One of the biggest advantages of positioning data is the possibility of monitoring tourism in real time. The data can be gathered regularly and visualised in a real-time environment. Positium ICT have developed a real-time tourism monitoring environment on the Internet for research purposes, and this is partly used by tourism managers from Enterprise Estonia and several municipalities. This system is called the Positium Tourism Barometer, and it helps to monitor short and long term changes in tourism and to evaluate the successfulness of marketing strategies, single campaigns or investments in certain locations. Real-time maps or live maps of tourism are also interesting data sources for researchers.

There are also problems with data, such as surveillance and privacy issues, which need to be addressed properly during studies and the development of new methodologies. Mobile positioning data is very sensitive to infringed privacy borders.

## References


Ahas, R., Aasa, A., Mark, Ü., Pae, T., & Kull, T. (2006). Seasonal tourism spaces in Estonia: case study with mobile positioning data. *Tourism Management* (published online in July 2006).

Ahas, R. Aasa, A., Roose, A., & Silm, S. (Submitted). Mobile positioning as a new data source and method for tourism surveys: an Estonian Case Study. *Tourism Management.*

Ahas, R. & Mark, Ü. (2005). Location based services – new challenges for planning and public administration? *Futures*, 37(6): 547-561.

Casino, V. J. D. & Hanna, S. P. (2000). Representations and identities in tourism map spaces. *Progress in Human Geography*, 24(1): 23-46.

DIRECTIVE 2002/58/EC: Directive on privacy and electronic communications of the European Parliament and of the Council of 12 July 2002 concerning the processing of personal data and the protection of privacy in the electronic communications sector. http://europa.eu.int/eur-lex/pri/en/oj/dat/2002/l_201/l_20120020731en00370047.pdf [8. Sep 2006]

EMT (2006). EMT homepage www.emt.ee.[Aug. 12, 2006]

ESA (2006). Estonian Statistical Board homepage. http://www.stat.ee. Accommodation statistics. [May 11,2006]

Hall, C. M., Page, S. (2006). *The geography of tourism and recreation. Environment place and space.* Routledge.

Kwan, M. P. (2000). Interactive Geovisualization of Activity-travel Patterns Using Three-dimensional Geographical Information Systems: Methodological Exploration with a Large Data Set. *Transportation Research C*, 8: 185-203.

Mountain, D. & Raper, J. (2001). Modelling human spatio-temporal behaviour: a challenge for location-based services. in *Proc. of the 6th Internat. Conference on GeoComputation* Eds (University of Queensland, Brisbane, Australia).

Positium (2006). Web-site of Positium ICT www.positium.ee [Sept. 5, 2006].

Ratti, C. (2005). Mobile Landscape - Graz in real time. *Proceedings of 3rd Symposium on LBS & TeleCartography*, Vienna University of Technology, 28-30. November 2005.


# CAIPS: A Context-Aware Information Push Service in Tourism


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## Abstract

A context-aware information push service provides the user with tailored information regarding her/his actual situation (the *actual situation* is also referred as *context*). This paper motivates and discusses the development of a context-aware information push service. A survey is presented motivating the implementation of such a system. Further, key requirements are identified leading to a description of the system architecture, thereby giving insight into how the requirements are tackled. Finally, the rule language which is used to formally declare push processes and the inference engine translating such rules into concrete push messages is explained in detail. The push service presented in this paper is part of the overall „Planner system, a framework for mobile tourist guides (Höpken, Fuchs, Zanker, Beer, Eybl, Flores, Gordea, Jessenitschnig, Kerner, Linke, Rasinger, & Schnabl, 2006a).


**Keywords:** context-awareness, push, production rule, proactive systems, ambient intelligence

## 1 Introduction

Tourism services are characterized by a strong need for information. Both on the consumer (i.e. tourist) as well as on the supplier side the sale, purchase, production, and consumption of a tourism product claims high effort in terms of information effort. Tourism experts therefore describe a main challenge of the tourism industry as the seamless integration of information and physical services, as well as a flexible configuration of the physical and the informational parts (Werthner, 1999). In this way intelligent information services are required in order to reduce the information retrieval effort and a possible information overload for the consumers (Höpken, et al., 2006a). The CAIPS (*Context Aware Information Push Service*) is a service designed to meet these requirements, by offering an intelligent mechanism for actively providing personalized information to tourists depending on their context. Similarly, Hinze (2003) proposed a notification system where tourists are informed about events or places in their domain of interest based on their location, profile and the actual time. Further, Cheverst, Davies, and Mitchell (2002) propose and implement both, a pull- and push-based mobile information service for the trourism domain (GUIDE). However, existing approaches are not suitable for completely coping with the requirements of CAIPS. The following scenario gives examples of possible use cases of CAIPS.

### 1.1 Scenario

A tourist plans to spend a weekend in Innsbruck. It is assumed that s/he has already used $_{et}$Planner during her/his trip to Vienna three month ago. Therefore s/he is already registered and known to the system by means of a user-profile. S/he has stayed in Vienna for two days and visited among other things "Schönbrunn Palace". Two weeks before departure s/he interacts with an online booking platform to plan her/his trip to Innsbruck. In first step s/he books a room in the "Innsbruck Inn" hotel. The $_{et}$Planner system is now able to infer where s/he wants to go to and how long s/he is planning to stay. In the next step, the system queries personal information to complete her/his user profile with the necessary information for the specified region, e.g. information on activities s/he is planning to conduct. S/he loves skiing and therefore searches skiing-regions near Innsbruck. The "Axamer Lizum" seems convincing and s/he therefore schedules the activity "Skiing in the Axamer Lizum" on Saturday. Two weeks later, on Friday night, s/he arrives in Innsbruck. During night there is a spontaneous and disadvantageous weather change – strong wind comes up and it will be snowing, soon. At breakfast time a message is sent to her/his mobile device, that there will be a blizzard in "Axamer Lizum" and it is not recommendable to go skiing on that day. Additionally the message includes a number of alternative suggestions for bad-weather activities based on her/his user profile. Amongst them, the user is welcomed to visit the "Hofburg" in Innsbruck (because s/he has shown interest in similar buildings in the past) and at the same time a 10% rebate on the entry fee is offered. After her/his visit of the "Hofburg" the system pushes a SMS to her/his mobile device informing her/him that Pizza Gino offers a special lunch menu (20% off) for all visitors of the "Hofburg". Both push information messages are triggered by business rules that have been defined by tourism-experts from the city of Innsbruck.

## 2 Push Services in Tourism

Prior to the design of the system described in this paper, a survey was conducted for determining the attitude towards such a system and the expected behavioural intention of potential users. Before presenting the empirical results the most promising functionalities of mobile information systems as suggested in the literature are sketched. In particular, for tourism related mobile information services the latter can be described as search & browse functionalities (Gretzel & Wöber, 2004), value adding functionalities, such as context-aware recommendation and push-functionalities, respectively (Ricci & Werthner, 2001; O'Grady & O'Hare, 2002), mCommerce functionalities (e.g. reservation, booking, ticketing, paying, etc.) as well as feedback functionalities (Forum, 2005). The aim of the briefly presented study was to identify most attractive mobile information services adequate to support tourists during their destination stay. In addition, the particular significance of the above stated functionalities has been evaluated by potential final users (i.e. tourists).



### 2.1 Study design

The first determination of potentially successful information services was derived from questions typically posed by tourists at prominent information points within a destination (e.g. tourist information points, welcome centres, taxi, airport, etc.). Thus, 15 qualitative interviews have been conducted in Innsbruck (Austria) during September 2005 (Rasinger, Fuchs, Höpken, & Tuta, 2006). Doing so, a total of 290 typical information requests along the destination value-chain could be identified (Bieger, 2005). In addition, focus interviews took place in fall 2005 with 17 individuals from different European countries (i.e. Italy, Germany and Austria). The obtained results led to a list comprising a total of 15 potentially successful mobile information services to be used by tourists during destination stay. Described by their functionalities and usability potentials they have been evaluated in Tyrol (Austria) in fall 2005 by tourists on the base of a quantitative pilot-study (N = 100) (Rasinger et al. 2006, p. 40). In descending order of importance six mobile information services have been rated as attractive by tourists, namely: (1) Transport & navigation (2) security assistant, (3) news & weather, (4) event information, (5) gastronomy & night-life and (6) sightseeing & shopping. Subsequently, in January 2006 data collection took place in Tyrol by interviewing a tourist sample totalling 705 individuals with respect to their perceived significance of the various functionalities for mobile information services. More precise, according to the Technology Acceptance Model (TAM) the 'intention to use' a specific mobile information service acted as dependent variable whereas the 'intention to use' the various functionalities served as independent variables (Venkatesh, Morris, Davis & Davis, 2003). Agreement measurement took place on a 6-point Likert scale.

### 2.2 Study results

The average age of the participants was 33.6 years with a range from 9 to 64 years, 40% were female and 60% male. The majority (i.e. 92%) of the respondents declared skiing and other sports activities as the main purpose of their current destination stay, 3% were present for business reasons. 40% of the respondents were holding a high school-, 32% a college-, and 28% a university degree. 54.9% of the respondents visited Tyrol for 3 days or less and 21.2% booked at least one tourism service via the internet. Generally spoken, the results of the pilot-study (N= 100) have been confirmed as the same mobile information services proved to be attractive for destination usage. The following sub-section displays the obtained regression results for each of the six examined mobile information services with specific consideration of the 'context-aware push-functionality'.

**Table 1.** Use-Intention of Mobile Information Services determined by Functionalities

| Information services | Functionalities | Beta | Description |
|---|---|---|---|
| *1. Transport & Navigation* | *Search & Browse* | .203** | Route and transport mean, actual and target position |
| | *Recommendation* | n.s. | |
| | *Context-aware P.* | .276** | Event-based (e.g. congestion) actively proposes routes |
| | *mCommerce* | .161* | Ticketing and reservation for public transport |
| | *Feedback* | n.s. | |
| F-value: 72.87 Sig. of F = .001 Adj. $R^2$ = .41 | | | |
| *2. Security Assistant* | *Search & Browse* | .360** | Search for risks per region and tourism activity |
| | *Recommendation* | n.s. | |
| | *Context-aware P.* | .442** | Active warning (e.g. storm, avalanche, etc.) |
| | *mCommerce* | n.s. | |
| | *Feedback* | n.s. | |
| F-value: 128.18 Sig. of F = .000 Adj. $R^2$ = .62 | | | |
| *3. News & Weather* | *Search & Browse* | .363** | Actual news and weather forecasts for various regions |
| | *Recommendation* | .189* | Location and preference specific information filter |
| | *Context-aware P.* | .484** | Location-, activity- & preference-based actively informs |
| | *mCommerce* | n.s. | |
| | *Feedback* | n.s. | |
| F-value: 93.88 Sig. of F = .000 Adj. $R^2$ = .54 | | | |
| *4. Event Guide* | *Search & Browse* | .261** | Simple and category-based search |
| | *Recommendation* | .313** | Filter for local/regional events during stay period |
| | *Context-aware P.* | n.s. | |
| | *mCommerce* | n.s. | |
| | *Feedback* | .108* | Evaluating and reading customer evaluations |
| F-value: 49.59 Sig. of F = .001 Adj. $R^2$ = .56 | | | |
| *5. Gastronomy & Nightlife* | *Search & Browse* | .435** | Simple and category-based search |
| | *Recommendation* | n.s. | |
| | *Context-aware P.* | n.s. | |
| | *mCommerce* | .181* | Checking occupancies and making reservations |
| | *Feedback* | .163* | Evaluating and reading customer evaluations |
| F-value: 92.21 Sig. of F = .000 Adj. $R^2$ = .61 | | | |



Continued ...

| | | | |
|---|---|---|---|
| *6. Sightseeing & Shopping* | *Search & Browse* | .373** | Simple and category-based search |
| | *Recommendation* | n.s. | |
| | *Context-aware Push* | .184* | Act. recommends sights/marts while moving in destination |
| | *mCommerce* | .199* | Ticketing (e.g. museums, etc.) |
| | *Feedback* | n.s. | |
| F-value: 42.63 Sig. of F = .001 Adj. $R^2$ = 0.51 | | | |
| **Dependent variable**: Intention to Use **Sig. of (std.) Beta: ** < 1% * <5%** not sig.: n. s. | | | |

First of all, the employed approach to statistically 'explain' the (i.e. dependent) TAM-variable 'intention to use' a specific information service by its typical functionalities proved to be adequate as for all the six examined mobile services the corresponding regression model showed significant F-values as well as relatively high adjusted $R^2$ values (i.e. ranging between .41 and .62). Secondly, the search & browse functionality can typically be classified as 'base-functionality' as it proved to be (i.e. significantly) relevant for all the six examined mobile information services. Interesting enough, for a total of four information services the context-aware Push functionality seems to play a significant role in determining the 'intention to use' the mobile tourist guide during the destination stay. More precise, for the three most attractive services in the eyes of the customers, namely (1) Transport & navigation, (2) the security assistant and (3) news & weather the corresponding context-aware Push functions are acting as the most prominent functionalities what can be seen from the high and strongly significant (i.e. standardized) regression coefficients (Hair, Black, Babin, Anderson, & Tatham, 2005). In addition, Push functionalities (significantly) support also the intention to use a mobile information service supporting (6) sightseeing & shopping activities in the destination (see Table 1). To summarize, in the eyes of the final users (i.e. tourists), the following context-aware Push functionalities emerged as highly relevant for mobile tourist guides to be used during destination stay (Table 2).

**Table 2.** Most relevant Push functionalities for mobile information services in tourism

| Mobile Service | Context based Push Functionality description |
|---|---|
| *Transport & Navigation* | In the case of transport-related events (e.g. postponements, congestion, detours, etc.) the system actively informs about delays and proposes alternative routes (e.g. connection flights, busses, etc.) |
| *Security Assistant* | While moving within the destination and depending on the individual location the system actively informs about risks (e.g. storm, avalanche, etc.) |
| *News & Weather* | Based on location, individual preferences (i.e. areas of interests), and actual (e.g. tourism) activities the system actively informs about the various destination offers and weather conditions/forecasts. |
| *Sightseeing & Shopping* | While moving within destination and depending on the location and individual preferences the system actively recommends sights and shopping opportunities |

After having empirically shown that context-aware *Push functionalities* play a significant role in altering the acceptance rate for mobile information services in tourism, the following sections introduce the context-aware push system (*CAIPS*).

## 3 Context Awareness

To have a better understanding of the proposed system it is important to know how the term *context* is used within CAIPS. One of the most often cited context definition is "Context is any information that can be used to characterize the situation of an entity. An entity is a person, place, or object that is considered relevant to the interaction between a user and an application, including the user and applications themselves." Dey and Abowd (Dey, 2000) emphasized the importance of creating "context categories". Based on the categorisations from (Dey & Abowd, 2000), (Schilit, 1994), (Schmidt & Beigl 1999), (Ryan, 1997], (Brekóp & Burnett, 2003) and (Hofer, 2003) the following *context categories* were identified (see **Table** ).

**Table 3.** Context Categories of CAIPS

| Context Category | Example Instances |
|---|---|
| User | the user's demographic data or current location |
| Environment | actual weather |
| Time | time of day, or time of year |
| Travel | flight information |
| Computing | used mobile device, display size |

The instances of these context-categories applied in CAIPS are used for realising the following context-aware system features:

Context-triggered message dissemination (cf. 4.3 and 4.4)
Context-driven content generation (cf. 4.3 and 4.4)
Context-driven presentation adaptation (computing context)

## 4 The CAIPS System

CAIPS is based on a client-server architecture, which is in the field of context-aware systems also known as the "Context-Server" approach (cf. http://www.infosys.tuwien.ac.at/Staff/sd/papers/TUV-1841-2004-24.pdf [Sep. 9, 2006]). One advantage of this approach is that the client is relieved of resource intensive operations (cf. requirement 2).

### 4.1 Requirements

A set of requirements for building the context-aware information push service were identified. The key requirements are:

R1: The system provider can define the sending time, the (abstract) content of a push message (PM) and the potential recipients in a declarative way compliant to the user's actual situation (context), cf. ease-of-use of the system.



R2: The system does not require additional hardware on the client side (tourist)

R3: The end-user must be able to expressively specify her/his information needs (cf. "expressive notification selection" in Mühl, 2002:3)

R4: Extendibility: The context data sources (cf. mediator and context triggers in section 4.4) should not be restricted to predefined context data sources. The CAIPS architecture must allow to further add context data sources and to easily embed them in the overall architecture.

### 4.2 Methodology

One of the key requirements of the proposed system is "ease of use" for the system provider (cf. *R1*), i.e. that s/he can straightforwardly define *when* to send *what* to *whom*. The proposed approach to tackle the requirement is to define push-processes through *rules*. Rules are a well known technique in the field of knowledge representation (Sowa, 2000; Brachman & Levesque, 2004). They provide an excellent trade-off between readability (i.e. understand-ability) of the knowledge representation and formal requirements. Conditional clauses (i.e. "if *condition* then *action*" clauses) were already used in pre-Christian times to express activity-instructions (cf. Jaynes, 1976). It therefore can be assumed that rules are well known for the user. Using rules addresses one of the prior objectives when designing a knowledge based system, namely the similarity to human thinking and the consequently improvement of usability (Baierle & Kern-Isberner, 2003). One of the key ideas when building CAIPS was therefore the design of a *rule-language* (see 4.3) which enables the SP controlling the push process in general. The system provider uses the language to write (production) rules which declare the sending time, the target group, and the push message's content. The content of the PM is thereby merely predefined in an abstract style, i.e. the system provider specifies the *type* of tourism service or type of additional information (respectively an aggregation of these types). The term *type* is employed similar to the term *class* known from object-oriented programming languages or *field* as referred to in the area of ontology languages (Antoniou & van Harmelen, 2004). The predefined abstract content is refined using a recommender system (cf. Beer, Höpken, Zanker, Rasinger, Jessenitschnig, Fuchs, & Werthner,, 2006), i.e. the recommender system determines the appropriate *instances* of the tourism services for every potential recipient, i.e. tourist. *Instances* in this context can be interpreted as *objects* or *individuals* as referred to in the field of object-oriented programming or ontology web languages, respectively. Using a rule language therefore addresses requirement 1. The approach to address requirement 3 is as follows. First, the user can set her/his preferences regarding a tourism service. Secondly s/he can specify her/his *information preferences* regarding a *category* of a push message. The SP is enabled to create different PM *categories* where each in turn can include several tourism services. The evaluation of these information preferences is automatically executed when the condition is checked (see 4.4). This approach stands in contrast to conventional *publish-subscribe systems* (Mühl, 2002) where the message is produced and subsequently the content is matched to the preferences of the potential recipients. The CAIPS approach instead produces tailored messages *on demand*.

### 4.3 Push Rule Language

Similar to active database systems (Dayal, Hanson, & Widom, 1994; Paton & Díaz, 1999) CAIPS uses an extended version of standard production rules (Brachman and Levesque, 2004), so-called E-C-A rules (*Event-Condition-Action* rules). This allows rules to be triggered by external events (see section 4.4) such as *Location*, *Weather*, or *Time* events. When the triggering event occurs the condition statement is evaluated against the connected data sources (cf. *Mediator* in section 4.4) and if the condition is satisfied the appropriate action is executed. A typical E-C-A rule applied in CAIPS for example is:

| | |
|---|---|
| *Event*: | [WeatherEvent (statechange=blizzard)] |
| *Condition*: | [User.bookedEvent = outdoor AND User.bookedEvent.location = weather.location] |
| *Action*: | [Recommendation(Event)] |

Because of comprehension purpose the notion of the rule syntax is in informal "pseudo code" only. The meaning of the rule is that when a weather-change occurs (e.g. a blizzard rises) an appropriate *Event* is triggered which in turn activates the condition evaluation. If there is one or more users fulfilling the condition (i.e. who booked an outdoor event today) they will be informed about a suitable indoor event. The condition statement is designed similar to the *where* clause of a SQL select statement. The result of its evaluation is a set of users (i.e. tourists) satisfying the condition. The content of the push message is generated using the recommender system and the template engine (see *Message Generator* in section 4.4) when the action is executed. As the recommender system in general takes into account the current weather conditions as part of the context it will select indoor events, only. The underlying inference process presumes *negation as failure* and is based on the *closed-world assumption* (cf. Russel & Norvig, 2003).

### 4.4 System Architecture

An overview of the architecture of CAIPS is illustrated in figure 1. One focus of this article is to explain the rule-based concept CAIPS is based on. The *Inference Engine* is therefore explained in more detail. The other components are briefly described as follows.

*Web-Application*: The frontend for the *Registration & Subscription Service* is realised as a web-application using *Cocoon* (http://cocoon.apache.org [Sep. 9, 2006]), as described in Höpken et al. 2006a.

*Message Gateway*: Responsible for delivery of the PMs. Beside traditional communication channels such as SMS or email a new communication channel is introduced, namely the *PP* channel (*Push→ Pull*).

*Rule-Editor*: To assist the tourism service suppliers in creating push rules a graphical editor is developed. The tourism experts are supported in writing rules by means of a high-level interface using wizards and graphical, context sensitive editors.

*Registration & Subscription Service*: To provide the tourist with tailored PMs it is fundamental for the system to "know" its user. This service enables the user to specify her/his demographic data, information preferences (cf. requirement 3), preferences concerning tourism services, or to access her/his travel-profile.



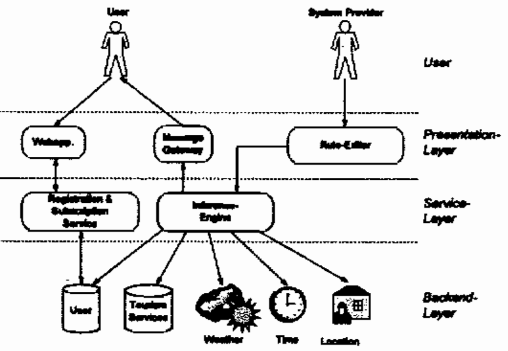


**Fig. 1.** CAIPS: System Architecture

### 4.5 Inference Engine (IE)

The IE evaluates the push rules, i.e. it transforms the rules into "real" actions. It is based on four elementary components, namely the *Event-Trigger*, the *Event-Handler*, the *Mediator* and the *Message Generator*. The concept of an abstract *Event-Trigger* enables the "plug-in" of different concrete *Event-Triggers* (cf. requirement 5) such as Time-, Location-, or Weather-Trigger. Depending on its configuration parameters (e.g. an event should be triggered if any user reaches location *y*) it triggers the occurrence of the configured event (e.g. Location *y* reached by user *u*). Context-aware applications have to deal with a huge amount of low level context data (i.e. sensor data). Tracking these fine-granular sensor data and mapping it to higher level context information (semantic or representational level) is encapsulated within the concrete Event-Triggers (cf. Christopoulou, Goumopoulos, & Kameas, 2005; Strang, 2003). The user is therefore enabled to use labels (which are mapped to a location defined via GPS coordinates) instead of using the GPS coordinates directly. The *Event-Handler* is responsible for interpreting occurring events i.e. it determines which condition is linked to the occurred event. The condition is evaluated using the *Mediator* (cf. Power, Lewis, O'Sullivan, Conlan, & Wade, 2004). To state expressive condition statements several heterogeneous data sources must be accessed, e.g. a database storing the user profile and a web-service for retrieving the user's actual location or the actual weather. The Mediator translates the condition statement (which is compliant to the shared schema) to the underlying query languages, retrieves the result and returns the result compliant to the shared schema (cf. Wiederhold, 1992; Kärger, Melis, & Ullrich, 2006; HERMES. http://www.cs.umd.edu/projects/hermes/publications/abstracts/hermes.html [Sep. 9, 2006]). The *Message Generator* uses the *Hybrid-Recommendation-Service* (as described in Beer et al. 2006; Höpken et al. 2006b) and the *Velocity* template engine (http://jakarta.apache.org/velocity/ [Sep. 9, 2006]) for generating personalised messages.

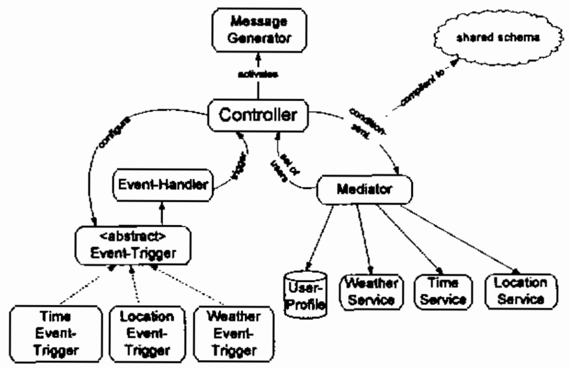


**Fig. 2.** CAIPS: Inference Engine

## 5 Conclusion and Future Work

Based on a large scale survey, push services were proved to enhance the overall intention to use mobile information systems in tourism. The proposed scenario illustrates the usefulness of such a system from the tourists' point of view. In addition, push services may leverage B2C communication by opening a new smart channel to tourists. Further, the paper explained why a rule language is well suited to control a context-aware information push service. It presented the architecture of a *context-aware information push service*. As part of the etPlanner application a first version of the CAIPS system was already implemented. A first field trial within the destination of Innsbruck took place in the autumn of 2006. The construction of the push rules applied in the field trial was based on interviews with domain experts. Future research will include an evaluation whether learning techniques are suitable for constructing useful rules.

## References

Antoniou, G., & van Harmelen, F. (2004). Web Ontology Language: OWL. In S. Staab & R. Studer (Eds.), *Handbook On Ontologies*. Karlsruhe: Springer.

Beer, T., Höpken, W. R., Zanker, M., Rasinger, J., Jessenitschnig, M., Fuchs, M., & Werthner, H. (2006). An Intelligent Information Push Service for the Tourist Domain. Paper presented at the European Conference on Artificial Intelligence (Workshop on Recommender Systems), Riva del Garda.

Beierle, C., & Kern-Isberner, G. (2003). *Methoden wissensbasierter Systeme*. Hagen: Vieweg.

Bieger, T. (2005). *Management von Destinationen, 6. Auflage*. München, Wien: Oldenbourg

Brachman, R. J., & Levesque, H. J. (2004). *Knowledge Representation and Reasoning*. San Francisco: Morgan Kaufmann.

Prekop, P., & Burnett, M. (2003). Activities, context and ubiquitous computing. *Computer Communications* 26(11), 1168-1176.

Cheverst, K., Davies, N., & Mitchell, K. (2002). Exploring context-aware information push. *Personal and Ubiquitous Computing*, 6, 276–281.

Christopoulou, E., Goumopoulos, C., & Kameas, A. (2005). An ontology-based context management and reasoning process for UbiComp applications. Paper presented at the Joint conference on Smart objects and ambient intelligence, Grenoble, France.



Dayal, U., Hanson, E. N., & Widom, J. (1994). Active Database Systems. In W. Kim (Ed.), *Modern Database Systems: The Object Model, Interoperability and Beyond.* Reading/Massachusetts: Addison Wesley.

Dey, A., & Abowd, G. D. (2000). Towards a Better Understanding of Context and Context Awareness (No. GIT-GVU-99-22): Georgia Institute of Technology.

Forum, UMTS. (2005). *Magic Mobile Future*. London.

Gretzel, U. & Wöber, K. (2004). *Intelligent Search Support: Building Search Term Associations for Tourism specific Search Engines*. Information and Communication Technologies in Tourism.

Hair, J.F., Black, B., Babin B., Anderson, R.E. & Tatham, R.L. (2005). *Multivariate Data Analysis*. 6th edition, Upper Saddle River, NJ: Prentice-Hall

Hinze, A., & Voisard, A. (2003). Locations- and Time-Based Information Delivery in Tourism. Paper presented at the Advances in Spatial and Temporal Databases, 8th International Symposium. Retrieved.

Hofer, T., Schwinger, W., Pichler, M., Leonhartsberger, G., & Altmann, J. (2003). Context-Awareness on Mobile Devices - the Hydrogen Approach. Paper presented at the 36th Annual Hawaii International Conference on System Sciences, Hawaii.

Höpken, W., Fuchs, M., Zanker, M., Beer, T., Eybl, A., Flores, S., Gordea, S., Jessenitschnig, M., Kerner, T., Linke, D., Rasinger, J., & Schnabl, M. (2006a). etPlanner: An IT framework for comprehensive and integrative travel guidance. In: Hitz, M., Sigala, M., Murphy, J. (Eds.): Information and Communication Technologies in Tourism 2006, Wien, Springer-Verlag, pp.125-134.

Höpken, W., Fuchs, M., Beer, T., Linke, D., Zanker, M., Aschinger, M., & Jessenitschnig, M. (2006b). Context awareness within mobile services. Paper presented at the MobileHCI (IMAC Workshop - Innovative Mobile Applications of Context), Espoo, Finland.

Jaynes, J. (1976). *The Origins of Consciousness in the Breakdown of the Bicameral Mind*. Princeton.

Kärger, P., Melis, E., & Ullrich, C. (2006). Querying Heterogeneous and Distributed Learning Object Repositories via Ontology-Based Mediation. Paper presented at the 6th IEEE International Conference on Advanced Learning Technologies, ICALT 2006, Kerkrade, The Netherlands.

Liang, T.-P. & Wei, C.-P. (2004). Introduction to the Special Issue: Mobile Commerce Applications. *International Journal of Electronic Commerce* 8(3), 7-17.

Mühl, G. (2002). *Large-Scale Content-Based publish subscribe systems*. Technische Universität, Darmstadt.

O'Grady, M. J. & O'Hare, G. M. P. (2005). Mobile Devices & Intelligent Agents - Towards a New Generation of Applications and Services. *Journal of Information Sciences* 171(4), 335-353.

Paton, N. W., & Díaz, O. (1999). Active Database Systems. *ACM Computing Surveys*, 31(1).

Power, R., Lewis, D., O'Sullivan, D., Conlan, O., & Wade, V. (2004). A Context Information Service using Ontology-Based Queries. Paper presented at the Sixth International Conference on Ubiquitous Computing (Ubicomp'04), Nottingham, England.

Rasinger, J., Fuchs, M., Höpken, W. & Tuta, M. (2006) A Customer Based Approach to discover Accepted Mobile Information Services in Tourism. In Research@EyeforTravel, London, 5-6 June, pp. 31-46.

Ricci, F. & Werthner, H. (2001). Case Base Querying for Travel Planning Recommendation. *Information Technology & Tourism* 4(3-4), 215-226.

Russel, S. J., & Norvig, P. (2003). *Artificial Intelligence: A modern approach*. Upper Saddle River: Prentice Hall Series in Artificial Intelligence.

Ryan, N., Pascoe, J., & Morse, D. (1997). Enhanced Reality Fieldwork: the Context Aware Archaeological Assistant.

Schilit, B. N., Adams, N., & Want, R. (1994, December 8. - 9. 1994). Context-Aware Computing Applications. Paper presented at the IEEE Workshop on Mobile Computing Systems and Applications.

Schmidt, A., Beigl, M., & Gellersen, H.-W. (1999). There is more to context than location. Paper presented at the IMC'98.

Sowa, J. F. (2000). *Knowledge Representation: Logical, Philosophical, and Computational Foundations*. Pacific Grove, CA: Brooks Cole Publishing.

Strang, T. (2003). *Service-Interoperabilität in Ubiquitous Computing Umgebungen*. Ludwig-Maximilians-Universität München, München.

Venkatesh V., Morris M., Davis G. & Davis, F. (2003). User Acceptance of Information Technology: Toward a Unified View. *MIS Quarterly* 27(3), 425-478.
Wiederhold, G. (1992). Mediators in the architecture of future information systems. Computer, 25(3), 38-49.
Werthner, H. & Klein, S. (1999). *Information Technology and Tourism - A challenging relationship.* New York: Springer.

# Exploring Tourist Satisfaction with Mobile Technology

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## Abstract

Wireless access with handled devices is a promising addition to the WWW and traditional electronic business. Handheld devices provide convenience, portable access, and large amounts of information to travelers. Many mobile commerce application models have been developed, however, limited research exists on mobile users' perspectives with regard to satisfaction towards mobile technology. There is a need to develop an understanding of travelers' satisfaction with mobile commerce in order to gain optimum competitive advantage. In this paper, we adapted and developed the American Customer Satisfaction Model (ACSM) to m-commerce in the tourism industry. The results of this study suggest that the degree of perception and perceived value are key factors affecting mobile travelers' satisfaction with mobile experiences. Satisfaction, in turn, influences the extent of intention to continue to use mobile devices during travel.

**Keywords**: Mobile commerce, customer satisfaction, the American Customer Satisfaction Model (ACSM), mobile technology

## 1 Introduction

In recent years, there has been significant growth in the use of mobile devices such as hand-phones, personal digital assistants (PDAs), and handheld computers. Mobile commerce is expected to grow to $250 billion worldwide by 2006 (Kumar & Zahn, 2003; Vogt, Gartner, & Pagnia, 2003). Mobile technology not only extends the reach of wired networks, but also serves as an alternative information channel providing a new range of opportunities to travelers as well as changing the way certain information-related activities are conducted. In the past, mobile devices were regarded as a luxury for individuals. However, mobile commerce (m-commerce) now offers great flexibility for the tourism industry both to suppliers and travelers. Users can surf the web, check e-mail, read news, pay transaction and quote stock prices using these hand held devices. From the supplier's perspective, the promotional message can be changed much more quickly than through the use of traditional media. M-commerce is now becoming the standard in handling travel yields effectively (Eriksson, 2002). Ninety percent of households in Japan, South Korea and urban China now own cell phones, as do 80% of households in Western Europe, 60% in Canada, and three out of four households in the U.S. (CNET News, 2006). With this skyrocketing rate of ownership of mobile devices (Fernadez, 2000; Bughin, Lind, Stenius, & Wilshire, 2001), considerable research efforts are now being devoted to understanding how mobile technology could support the information needs of travelers, ranging from touring in