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An Appeal to Discuss Ethical Issues in Context with Cooperative User Localization

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ABSTRACT

Rapid technical developments in GNSS and other ubiquitous positioning methods led to new applications and technical possibilities. Technical researchers and developers mostly imply that it is mainly about further enhancing localization technologies and algorithms including the development of new advanced Apps for Location-based Services (LBS). They are aiming to deliver personal navigation with a higher availability, integrity and reliability in any environment. Hence, localization technologies have become very powerful tools when tracking an individual or a group of users. As meanwhile LBS influences every individual's life there is a need that ethical and political issues have to be addressed within our research community. Although there is a lot of research going on in developing algorithms to keep ones data and LBS search request in private, researchers can no longer keep their credibility without cooperating with ethical experts or an ethical committee. From our point of view, we should include the issue of the user's privacy and ethical implications in mind from the very beginning of our research process. At the Department of Geodesy and Geoinformation of the Vienna University of Technology, Austria, cooperation with social scientists in this respect started recently. A study for the acceptance and user needs in a new project proposal dealing with cooperative positioning was initiated. In this project a mobile LBS user is guided with an App and located with assistance of the whole user group. Then users can help each other to find their way through complex environments such as multimodal public transport interchanges, airports, shopping malls, etc. Users of such services should get the right to withdraw their consent for transferring location based and other personal data at any time. They also should get clear and comprehensive information when and for what they give away their personal data and location and its further use.

KEYWORDS: Cooperative Positioning, LBS, Privacy, Ethical Thinking.

1. INTRODUCTION

Over the past decade continuous ubiquitous positioning and navigation developed very fast in many research directions. Hence, such developments became more and more influential in everyone's daily life privacy. Smarr, the funder of NCSA (National Center for Supercomputing Application) and now director of California Institute for Telecommunications and Information Technology, said in 2003 that "We are moving into a world where your location is going to be known at all times by some electronic devices. […] It's inevitable. So we should be talking about its consequences before it's too late". In the context of localization of individuals or groups of people the current trend is, however, that technical researchers and developers mostly work on further enhancing localization technologies and algorithms including the development of new advanced Apps for Location-based Services (LBS) and not considering the impact of their developments on user's privacy in many cases. One can see that continuous localisation and tracking of certain people or even the whole population is made possible when looking at such technological developments.

GNSS and other ubiquitous positioning methods are very powerful tools as they can enable the tracking of an individual or a whole population. Due to technical developments users are often only vaguely aware of the fact that they transmit their current location and trajectory to navigation and guidance service providers while at the same time receiving aggregate information based on data transmitted by other users (see Ng-Kruelle *et al.*, 2002). Such developments show that user's privacy frequently is exchanged for convenience. Ng-Kruelle *et. al*. (2002) also elaborate it to the point in their paper "The Price of Convenience: Privacy and Mobile Commerce" that individual consumers of such navigation services must always balance costs against benefits obtained. Cooperative (CP) localization approaches (or also referred to as collaborative positioning) are developed in particular, to deliver more robust positioning performance and to increase positioning quality using shared information between the user groups that operate within a defined neighbourhood (see e.g. Grejner-Brzezinska and Toth, 2013). When looking at such CP approaches applied in Intelligent Transport Systems (C-ITS) users have to transfer their current location to the service provider to improve road safety and efficiency of the road network (Kealy et al., 2014). Thereby they exchange the loss of privacy pertaining to personal location and driving speed for navigational support, improved road safety, collision avoidance, etc. Such developments show that user's privacy frequently is exchanged for convenience nowadays. People, however, are beginning to get aware of that. More or less conscious and with an astounding indifference, many people are willing to give away and to disclose their data for a small benefit or convenience. They negate the fact that all their data is collected. There is a possibility that we may be intercepted, monitored and tracked. 74% of the Europeans see disclosing personal information as an increasing part of modern life (European Commission, 2011). "Digital technologies are setting down the new grooves of how people live, how we do business, how we do everything" said Lanier (2013) in his book "Who Owns the Future". One sees that quite a lot of location and navigation services are and certainly will be based on that life style. "We want free online experiences so badly that we are happy to not be paid for information that comes from us now or ever". Lanier (2013) and many researchers for LBS strive for a future where…"In a world of digital dignity, each individual will be the commercial owner of any data that can be measured from that person's state of behavior". "What we define as privacy and intimacy today is far from 100 years ago. Of course the understanding of privacy did change over the last century. Think about the bathing cloths people were wearing in 1900 and today or the massive protests against the census in Germany in 1987 where – from nowadays perspective – people had to reveal much less personal data than many of us are willing to disclose today on the internet. Our research outcomes are shifting and shaping common standards, constantly influencing political and social structures as well as decisions, no matter if we come from the 'hard' or 'soft' sciences" (Obex and Retscher, 2014).

In this paper a study called InKoPoMoVer (Cooperative Positioning for Real-time User Assistance and Guidance at Multimodal Public Transit Interchanges) conducted at the Engineering Research Group of the Department of Geodesy and Geoinformation of the Vienna University of Technology, Austria, is presented. With it the involved technical researchers started for the first time cooperation with social scientists. In this study the end-user's acceptance of CP localization technologies and the user needs are the major research focuses apart from enhancing technological developments. As a use case a service is considered which provides assistance for public transport users at multimodal transit interchanges. CP is applied to locate an individual user who needs assistance with the help of other users with the InKoPoMoVer App. Due the use of the App improved passenger assistance and guidance can be achieved. In the following, the background of the study is elaborated before a detail presentation and assessment of the InKoPoMoVer research project is presented. Discussion and remarks concerning ethical and sociological aspects as well as privacy issues conclude the paper.

2. STUDY BACKGROUND

For technical developments the consideration of the needs and acceptance of end-users has become entrenched as state-of-the-art for some time. A widespread concept for assessment of users's acceptance is the so-called technology acceptance model (Davis, 1989; Venkatesh and Bala, 2008) which can be employed also for LBS research topics such as for the analysis of smartphone-based solutions for navigation and guidance of individual or a group of users. As Wanka (2014) in personal conversation said, the key hypothesis of the technology acceptance model implies that the end-user's intension to use a technical solution is mostly driven by conviction of two main factors, i.e., the

1. subjective perceived usefulness leading to a user's benefit and
2. subjective perceived level of difficulty of the utilisation.

Whereby (1) is influenced by social norms and demands while (2) is based on the experience with (similar) technologies, technical stances and scepticism and external support resources (Wanka, 2014). Studies in which this model was applied for LBS questions found interesting conclusions. For instance, in the research project CAIRO (Context Aware Intermodal Routing) conducted at the RWTH Aachen University, Germany, significant inferences could be drawn for the use case of smartphone-based mobility research.

The project CAIRO dealt with the development of novel mobile, context sensitive passenger information systems for multimodal travelling scenarios, i.e., travelling with different transport systems. The research findings indicated among others that user experience research with regard to communicative formats and/or products should include research into functional contexts and alternative established topic-related media (networks). Reconstructions of these contexts and networks should be part of future investigations of novel types of applications (or other products) with a communicative purpose. Furthermore, the study CAIRO showed the importance of a participatory approach continuously integrating users into research as insights into the relevance of topic-related communicative formats and media for the evaluation of a certain communicative format/product that can only be gained from users themselves (Wirtz and Jakobs, 2013).

User acceptance evaluation studies conducted so far are based on a high selectivity and lead therefore to the unconsciously exclusive technological developments for a certain personal end-user group which includes mainly only young people, male and people living in cities (compare Hunsicker *et al.*, 2007; Jonuschat *et al.*, 2014). To achieve a more representative evaluation it should be ensured to combine models which are targeted on individual characteristics with sociological concepts. Especially for societies in demographic transition the concept of technology generations (see Sackmann and Winkler, 2013) is applicable which considers the influencing factors of the technology acceptance of different user ages and ambiences. Then conclusions can be drawn about the specific needs of the end-user group. Thereby the state-of-the-art for involvement of end-users surpasses the user-centred design. Besides to the overall orientation to the needs of subsequent end-users, the inclusive design, specific of the targeted users and the involvement of the users in the concept, development and evaluation process are of high importance. Such an approach is often achieved in so-called 'Living Labs' (Wanka, 2014). The concept of Living Labs was already developed by Robert Parks in 1915 where a city is considered as 'social lab'. Recently, this method was applied by Mitchell (2005) for testing of user acceptance of smart homes.

The influence of personal factors (such as gender and age) on user experience of novel technologies is major point which has to be investigated with respect to trends, such as demographic change and a longer life expectancy. The investigation of the impact of personal user attributes, such as age and gender, or the membership in a certain technology generation is another research question (Wirtz and Jakobs, 2013). For instance, Sackmann (1996) states in his paper "Generations, Inter-cohort Differentiation and Technological Change" that the way we experience technologies is influenced by earlier experiences, especially experiences with innovations in everyday life technologies, which have coined the social life during our youth.

The success of ubiquitous localization applications depends on the realization of the underlying scenario and on successful user guidance through it. In addition, it depends on a thorough integration and implementation of well-established, familiar, and accepted patterns for the representation of functions and content. A substantial prerequisite for the design process is the identification of these patterns and the examination of their best representatives in the sense of prototypes. The analysis of reference objects could especially be beneficial in early product development stages. It could help developers and designers to anticipate the expectations of potential users. Therefore, the design process should include a careful analysis of well-established alternative media and media networks as well as the identification of prototypes and related communicative patterns (Wirtz and Jakobs, 2013).

Thus, the identification of prototypes is of major importance. They have the strongest influence on user's experience in initial contact situations. The implementation of familiar communicative patterns can be beneficial for a positive first impression and facilitate the acquisition for the users in initial contact situations. It should be considered whenever the restrictions of the mobile phone application, such as a small screen for displaying information, allow it. Self-services – as part of media networks – require terminological, structural, and visual harmonization. In the process of harmonization, designers should be aware that users of new technologies and applications develop their evaluation criteria from different reference objects – primarily from topic-related already established alternative media and communicative formats (Wirtz and Jakobs, 2013).

3. PILOT STUDY InKoPoMoVer

In many services dealing with navigation and route guidance the user is only assisted so far at what we call the macro-level, i.e., that the user is provided with services for best routing from a start point A to a destination B. In the study InKoPoMoVer also a routing on the micro-level shall be achieved by providing the user assistance and guidance when transferring between different means of transportation in a multi-modal transit situation (such as on a large transfer interchange where different public and other transportation means are available). In the following the objectives of the InKoPoMoVer study are presented and discussed.

3.1 Problems associated with the state-of-the-art

There is still limited understanding of people's behaviours in transit situations, which results in a gap in smoothly guiding users from a start point A to a destination B in multimodal transportation networks, on the one hand. On the other hand, the positional accuracy of tracking (groups of) persons is not sufficient for real-time passenger guidance in multi-modal transit situations. Existing solutions and research on multimodal transportation mainly focus on routing, e.g., computing a route from a start point A to a destination B. However, in reality, especially in very large multimodal transit stations, passengers still have many difficulties in finding or reaching their connecting train, underground or metro line, bus, etc. This is mainly due to the lack of real-time transportation information. In addition, little knowledge has been known regarding people's indoor mobility patterns, e.g., in large public areas. Existing behaviour modelling mainly focuses on outdoor patterns.

3.2 General aims and study objectives

InKoPoMoVer aims to address the above challenges, and focuses on improving the indoor positioning and tracking accuracy, deriving movement patterns, and developing guidance systems for transit stations. Therefore the major aims of the service can be summarized as:

1. Smooth transit: providing real-time information for passengers to smoothly transit at stations where they need to change their transport modes or lines, e.g., real-time information of their connecting trains and underground lines, alternative routes, indoor navigation guidance,
2. Indoor behaviour modelling: modelling passengers' travelling behaviours within the transit stations, e.g., typical routes from one underground line to the other, and time-dependent patterns; results of this part can provide inputs for the traffic management sectors to make decisions, e.g., during an emergency, services maintenance, and
3. End-user orientation: supply of an end-user oriented demonstrator as guidance system and service for routing of individuals and /or user groups.

To achieve this aims a new method of intelligent Cooperative Positioning (CP) is developed. Similar to Differential GPS (DGPS), the method of Differential Wi-Fi (DWi-Fi) and an algorithm will be developed for CP. To further improve the accuracy and coverage of the person tracking, DWi-Fi will be combined with RFID (Radio Frequency Identification) technology. The targeted increase of RFID coverage and the evaluation, to which extent existing mobile devices can act as RFID reader have the potential for a technological leap. The new CP method will first be used in small groups in a lab setting. Then movement patterns of the participants will be derived from trajectory analysis. Based on the generated data, a concept for passenger information and guidance will be developed and implemented as an App prototype. In the project social scientists are consulted to openly address ethical issues connected with privacy and data security. Heterogeneous user groups will be involved to investigate the acceptance of the positioning method. The resulting prototype will later be tested in focus groups and also larger groups in a real live setting at a large multimodal transit station in Vienna, Austria. The prototype will be user-oriented and interactive to allow for real-time guidance in transit stations, which also takes into account the available time and crowdedness. This will support users smoothly transit at the stations, thus close the gap in current multimodal transport information systems. After an evaluation and careful validation of the results, a recommendation catalogue on how to implement the existing prototype in real applications will be provided.

3.3 Solution strategy

A steady flow of passenger traffic and support of people which are unfamiliar with the transfer situation shall be achieved in this study. This can happen by the development of a system for positioning, navigation and if necessary diversion of people at multi-modal public traffic interchanges. The interaction of the people with the data of the system takes place via a developed App. As a condition for the interaction with the system the use of standard mobile devices such as smartphones or tablets is foreseen. Thus in the course of the just mentioned contributions such a system can be seen as part for further development of a smart city concept.

In the positioning and navigation system smartphone sensors such as inertial sensors consisting of accelerometers and gyroscope as well as magnetometers or digital compasses are included and integrated with infrastructure-based systems like Wi-Fi, RFID, etc., as well as with dynamic measuring-.technical infrastructures. A use of data projection-juridically sensitive data, such as cellular phone network data or cellular positioning, for instance, is explicitly not foreseen. In addition to the measured positioning data the current traffic information shall be included with the route calculation and guidance on a real-time basis. In the innovative concept not only an individual but the group of all App users are positioned absolutely and relatively to each other. Thus an enhancement of a single positioning system to sensor networks takes place what guarantees a resource efficient and qualitatively optimized position and trajectory estimation.

By analyses of trajectories of the user's group it is possible to provide assistance for a person who has lost, e.g., the orientation. The navigation system offers in addition to visual also audio input and output. With it equal mobility is provided for underprivileged user's groups, as for example visual impaired and disabled persons. A crucial added value for all interest groups is achieved by integration of all players dealing with traffic management, such as public transport and train operators, taxis, carsharing, citybikes, etc., with an airport operator, tourism association, event organizers, etc., into the development process. Then it is possible to provide additional information to an App user, for instance, concerning tourism highlights and events for visitors of the city or locals apart from navigation and route guidance with different means of transportation. Thereby a priority aim is that the means of public transportation are used increasingly.

Thy system processes the information about the different flows of traffic taking into account traffic jam announcements, delays, diversion, failures, etc., and then offers the fastest possible connection from A to B. Where appropriate this is guaranteed by tracking of all App users. Thus the guidance management for large crowds at neuralgic points is achievable, for instance, at the end of soccer matches, security checkpoints at airports, etc. Hence, also people guidance at mass events is considered in the study. The navigation contains not only the calculation of the fastest and safest route to the destination but also it includes information about places of interest as well as information about the most inexpensive route for prize-sensitive users. The purchase of tickets for public transportation means is then combined with the route choice on the mobile device.

With this traffic infrastructural variety further information is made available to the user, for example, interesting and relevant information for a tourist with regard to places of interest, cultural and other events, etc., can be provided while navigating and guiding a visitor of the city from the airport to his accommodation. Such a service can be achieved in cooperation with tourism associations, event organizers, etc. It is also conceivable that the suggestions are adapted in dependence of the current weather situation. Then for a tourist, for instance, information and navigation to current exhibitions, museums, etc. may be provided in the case of bad weather. Another example is that the App offers flight departure information for a person who is on the way to the airport. Existing applications can be integrated into the concept and extended functionally. In Vienna the routing service of the public transport authority (Wiener Linien) called 'qando' is a suitable candidate for integration into the InKoPoMoVer App. Then the service qando can also contribute interactively to real-time navigation apart from giving directions how to get from A to B. For example, it is possible to provide information which exit one has to take from the underground or metro line to reach the connection to the next means of transportation in the shortest time.

By the integration of the social sciences the ethical problem formulation and the acceptance for people of all age groups is first clarified. As a result of the investigation with test persons an application (demonstrator) is developed for mobile devices and is tested at a later stage for its applicability and then modified if necessary.

The study follows a holistic innovation understanding and is obliged with it of the orientation towards the need of the end-users. The interest, needs and behaviour patterns of the population offer starting points for innovation and development. The urban life styles which come along witth a higher magnitude in flexiblity, mobility and need for efficiency can be supported by means of intelligent route guidance. Nevertheless, it puts to itself the questions which concrete user's groups show the biggest need for such technological innovations and which steps must be taken in the process of development to be adapted in the best way possible to the needs of this group. Besides it is also essential to address potential barriers of utilisation, above all concerning ethical and data protection-juridical acceptance. It is not only about the orientation towards the end-user, but about the differentiation of different target groups and their active involvement into the scenario development. For this reason an extensive need and acceptance analysis is carried out which aims at:

1. identification of possible end-user groups,
2. collection of their actual need as well as estimation of their acceptance in view of ethical implications of such technologies, and
3. working out of the concrete need and use situations (Living Labs).

3.4 Innovation salary

The transport authority of Vienna (Wiener Linien) already use successfully and internet-based route planning service at macro-level, i.e., the already aforementioned service qando, for the routing from A to B. For the users, however, no data on real-time basis is provided but only several route possibilities for route planning are suggested based on timetables. They are not based on the positioning of the users in real-time on the micro-level in concrete multimodal traffic interchanges. The innovative approach focuses on the derivation of movement patterns of individuals or groups of persons from the ascertained trajectories and their analysis which forms the basis for the determination of strongly popular areas in the traffic interchanges in which personal streams concentrate. For the first time the members of a user group get aid with the InKoPoMoVer App with the principle ‘everybody helps everybody’. Thereby the identification of strongly popular areas or bottlenecks in the station layout is made possible through the common indoor positioning and trajectory estimation of the whole App user group. Typical use cases of the service are the improvement of the management of passenger streams which originate, for example, at rush hours and in large mass events or the assistance of a user who does not know the way between different means of transportation or has lost his orientation. In addition, the security of the traffic flow is increased in these situations and a contribution to the traffic management is made, e.g., during an emergency or service interruption.

The DWi-Fi approach is new and is not available in this form yet. It is derived from the well known DGPS method for indoor environments and areas in which Wi-Fi is available. Similar effects and improvements are achieved like as in DGPS as they are transferable on the use of Wi-Fi lateration. Also the CP method is researched since a short period of time and the integration of DWi-Fi and RFID is an absolute novelty.

The project is designed to promote research in the area of multimodal transport information services (i.e., Advanced Traveller Information System, ATIS) and indoor positioning. In comparison to the present state of the research, the following innovations can be emphasised from cartographic point of view:

1. a better understanding of the movement behaviour of people at traffic interchanges,
2. development of a method for consideration of the time required for changing between lines and animacy of the public traffic interchanges,
3. specifications of landmarks for interchanging situations and their role for the navigation, and
4. development of a method for the effective map and Augmented Reality (AR) based route communication in interchanging situations.

Additionally the study follows a holistic innovation understanding and is obliged with it of the orientation towards the needs of the end-users whereby the starting point for innovation and development are delivered by the interests, needs and behaviour pattern of the population. Thus the acceptance of the new application and service is examined in detail.

Finally it can be said that in the course of the abovementioned contributions the research project is seen at the same time as a development for a smart city as Vienna aims to be.

4. SOCIOLOGICAL AND ETHICAL ASPECTS

In the sociological part of the research project male and female youngsters as well as elderly are integrated in the development and test of the App. The final product concerns all age groups and personal groups which are capable to use a mobile device (i.e., smartphone) and the software to be developed for it. In the following the contribution of the scheme to social and ethical aspects and the methodical approach are discussed.

4.1 Contribution of the scheme to social and ethical aspects

The basic ethical question refers to data protection and data security in the present study. The latest events such as the NSA scandal or ACTA protests have shown these doubts to a larger public and have strengthened them further. Data retention for future reference is an important aspect which attracts currently big public attention as the massive storage of personal data enables the additional subsequently localization of people. Back in the 90's seven basic principles were developed in localization research for the protection of the privacy of users (Cavoukian, 2009). The developed 'Privacy by Design' (PbD) concept addresses the ever-growing and systematic effects of information and communication technologies and of large-scale networked data systems. It advances the view that the future of privacy cannot be assured solely by compliance with regulatory frameworks; rather, privacy assurance must ideally become an organization's default mode of operation. The objectives of PbD – ensuring privacy and gaining personal control over one's information and, for organizations, gaining a sustainable competitive advantage – may be accomplished by practicing the following seven foundational principles as prepared and postulated by Cavoukian (2009):

1. Proactive not reactive; preventative not remedial: the PbD approach is characterized by proactive rather than reactive measures. It anticipates and prevents privacy invasive events before they happen. PbD does not wait for privacy risks to materialize, nor does it offer remedies for resolving privacy infractions once they have occurred − it aims to prevent them from occurring. In short, PbD comes before-the-fact, not after.
2. Privacy as the default setting: we can all be certain of one thing − the default rules! PbD seeks to deliver the maximum degree of privacy by ensuring that personal data are automatically protected in any given IT system or business practice. If an individual does nothing, their privacy still remains intact. No action is required on the part of the individual to protect their privacy − it is built into the system, by default.
3. Privacy embedded into design: PbD is embedded into the design and architecture of IT systems and business practices. It is not bolted on as an add-on, after the fact. The result is that privacy becomes an essential component of the core functionality being delivered. Privacy is integral to the system, without diminishing functionality.
4. Full functionality − positive-sum, not zero-sum: PbD seeks to accommodate all legitimate interests and objectives in a positive-sum 'win-win' manner, not through a dated, zero-sum approach, where unnecessary trade-offs are made. PbD avoids the pretence of false dichotomies, such as privacy vs. security, demonstrating that it is possible to have both.
5. End-to-end security − full lifecycle protection: PbD, having been embedded into the system prior to the first element of information being collected, extends securely throughout the entire lifecycle of the data involved − strong security measures are essential to privacy, from start to finish. This ensures that all data are securely retained, and then securely destroyed at the end of the process, in a timely fashion. Thus, PbD ensures cradle to grave, secure lifecycle management of information, end-to-end.
6. Visibility and transparency − keep it open: PbD seeks to assure all stakeholders that whatever the business practice or technology involved, it is in fact, operating according to the stated promises and objectives, subject to independent verification. Its component parts and operations remain visible and transparent, to users and providers alike. Remember, trust but verify.
7. Respect for user privacy − keep it user-centric: Above all, PbD requires architects and operators to keep the interests of the individual uppermost by offering such measures

as strong privacy defaults, appropriate notice, and empowering user-friendly options. Keep it user-centric.

We believe that these seven foundational principles shall be considered also in LBS service design and implementation. Concerning the technological aspects in the project the method of CP and its integration with DWi-Fi and RFID are used and employed in such a way that only anonymous measurements of the signal strengths (i.e., Received Signal Strength Indicator RSSI) are considered for localization determination and on the use of personal data explicitly is renounced. The privacy of all involved partners is thereby protected. Also in the determination of movement patterns no data referring to a certain person is collected or logged. A use of data protection-juridically sensitive data, as for example mobile or cellular phone information, explicitly is renounced. Hence, the following ethical aspects are central in the development and use:

1. Transparency: clear statement of the research purposes, the use, evaluation, the storage location, the storage duration, etc., of the collected data in an 'informed consent',
2. Data highness: users can switch on and off data transfers from their own smartphone independently, delete data and understand the data, and
3. Thriftiness: restriction of the collected data on the necessary minimum.

Because of the fact that the end-users are involved during the whole research procedure and duration, other ethical questions can be picked up as a central theme earliest-possibly.

4.2 Methodical approach

So that technological innovations become social innovations, i.e., that the change human behaviour patterns, it requires the integration of the targeted end-user group into the technological developments. This general statement in particular also concerns LBS research. Untimely integration of the end-users serves to influence the perceived added value of the usefulness as well as the perceived simplicity of the usability positively. Such an integration also clears up data protection doubts (Jonuschat *et al*., 2014). To guarantee this integration different attempts have been developed in social science research. Examples are action research, participative development or user-centred design (compare Schuler and Namioka, 1997; Hakley and Nivala, 2010). However, these often do not produce the desired results because the lack of openness, process orientation and everyday nearness (Comyn *et al*., 2006). An approach which integrates targeted end-users and researchers equally into the development process is represented by Living Labs. As mentioned in section 2 this concept was already developed back in 1915 and then applied to test user acceptance of smart homes. Since 2009 the European Commission supports the use of Living Labs especially in smart cities research (Cossetta and Palumbo, 2014). Thereby potential end-users are not discussing only technological innovations but also try them out themselves in their social environment and develop them with the involved scientists, companies and/or political stakeholders. In our study it is investigated in focus groups and Living Labs

1. which level of knowledge different user groups have about the transference of their data on their smartphone and on which way transparency can be created for them (e.g., in technological blogs, new media, senior citizens pensioner's clubs),
2. which data different user groups are ready to reveal, what this readiness depends on and whether differences exists in data and transference ways,
3. which benefit do different user groups expect for the supply of their data, and
4. like with regard to sensitive data a safe and secure solution can be found from user's point of view (e.g. passwords, selfexclusion, encoding).

For tests in the development stage and implementation as App prototype multimodal transit interchanges are the major focus of investigation in the InKoPoMoVer study. Together with the Vienna Public Transport Organization 'Wiener Linien' a large multimodal transit junction in the Vienna city centre is the test playground. The service is also applicable for navigation and guidance at airports, shopping malls, etc. In addition, as a smart city concept it is applicable worldwide. Hence, cooperations with other worldwide known institutions and University departments are already on the way for the further development of the InKoPoMoVer navigation App. When using the App also the aim to reduce car traffic and to increase the use of public transport systems is targeted.

5. CONCLUSIONS

A better understanding of passenger movement at multi-modal transit situations for providing improved passenger assistance and guidance is achieved by using the novel DWi-Fi approach through intelligent CP. Then algorithms can be generated, which considerably increase the accuracy of person tracking, allowing for the derivation of movement patterns. Due to user support smoothly transit at the stations is enabled, thus the gap in current multimodal transport information systems where routing is not performed at the interchange itself is closed. Addressing ethical and usability aspects will ensure user-friendly results. The main aim of the study regarding ethical questions is discussed in detail in the paper. Users are given the right to withdraw their participation in localization of a user group when using the InKoPOMoVer App. The measured data from a certain user is not only anonymized but the users are asked to give their informed consent for every step in the whole localization procedure.

A further major aim of this paper is to raise awareness of the importance to take ethical and political thinking into account when designing and conducting research projects in LBS research fields. We think that every researcher in general is responsible for the effects and consequences of his research outcome. Hence it becomes necessary to think about it at the very beginning when setting up a research project. Although there is a lot of research and development going on in developing algorithms to keep ones data and search request anonymous we question if this is enough to maintain the people's privacy when using current advanced localization technologies. Mascetti et al. (2007) argue that "in general, the association between the real identity of the user issuing an LBS request and the request itself, as it reaches the service provider, can be considered a privacy threat. […] Simply dropping the issuer's personal identification data may not be sufficient to protect user's privacy". Thus we claim that users of localization services should get the right to withdraw their consent for transferring location based and other personal data at any time. They also should get clear and comprehensive information when and for what they give away their personal data and location and their further use.

Many countries realised that the data protection rules, such as the ones introduced in the European Union in 1995, are outdated and need a comprehensive reform to strengthen individual rights and tackle the challenges of globalisation and new technologies. Ahas *et al*. (2014) conducted in their "Eurostat Feasibility Study on the Use of Mobile Positioning Data for Tourism Statistics" a legal analysis on privacy protection aspects and of the legislation at EU and national levels namely in Germany, Estonia, France and Finland. They come to the conclusion that:

1. a good many countries are reviewing their national legislation in order to cope with social issues as well as security threats in the area of data protection,
2. the legal acts do not specifically concentrate on the use of mobile positioning data in statistics.
3. legal restrictions are the most important barrier when it comes to accessing the data, and
4. there is a need for research programmes to develop the process of anonymisation as no conclusive methods have been produced so far.

Therefore the research community should keep privacy and ethical implications in mind from the very beginning of their research projects and already ongoing research activities. Meanwhile LBS influences every individual's life, hence ethical issues have to be debated within the research community and taught our students. Technical Universities and especially the developers of LBS can no longer keep their credibility without cooperating with ethical experts or an ethical committee. The more the science of LBS gets interwoven with society, the more it should consider a robust partnership with social sciences.

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