Digital Graffiti – A Comprehensive Location-Based Travel Information System

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1 ABSTRACT

Digital Graffiti is an open, extensible platform for mobile location-based services that context-sensitively supports travelers using public transportation on their individual travel routes across transportation companies. The personal mobile phone of each traveler automatically checks for connecting transportation options, shows their current locations and triggers re-planning on delays such that the mobile phone appears as an intelligent companion throughout the journey. It additionally enables its users to produce user-generated location-bound content for other travelers in order to enrich navigation in a self-organizing way, e.g., for more appropriate instructions for handicapped people (blind people guide blind people). This paper sketches the basic architecture of the system and gives an impression on its potentials.

2 INTRODUCTION

Today, travelers are facing a jungle of available systems providing travel information for public transport not offering closed information chains when using various transport providers. Moreover, the provided information is often inadequate, only focusing on arrival and departure times and not considering the processes every traveler has to pass through at the stations (e.g., orientation). Especially, handicapped people are requiring a more sophisticated information offer. The authors presume the reasons for this deficiency of current travel information systems in their closeness, making it difficult to link various information sources or even including new ones.

In the course of the research project ways2go within the framework of the strategic initiative IV2Splus in Austria the basis for an open and extensible platform is being created (similar to successful open source projects like OpenStreetMaps or Wikipedia) enabling the consolidation of diverse travel information systems and providing quantitatively and qualitatively better information for travelers (especially for handicapped people) from arbitrary sources, even by the users themselves.

The technical basis for implementing this research issue is a mobile location- and context-sensitive information and communication system (Digital Graffiti) developed by the Johannes Kepler University of Linz in association with Siemens Corporate Technology in Munich and the Ars Electronica Futurelab in Linz, which enables its users to arbitrarily place information to both public and private locations and perceive this information using state-of-the-art mobile tracking-enabled cell phones. Hence, in addition to the openness the requested platform also considers the current residence of a traveler as a contextual input for better preparation and delivery of information.

The option of Digital Graffiti not only to place text, pictures or videos but to link to external sources or even trigger electronically controlled actions just at spatial proximity of a user is considered as the basis for a unique, common standard for networking travel information from different operators. With the aid of the project partners ÖBB (Austrian Federal Railways Company), OÖVG (Upper Austrian Transport Association) and Linz AG (Local Traffic Line Service Provider in Linz) the interfaces of existing systems are being identified, classified and made generic, in order to enable networking among the partners and beyond.

For extending the quantity and quality of the offered information the research project considers the possibility of Digital Graffiti to place information by the users themselves. The openness shall inspire the users' creativity such that users provide content for users. Blind people shall be able to annotate their way for other blind people regarding their special needs. In cooperation with the Department Integriert Studieren at the University of Linz and CEIT Alanova (Central European Institute of Technology in Vienna) new paradigms for barrier-free interaction shall be created considering open, location-based communication for handicapped people.

3 STATE-OF-THE-ART

Several public transportation service providers already offer Internet-based information systems enabling their users to consume route-specific travel information on their mobile phones when entering their desired start and target coordinates into a web-form (e.g., Scotty – a route planning service of ÖBB (SCOTTY 2011). However, the potentials of such services are far from being exploited, yet. Apart from the fact that the traveler is hardly able to keep an overview on the vast heterogeneity of existing, mostly web-based travel information systems (he must remember a proper web-address for every transportation node), the process of typing start and target coordinates is tedious. The traveler is supposed to stop and interrupt his journey, because typing requires all of his attention. User interfaces for current travel information systems are rather designed for desktop usage at home than for mobile interaction.

Newest studies like MofA – Mobility for All (MOFA 2010) try to employ weak-point analysis in order to manifest rating systems for travel information services, evaluating form and up-to-dateness of the provided information (e.g., real-time capabilities, elevators, width of doors, stairs and level differences, etc.).

Most systems do not inform its users about changes in the time schedule, once the trip has been calculated. Travel information has to be requested from scratch at every transition point. Until today, there is no automatic mobile travel information system that continuously guides the passenger during his journey and location-sensitively keeps him up-to-date considering transfers or delays.

Reference to actuality and automatic delivery of personalized travel information (and consequently the difficulty of a closed information chain) are already recognized as key issues in a series of current research projects: WISETRIP – Wide scale network of e-systems for multimodal journey planning and delivery of trip intelligent personalized data (FOSTIERI 2007) is an approach within the course of an EU project to connect different travel information systems and transmit personalized data in real-time. Similarly, i-Travel – service platform for the connected traveler (COMPFNER 2007) is trying to develop a virtual travel assistant providing current travel information for passengers during their journey. OASIS – Open architecture for accessible services integration and standardization (BONFIGLIO 2007) even goes a step beyond and develops a generic platform for integrating different information services (e.g., travel information, health monitoring or community platforms) and appropriate standards.

Such developments often face proprietary information systems, the consolidation of which is a particular challenge. To plan a continuous travel route is a complex combination of varied depending information schemes, which have to meet specific prerequisites for common usage. Target-oriented automatic delivery of information to the traveler (e.g., for indicating a transfer or delay) is controlled by a complex system of rules, which tries to recognize the type of information to be delivered to the passengers.

Considering the technical basis of our proposed service (the Digital Graffiti system) we realize location-based services as an emerging focal point of investigation for an increasing number of research labs and industry (e.g., GUTWIN 2004, HOLMQUIST 1999, SOHN 2005, ZAMBONELLI 2004). LocatioNet (LOCATIONET 2011), Mobiloco (MOBILOCO 2011), Plazes (PLAZES 2011) or Socialight (SOCIALIGHT 2011) are services for mobile phones that enable users to get in touch with friends and/or mark real physical locations with simple electronic tags. A comparable application is Google Latitude (GOOGLE 2011) connecting users to their friends and their current place of residence and providing location-based information within a virtual global, public information space. However, most of such services are designed for commercial usage in the consumer segment and therefore lack appropriate secure interfaces for the integration of sensitive data from third-party vendors.

4 APPROACH

In order to meet the requirements for a comprehensive location-based travel information system we propose a flexible network of mobile, GPS-enabled devices (i.e., mobile phones, PDAs, netbooks, etc.) wirelessly obtaining and storing information from and to a central server system. Digital Graffiti is considered such a platform and conceived as a system to manage and visualize location-based information within the context of a mobile user. It has been enhanced with functionality to fulfill the demands for a social network, comprises a map server (e.g., for custom floor plans or industry areas), provides an elaborated user and privileges management concept and additionally handles chat messaging and communication encryption for secure data transfer.

The clients are supposed to be executed on any mobile platform, either as a native application particularly designed for the device or as a web application (utilizing the novel W3C standard and HTML5 for accessing GPS out of a browser and complying with the requirements of a bare device without the needs of installing client software). Once registered and logged in, the user is visualized as an avatar at his exact residing position in front of a map and his geographical position is textually resolved into a human readable address (e.g., building names, floor descriptions or office numbers). Alternatively to outdoor GPS tracking Digital Graffiti supports a seamless transition from and to indoor WLAN localization as well (SCHMITZBERGER 2010). The position of the user is updated at a near real time frequency (every second at GPS usage and – due to the configurable transmission cycle length in WLANs – every three seconds). Alongside user's own position, the system also offers to track the position of the user's friends, provided that the respective friend has granted permission. To sustain privacy this permission can be revoked by one click in the user interface.

Similar to conventional cellular telephony the system uses a distributed provider model for the server-side component where users all over the world can join the provider of their choice in order to take part in the mobile location-based information service. This proven model distributes the load ensuing from (asynchronously) communicating users and guarantees scalability of the service all over the world as each provider only handles a limited number of clients (KORTUEM 2001).

Every provider stores a set of geographically linked information in appropriate fast traversable geo-data structures (e.g. r-trees) containing hierarchically combinable content modules (which we call gadgets) for text, pictures videos, sound, etc. The name gadget already refers to a possible activity within a module and is the key for a generic approach of integrating arbitrary system connections or electronic actions to be triggered automatically on arriving users. They provide the basis for a high degree of extensibility to third-party systems, for the number and variety of electronic connections is unforeseeable and simultaneously enriches the potentials of such a service (NARZT 2009). Fig. 1 illustrates the common principles of a flexible component architecture which enables fast connections to third party systems:

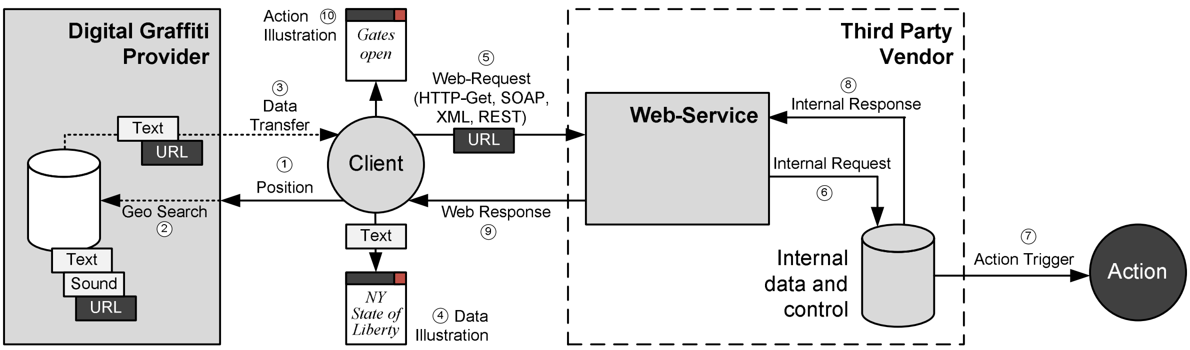

Fig. 2. Extensible Component Architecture for Connecting to Third-Party Systems

The basic technical approach is a client-server model where clients repetitively transmit their own (commonly by GPS-based) position to a server (1) which evaluates the geo-data considering visibility radiuses and access constraints (2) and transmits the corresponding results back to the clients (3). Generally, when the transmitted information contains conventional gadgets as text and pictures, it is immediately displayed on the output device of the client (4). The basic idea for executing code is to use the gadget metaphor and store executable code inside instead of text or binary picture data (smart gadgets). Therefore, we propose a web-service-based mechanism which is both effective and simple to extend: Smart gadgets contain a simple URL or XML-based web-request to a remote web-service, which is the actual component to execute the code. When a client receives information containing a smart gadget, its URL is resolved (5) which is handled internally (6) and finally triggers the desired action at the third-party vendor (7). A response back to the client (8, 9) can additionally be illustrated as a visual confirmation whether the action could have been executed successfully or not (10).

This approach is simple, because the clients just have to handle standardized HTTP-requests. A majority of currently utilized mobile platforms support these mechanisms. Important for third-party vendors: Their internal data representations, servers and control units are hidden from the publically accessible location-based service, guaranteeing a maximum of data security for the vendors.

5 USE-CASES

Applying this mechanism for public transportation means providing web-based interfaces by the transportation providers (e.g., in terms of an interface to transportation schedules). Arriving at a train station automatically pops up a corresponding, interactive time schedule at the user's mobile device (similar to the big screens at the stations showing the departing trains), where the user is able to pick the desired destination by a single click and thus anonymously specify a route. The system is consequently able to provide customized travel information regarding this selection (e.g., show the ticket counters, announce the station platform number and actively keep the passenger up-to-date on changes).

Considering travel routes across transportation companies, the system does not invent routing algorithms and scheduling procedures from scratch. Instead, it uses the existing web-based services and triggers them on demand in the same way as the time schedule example given above. So, at spatial proximity of a user to his next stop the system automatically triggers the route planning service of the appropriate vendor and informs the user about his connecting means of transport, giving the passenger a continuous information chain during his journey.

Fig. 3. Digital Graffiti Prototype showing live Positions of Trams and Time-Schedule

The applicability of this system architecture is currently being demonstrated in the course of a first reference implementation at the University of Linz, available for students, academics and maintenance staff. At the moment, the deployment of third-party components contains university-related information systems (e.g. event management, study support system, lecture room occupation plan). However, the mechanism already includes a prototypical connection to the service of one of the project partners from the Linz AG, showing time schedules for trams and busses within the city of Linz. In addition, also the live positions of a few selected trams are already available on mobile phones (see Fig. 2).

Fig. 4. Digital Graffiti Prototype in Public Transportation

The variety of client platforms for Digital Graffiti also allows a scenario which we have demonstrated in the course of a public event, where large screens inside public transport busses showed the bus's own position in a map and also those of the connecting busses (see Fig. 3). On the right side of the screen, common location-based information is displayed considering current place and driving direction (e.g., traffic signs or information to POIs along the route).

6 CONCLUSION AND FUTURE WORK

Mobile location-based services combined with a flexible, web-based approach for connecting to third-party vendors offer large potentials in terms of supporting travelers during their journeys across transportation companies. A prototypical implementation of such a service (Digital Graffiti) already reveals applicability, although the system is still under development.

Whereas the next steps will be the consolidation of the provided data of varying transportation vendors in order to implement our vision of a closed information chain, the system architecture is open for more beyond transportation areas: Just considering the user's position for triggering actions brings up innovative interaction paradigms (especially for handicapped people), without the needs of glimpsing at displays, typing, clicking or pressing buttons (FERSCHA 2004, BRUNETTE 2003).

As a consequence, the context location in combination with personalized access privileges are the triggers for opening gates, automatically stopping engines in danger zones or validating tickets at entrance areas. Hence, people are able to continue their natural behavior without being distracted from their focused task and simultaneously execute an assumed incidental but necessary action. The users' mobile devices enabling location-triggered code execution remain in their pockets.

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