in a field trial with six bikers (Esbjörnsson et al, 2002c). Two tests with three bikers were performed in order to get feedback on the usage experience. The test consisted of driving a route while using the Hocman in cruise mode. After driving we monitored the users using the prototype in browse mode. We also interviewed them to learn about their experience. The bikers enjoyed the concept and deemed it relevant. Hearing the sound icon when becoming co-located with other users especially intrigued them. However, they showed discontent with the actual handheld computers we provided, i.e. they were bulky, and the earphones uncomfortable. We concluded that Hocman is able to add value to biking and especially doing so in traffic encounters involving bikers.

3.2 Sound Pryer

The Sound Pryer concept is based on two appreciated activities, joint music listening and flâneuring. It provides joint listening among drivers in everyday traffic encounters adding a novel flavor to the flâneuring aspects of the interaction. In essence, it works as a shared car stereo. A user can hear the tunes played on his or her stereo, but also, if so inclined, eavesdrop the music played at other stereos, in vehicles close-by.

We argue that such experiences would make driving more enjoyable. First, many drivers are entertained by listening to music. For instance, in a recent study concerning the music listening habits of a group of music enthusiast, it was found that at majority of the time they spent in cars, they listened to music (Brown et al, 2001). Second, since traffic is co-operative, a driver must keep track of the surrounding traffic. This co-operative work includes getting a quick glance of other drivers and their cars. But most of the times, for maneuvering purposes, an impression of the movement of surrounding vehicles is adequate. We argue that most people also enjoy looking at others beyond what is necessary for co-ordination. The individual apprehension of a traffic encounters possesses in many cases the same qualities as what appeals to the flâneur. He or she appreciates:

> *"[t]he unpredictable juxtapositions, the fleeting occurrences, the disparate rhythms and multifarious sights, smells and noises… of the urban realm. (Edensor, 1998)."*

However, a participant of a traffic encounter seldom reacts like the flâneur e.g. taking off at an unexpected direction, as road use seldom is spontaneous in this sense. Finally, as most traffic encounters are temporally bounded, a Sound Pryer user would often only be able to eavesdrop fragments of tunes played in other vehicles. We believe, hearing what is being played, even if it only means for a few seconds, would add a new dimension to the apprehension of traffic, beyond the glimpse of the identity of the individual driver and his or her vehicle, and therefore make driving more fun.

Sound Pryer (Figure 2) is designed as a wireless ad hoc peer-to-peer streaming application. Joint music listening experiences are provided by two modes of playback: *local* and *remote*. In local mode, a user may select and listen to MP3 music files stored locally, however, while listening, the file is also broadcasted. In remote mode a peer is able to receive and play the MP3 stream from any peer in local mode interconnected via the ad hoc network. The Sound Pryer concept is dependant on the number of co-located peers. When co-located, the remote-listening function is dependant on the number of music providers. Therefore, a user is required to assemble a play-list, prior to entering the remote mode. Moreover, in order to maximize provision, whenever the remote source fails to provide music e.g. goes away or is turned off, the peer automatically falls back to local mode. Finally, in order to balance the two modes, only peers in local mode are viable as remote sources.

Figure 2: Screenshot when receiving music (left). Sound Pryer mounted on the instrument panel

In order to deepen our understanding of the Sound Pryer concept and refine the design we tested the concept. Our goal was to get an idea of the prototypes ability to provide awareness of from whom you are receiving music. Does the user make a connection of events in traffic and the corresponding icons in the interface?

We used a Wizard of Oz (WOZ) experimental evaluation method (Dahlbäck et al, 1993) consisting of two inter-connected handheld computers. The first was mounted in the vehicle next to the driver and ran a limited implementation of the Sound Pryer concept. It only displayed awareness information and played local files. We prepared it with a selection of snippets of music files. The “wizard” controlled the other device. It worked as a remote control from where it was possible to send commands to the first handheld, e.g. making it show a red car and play the fifth track in the play list. The user was instructed to drive along a particular route and interact with the prototype when the situation allowed. The “wizard” selected vehicles in upcoming traffic encounters and sent commands that made user’s prototype show a corresponding representation of them. We have successfully run a primary WOZ test with two persons and demonstrated it in a car in front of a group of three.

The WOZ test implied that the Sound Pryer concept was able to add value to driving. However, the test implied that having a good experience is dependant on hearing music from one appropriate remote source. First, there is no time to select a source to listen to in case of several. Second, the source should ideally be selected among the vehicles in a traffic encounter in which the driver has to pay attention to, in order to manoeuvre successfully. This implies that oncoming traffic often constitutes poor candidates as these vehicles often travel in another lane and therefore the driver can safely neglect them. However, cars in front, going in the same direction are often good sources.

We have also completed a prototype proving the technical feasibility. The prototype consists of a RTP server and a client. The server is playing a file and simultaneously streaming it to a multicast group using RTP. Any number of clients may receive the stream and play it at the same bit rate as the server.

4 A DESIGN RATIONALE FOR TRAFFIC ENCOUNTERS

From our experience with designing these prototypes we identified a set of issues that must be addressed, when designing services using mobile ad hoc computing platforms adding value to traffic encounters:

- **Convenient Interaction**: the Human-Computer interface of the service must encompass variability in user's attention; since traffic encounters are seamlessly integrated into other social activities and participants show indecisive commitment to them.
- **Participator approximation**: Participants in traffic encounters are co-located. Moreover participants often pay attention to each other, as encounters are co-operative. Traffic encounters are also temporally bounded. Therefore, the service must select participants rapidly within appropriate physical proximity.
- **Data Exchange**: Peer-to-peer architectures over wireless ad hoc networking are appropriate to convey data as traffic encounters involve co-located participants and are temporally bounded. Using wireless ad hoc networking technology is also motivated by interaction in traffic encounters already is mediated locally.
- **Personal Technologies**: Services for road use are staged on personal computing devices, as traffic encounters are omni-present and seamlessly integrated with other social activities.

4.1 Convenient interaction

The effect of in-car interfaces, i.e. mobile phone dialling interfaces, radio, and climate control, on traffic safety has been thoroughly explored. It is an established fact that interfaces that demand visual attention has a large effect on driver behaviour, such as, steering and maintaining speed. However, this does not rule out all in-car interfaces as hazardous. Splitting attention with interaction interface of a different type than driving, i.e. audio-based, has no significant impact (Salvucci, 2001).

Moreover, many drivers deem themselves capable of interacting with interfaces, even the ones that demand visual attention, and keep vehicular control and safe navigation at top priority. There is room for well-balanced interfaces, taking the user's primary tasks into account, yet allowing convenient interaction. Thus driving-friendly interfaces must be largely audio-based or when out of necessity visually oriented, prioritize checking state with quick glances. Interfaces must be somewhat autonomous. To a large extent they must be designed to be unattended, however letting the user effortlessly gain control whenever he or she finds it adequate.

4.2 Participator approximation

The range of radio transmissions is useful when approximating the participants in a traffic encounter. Careful calibration of the range is crucial in order to select candidates that fit the prevalent social interaction. If the transmitter is too strong users out of sight and not yet relevant to the co-operative aspects of it, will be included. On the other hand, if the range is too short, it may only include users that may be within sight, hence most likely no longer relevant. Furthermore, considering users move in high speed relative to each other, if the range is short, the time the service may add value to the encounter becomes too brief to provide meaningful experi-ences. Additionally, high speed requires that this issue procedure is timely. We have found that for services that add value to traffic encounters, the appropriate range of the participator approximation is about 200 meters. Moreover, it must react to changes to the set of participants within sub-seconds.

4.3 Data exchange

Services based on IP over mobile ad hoc networks[1] (MANETs) are highly appropriate for implementing data exchange during traffic encounters. Ad hoc networks are self-organizing, transient, wireless networks. Nodes in such networks do not rely on infrastructure, such as, base stations, routers, or DNS servers, to operate. Two nodes may communicate directly if they are within wireless range or indirectly by a chain of hops, where each intermediate pair of nodes is within range. However, the multi-hop feature is somewhat superfluous considering participator approximation, as nodes outside a certain radius are deemed irrelevant to the prevalent encounter. There is thus little point in distributing data to them.

Due to the temporally bounded nature of traffic encounters, the ad hoc networking connections are very transient and availability of remote nodes are unpredictable. Thus, services cannot rely on client/server schemes. A peer-to-peer architecture better fit this situation. However, in contrast to peer-to-peer system for wired networks[2], there is no need for a virtual network overlay. Having no virtual overlay in combination with single-hop ad hoc networking gives adjacent peers in the network are also close in the physically. Peer-to-peer concepts are dependant on the number of users. Therefore it is important to use widely available standards, e.g. HTTP (Berners-Lee et al, 1996), or RTP (Schulzrinne et al, 1996), to implement the data exchange.

4.4 Personal technologies

We argue staging added-value services for traffic encounters to accompany the person, not the vehicle. We believe that handheld devices capable of ad-hoc networking will enjoy widespread usage in the future. These devices will become personal accessories and be present in many and varied situations of life in contrast to vehicle embedded devices. Whereas embedded devices are coupled to a particular vehicle, handheld devices etc. may also be used “off-road” e.g. during office work. Thus, many drivers will acquire the devices needed for other reasons than road use.

Handheld computers as of today rely on a scheme where they are inactive most of the time. The reason for this is to preserve battery power. In order to react automatically to dynamic changes in the traffic environment, we use schemes where the devices are active all the time. However, charging a battery is seldom a problem in a vehicle.

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[1] http://www.ietf.org/html.charters/manet-charter.html
[2] http://www.gnutella.com/

5 HOW THE PROTOTYPES FULFILS THE DESIGN RATIONALE

5.1 Hocman

5.1.1 Convenient interaction

The main use of this service when motorcycling is having it in cruise mode. Being tucked away, for instance in the pocket, it works completely in the background of user attention. Whenever motorcyclist augmented with a Hocman peer is discovered, the user is notified by playing a sound-icon and pages from other Hocmans will automatically be downloaded. When motorcycling it is hard to perform other activities than driving. The users gain from the information collected, when in retrospect pondering on the traffic encounters involving other bikers.

5.1.2 Participator approximation

Biking is mainly about driving. Bikers enjoy meeting other bikers when doing so, however these encounters are often very brief. We have constructed an algorithm to approximate traffic encounters among bikers accurately. The Rapid Mutual Peer Discovery (RMPD) algorithm (Esbjörnsson et al, 2002 B) is implemented with UDP. Running it over IEEE 802.11b compliant wireless network interface cards, the range and timing constraints are met.

5.1.3 Data exchange

As traffic encounters involving bikers are brief, data transfers must be set up with low delay and be performed at short duration. Hocman uses the IEEE 802.11b IBSS mode, which is a single-hop ad hoc networking technology, having a transfer rate of 2 mbps. Data exchange is implemented by a peer-to-peer concept consisting of the RMPD protocol, HTTP client and HTTP server. Data exchange is initiated when the RMPD protocol finds new node and performed with HTTP/1.0 over TCP.

5.1.4 Personal technologies

Biking involves driving, but also other activities, e.g. hanging out at cafés, or walking about and watching other bikers do stunts. The Hocman prototype therefore is staged on a platform with handheld computers that could be carried in the clothes but also used comfortably overtly. We have successfully demonstrated the Hocman service on Compaq Ipaq H3660 with Lucent Orinoco cards and Symbol PPT2700 with Spectrum24 cards. Both devices are running the PocketPC Operating System (OS).

5.2 Sound Pryer

5.2.1 Convenient interaction

We argue that besides hearing music, it is crucial to get an impression of who is providing it. We achieve this by displaying a stylized figure of a road user, i.e. the shape of a vehicle and the color of it. Moreover, Sound Pryer also selects one remote source automatically whenever there is more than one participant in the prevalent traffic encounter.

5.2.2 Participator approximation

The participator approximation scheme used in Hocman also fit the Sound Pryer concept with some modifications, although it does not discern the appropriate context e.g. direction, or relative position of the participants. In Hocman the RMPD algorithm is used to monitor the presence of other Hocman HTTP servers. These servers are available as long as the device it is running on is within wireless reach. In Sound Pryer the available streaming servers is also under the influence of the user. Availability may change several times although the devices remains within range.

5.2.3 Data exchange

Similar to Hocman, Sound Pryer also use the IEEE 802.11 IBSS ad hoc networking technology. However, the peer-to-peer concept consists of a combination of RMPD, a RTP client, and a RTP server. Streaming is implemented with a port of the publicly available MPEG Audio Decoder library[3] and a port of the LIVE.COM Streaming Media RTP stack[4] to the PocketPC 2002 OS.

5.2.4 Personal technologies

The Sound Pryer concept is designed to premier the experience of driving. It also accommodates other forms of road use. By staging the device on handheld computers, it is also accessible to pedestrians, bikers etc. The Sound Pryer service runs on Compaq Ipaqs H3850 with the PocketPC 2002 OS equipped with Lucent Orinoco IEEE 802.11b cards.

6 RELATED WORK

The design rationale for traffic encounters relate to work in two research areas: Intelligent Transportation Systems (ITS) and Mobile Ad Hoc Collaboration (MAHC). ITS research has mainly focused on applications supporting safe co-ordination of traffic encounters overlooking the issues of adding value to the social interaction. Different technologies, such as short-range wireless links and radars, have been used to communicate and detect surrounding vehicles. Most efforts has been made to provide services that automate some of drivers co-operative tasks, like remaining at a certain distance to vehicles in the front, or staying centred in the lane. Other services aim at giving the driver better awareness of the context, e.g. alerting the presence of cars overtaking (Zimmer et al, 1993).

MAHC research has taken an interest in social interaction for other purposes than mere co-ordination or rationalization of movement. However, the interaction referred to in this domain does not account for the specifics of traffic encounters. The term impromptu collaboration (Kortuem et al, 2001) characterizes the social interaction interesting to MAHC research. It is defined as being opportunistic, spontaneous, proximity-based and transient.

The co-operation in traffic encounter happens contingently rather than opportunistically due to its omni-present nature. A driver knows what kind of situations they might expect that requires collaboration e.g. overtaking, or intersections. A road user also knows well in advance what means he or she have to use in a particular collaboration situation e.g. break, or turn signal. Some details of co-operation during an encounter are unpredictable. However, such details are often routinely dealt with.

The co-operative aspects of traffic encounters are not spontaneous in the same sense as impromptu collaboration. In most cases road users know the reason why they are on the road and what to find at their destination. Dealing with the details of a random traffic encounter seldom requires planning, as drivers are guided by formal and informal rules. On the other hand, a driver must be trained in these rules i.e. acquiring a license to drive.

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[3] http://www.mars.org/home/rob/proj/mpeg/
[4] http://www.live.com/liveMedia/

Impromptu collaboration and traffic encounter co-operation is proximity-based. In first case the face-to-face distance usually bound the range. In the latter, the distance to other cars in a given traffic encounter bounds it. This interaction typically happens within a few hundred meters whereas face-to-face interaction takes place within a few meters.

The interactions described by impromptu collaboration are transient, lasting from hours to seconds. Again this comes from the time face-to-face interaction takes. Traffic encounter collaboration is temporally bounded by the time at least two people on or by the road are co-located. This interaction is very much more transient, typically never lasting more than seconds.

7 CONCLUSION

We argue for a design rationale for services adding value to traffic encounters. These encounters constitute an important omni-present phenomenon. The participants being engaged briefly and being enclosed in vehicles governs the social interaction in these situations. The specific features of traffic encounters are overlooked by the related research and therefore their approaches are not successful in adding value to them. Our arguments for the design rationale originate from, and is demonstrated by two prototypes services: Hocman and Sound Pryer. Hocman provides added value to biking encounters. Sound Pryer gives joint listening experiences when co-located in traffic.

ACKNOWLEDGEMENTS

The SITI, VINNOVA and SSF funded this work. We would like to thank, anonymous reviewers and our colleagues in the Mobile Life Research Program at the Swedish Institute of Computer Science, the Interactive Institue, and the Viktoria Institute, for valuable comments.

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