Developing Location Based Services for Tourism - The Service Providers View

Alexander Zipf and Rainer Malaka
European Media Laboratory - EML - 69118 Heidelberg, Germany
<firstname>.<lastname>@eml.villa-bosch.de

1 Introduction

Even conservative estimations suggest that future services for mobile Internet applications for nomadic users have a great potential – especially in terms of user penetration. Future higher-bandwidth mobile networks like HSCSD (High-Speed Cicuit-Switched Data), GPRS (General Packet Radio Service) and UMTS (Universal Mobile Telecommunications System) together with next generation smart phones and web-enabled PDAs (Personal Digital Assistants) will allow more acceptable services than today's – sometimes cumbersome – WAP (Wireless Application Protocol) services. Bundled with localization technology like (d)GPS (differential Global Positioning System), or even only information about the actual mobile network cell, it is possible to develop a range of new and exciting tourism-related applications. Combined with new technologies like intelligent software agents and user modelling like profiling of personal interests the potential for intelligent tourism-related services is even higher. First examples of research projects heading in that direction are for example "Deep Map" (Malaka and Zipf 2000, Malaka *et al*. 2000). Now, the new EU-funded project "CRUMPET" focuses research on the "CReation of User-friendly Mobile services PErsonalized for Tourism". . Within the IST framework of the European Commission, researchers are aiming at implementing, validating, and trialling tourism-related value-added services for nomadic users across mobile and fixed networks. In particular the use of agent technology will be evaluated in terms of user-acceptability, performance and best practice as a suitable approach for fast creation of seamlessly accessible nomadic services. The implementation will be based on a standards-compliant open source agent framework (FIPA), extended to support nomadic applications, devices, and networks. Features of the CRUMPET approach include:

- tourism-related service content,
- adaptive nomadic services responding to underlying dynamic characteristics, such as network Quality of Service and physical location;
- a service architecture implementation that will be standards-based;
- suitability for networks that will be those that a typical tourist user might be exposed to now and in the near future (like GPRS and UMTS);
- suitability for a range of terminal types, like next generation mobile phone;
- services that will be trialled and evaluated by mobile service providers;

This paper introduces and discusses some important technologies for offering spatially enabled data sources and for developing services for tourism within a nomadic environment. The implications for the service infrastructure as well as possible scenarios and use cases for such services within an seamless integrated wireless network will be considered. The potential of such applications is eminent, but considerations have to be taken on the architecture of such “smart environments”. This is being addressed through the use of agent technology.

2 The Potentials of Location-Based Services for Tourism

First we want to illustrate the potentials of location-based services (LBS) for tourism by indicating some example applications. LBS are services for mobile users that take the current position of the user into account when performing their task. Nomadic information systems can make use of roaming in the physical space by localisation technologies to adapt to a richer context model of the user’s previous and current position (movement evaluation). Here is a subset of possible applications of LBS also relevant to tourism, taken from the OpenLS Initiative (OpenLS 2000):

- Traffic Information, e.g., there is a traffic queue ahead, turn right on the A3.
- Emergency Services, e.g., “help, I'm having a heart attack!”
- Roadside Emergency, e.g., “help, my car has broken down!”
- Law Enforcement, e.g., “ what is the speed limit on this road where I am at?”
- Classified Advertising, e.g., “where are nearby yard-sales featuring antiques?“
- Object visualization, e.g., “where is the historic parcel boundary?“
- Underground Object Visualization, e.g., “where is the water main?”
- Public Safety Vehicle Management, e.g., “who is closest to that emergency?”
- Location-Based Billing, e.g., free calls on your phone, in a particular location
- Leisure Information, e.g., “How do we get to the Jazz Club tonight from here?”
- Road Service Information, e.g., “Where is the nearest petrol station?”
- Directions, e.g., “I'm lost, where is nearest Metro station?”
- Vehicle Navigation, e.g., “how do I get back to the Interstate from here?”
- Vehicle Theft Detection, e.g., “my car has been stolen, where is it?”
- Child Tracking, e.g., ”tell me if my child strays beyond the neighborhood.”

These examples take location as the only instance of the broader issue of “context awareness”. If we add more general context awareness by exploiting further sensors and information sources it is possible to build even more sophisticated and interesting tourism applications. The problem here is how to get this additional dynamical context information from the user in an non-intrusive way. Additional sensors would be needed to allow this, but we can’t assume that all of these will be available in 3G or 4G devices. Some research projects like Deep Map (Malaka and Zipf 2000) aim at incorporating more sophisticated context or dialog information, but we want to focus within this paper on location awareness. Equally important for CRUMPET is the issue of service and content adaption to the users' individual interests by the means of user modeling (using techniques for the dynamic profiling of personal interests).

3 Initiatives Regarding LBS

Services on mobile terminals for nomadic users need the following main components, which need to interact: location service and content providers, wireless operators and mobile terminal. The information may have to be substantially adapted as it crosses system boundaries. In this paper, we focus on tourism aspects and are thus most interested in location services and content providers. We will, however, keep the restrictions of an interfaces to the mobile device in mind.

In the area of LBS the OpenGIS Consortium recently started an initiative called "Open Location Services Initiative" (OpenLS). This initiative wants to develop open interface specifications in the areas of *Location application services and related location content* as well as *Gateway Services*. For tourism applications the first one seems most interesting. The gateway services integrate the above location application services with common mobile terminals, wireless platforms, Internet Protocol (IP) platforms, and/or mobile position determination systems. These services operate between wireless-IP systems and location application servers. The following lists show important examples for both:

Table 1: Location application services and related location content:

Electronic yellow page	providing online access of yellow page directories
Route determination	calculating and using route information
Map/feature display	displaying maps, images and geo-spatial features
Map/feature interaction	provide user interaction with displayed location information

Table 2: Gateway Services

Device Location services	Acquires the current position of a terminal from the mobile positioning server that is in use by a wireless operator
Content Transcoder service	Handles the trans-coding of content, depending on terminal characteristics
Portal service	The Web/WAP Gateway Server between location application servers and mobile terminals. Handles customization, privacy and security

A general system concept for location services from a technical view is shown in the following picture.

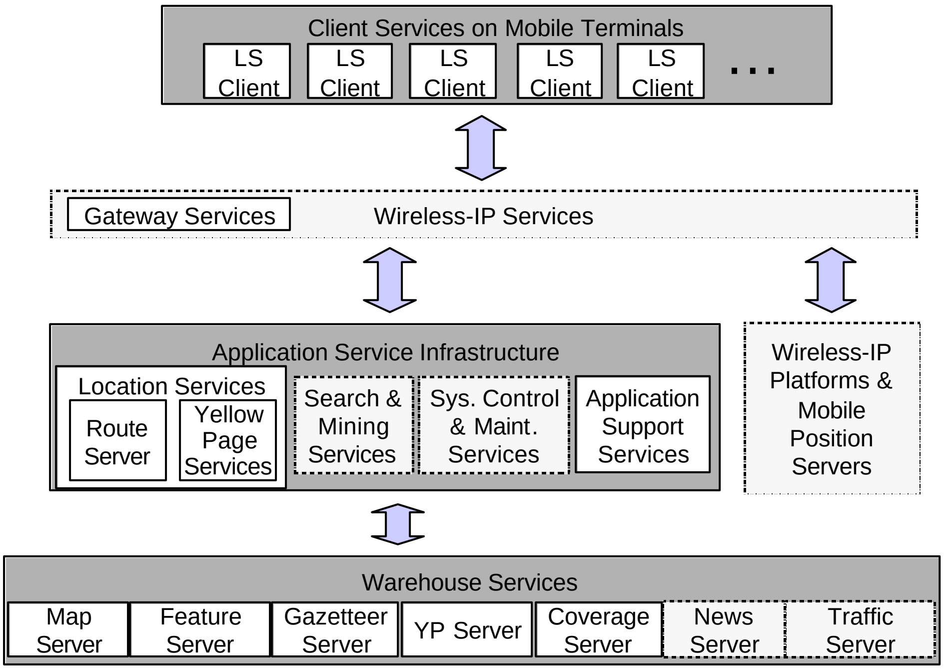

Fig. 1: Location Services Framework (OpenLS)

Within the OGC Services Framework a range of necessary or interesting services and content protocols have been identified supporting the location application services from table 1, being applicable to tourism:

- *Location content access services* (i.e., Web Map Service, Web Feature Service and Web Coverage Service) - these provide access to repositories of geo-spatial data, including imagery.
- *Geocode, geoparse and gazetteer services* – determine the geographic location for addresses, landmarks, places and other textual/coded location descriptors.
- Coordinate transformation services - these provide the coordinate transformations between various geodetic and map projection coordinate systems.
- *Discovery of location services and content holdings* (i.e., basic service model and catalog services) - used to discover location services and location content.
- *Portrayal services* (i.e. Style Layer Descriptor and Legend) - provide for the customization, tailoring and understanding of the display of spatial information.
- *Location content encoding and transport protocols* (i.e., Geographic Markup Language, Location Organizer Folder and Geolink) - these content specifications apply to the encoding and transport of collections of related location content.

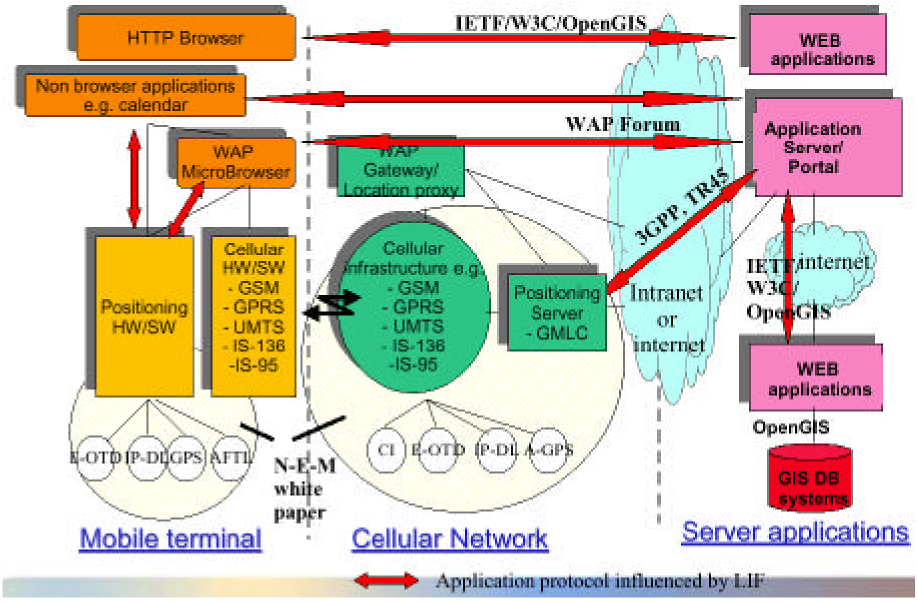

Fig. 2: Location Interoperability Forum (LIF) – the relevant bodys

Some of these services have been identified to be useful for intelligent LBS for tourism and CRUMPET and will be explained below. Figure 1 gives an overview of the generic services framework in which location services can be placed. Also other initiatives have identified the potentials of FBS. The most prominent example is the Location Interoperability Forum (LIF) initiated by Nokia, Motorola and Erricson. In Fig. 2 they show their view of the relevant system components and the corresponding bodies responsible for the respective standards and interoperability. Notably the Open GIS Consortium is depicted at several instances on components relevant to tourism services. Therefore we will introduce the role of the relevant Open GIS Specifications for LBS for tourism. Some of these are being implemented as FIPA agents within CRUMPET by EML.

4 Geographical Information Systems as Basis for LBS

Recent research has focused on the handling and application of geographic information (GI) technologies for tourism over the web, like the Deep Map WebGIS developed at EML (Zipf *et al*. 2001). Little effort has been committed to the standardised, flexible dissemination of (generally high volume) geographic data on wireless networks for mobile and nomadic applications. However, recently the OpenGIS Consortium has announced two new important specifications: the Web Mapping Interface Specification and the Geographic Mark-up Language (GML) based on the older Simple Feature Specification. GML is an XML-version of the OpenGIS-Simple feature specification: a specification for vector based map-content (geographic features) for GIS systems. This geographical information is a crucial feature of every tourism application as every user will wants his/her individualised information, with latest details on such topics as traffic, weather, sights, availability of services within the town, navigation aid and historical and economic background.

4.1 Geo-Data Server for Distributed Services

When developing LBS for tourism like in projects like CRUMPET it is necessary to be able to manage large volumes of geographical data on a sound server platform in order to make it possible to deliver a range of functions on geo-objects to several clients. So-called geo-data servers handle geographical data. They are extensions to databases providing extended spatial query and indexing capabilities. In order to improve the interoperability between several GIS products, OGC published the Open GIS Simple Features Specification (SFS) defining interfaces for handling geographical data and services. There are implementation specifications for available SQL, COM and CORBA. The last one was not yet implemented, but as CORBA seemed very adequate for developing a distributed and platform-independent system on an new technology it was chosen to implement the SFS for CORBA in Java and made accessible to other intelligent agents via a specific FIPA agent. This is a new approach to develop distributed GIS services based on CORBA-based geo-data servers. (Zipf and Aras 2001). More specifically the OGC SFS for CORBA was implemented using the Java API of ESRI's Spatial Data Engine (SDE) for Oracle.

The OGC Simple Feature Specification (SFS)

Features are intended to describe the geography of entities in the real world. Simple Features are features whose geometry properties are restricted to holding 'simple geometry' (for example, coordinates are defined in two dimensions and the path of a curve between coordinates is assumed to be interpolated linearly). Real world entities such as "Roads" are typically represented as features comprising a set of spatial and non-spatial attribute values (e.g., a geometry such as a line string representing the road's spatial extent, a string representing its name, etc.). Features may have an associated set of operations or behavior. The UML diagram in Fig. 3 shows the most important methods of the *Geometry* interface of the Simple Feature Specification. Each geometrie-object is linked with a *SpatialReferenceSystem*.

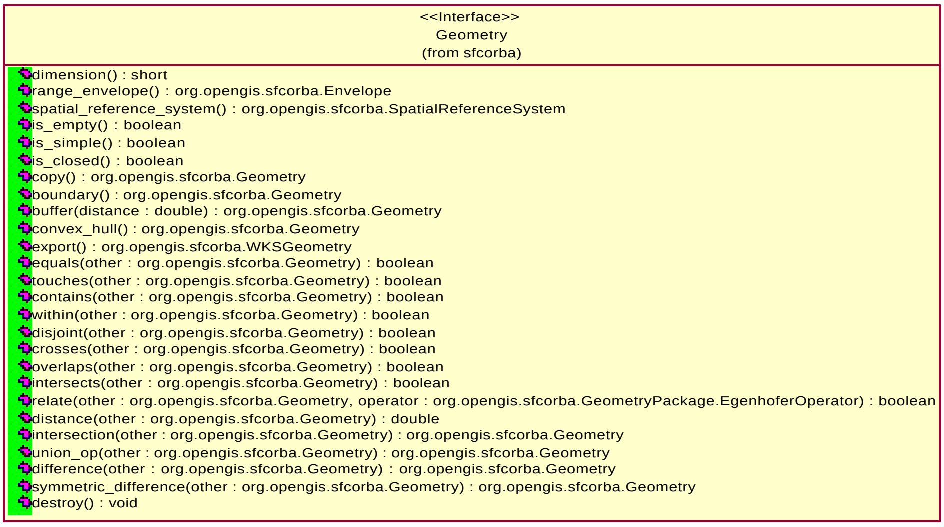

Fig. 3: Geometry-Interface with the most important functions of the SFS

The Geographic Markup Language (GML)

GML is a XML representation of Simple Features. In order to draw a map it is necessary to transform the GML into a graphic format, either by direct rendering, or by transformation into (XML encoded) graphics elements. This can be done anywhere in the processing chain between the data store and the visualization device. GML can be related to other new XML-based standards like the "Point Of Interest eXchange Language" (POIX) from the W3C Consortium. This is a more simplified model for position and direction information. POIX data can be generated from GML.

Spatial Agent

An OpenGIS-Server or implementation provides the software that exposes these constructs to outside clients through specified interfaces. A so-called "Spatial Agent" is being implemented making the OpenGIS server functionality available to other FIPA agents. The Spatial Agent performs a wide range of spatial functions from spatial queries and selections, distance measures, export of geometry data to visibility analysis. The agent consists of a three-tier-application using a database with the SDE middleware as store for geographical data and an object-oriented access tier using the SFS for CORBA. Within the application tier the more complex functions are performed, that cannot be solved using the methods provided by the spatial database engine directly.

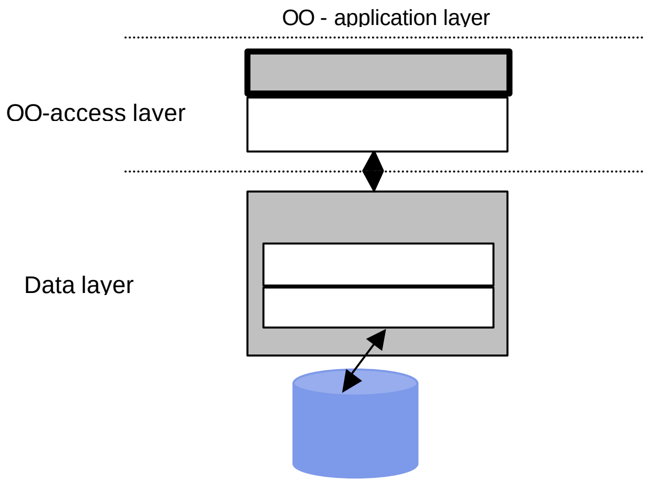

Fig. 4: System interaction between access- and data layer of the Spatial Agent

4.2 Further Important geo-Services for LBS

Web Map Server
A Web Map Server (WMS) provides maps either as rendered bitmaps or as a series of displayable graphic elements. In the case of bitmaps, WMS typically support GIF, JPEG or PNG and are increasingly able to support WBMP (WAP Bitmap) format. SVG (Scalable Vector Graphics) is the most common graphic element format. Clients request maps from a WMS in terms of named layers and provide parameters such as the size of the returned bitmap as well as the spatial reference system to be used in drawing the map. In this way, a client can make requests to different WMS implementations and the results can be overlaid to form a rich layering of map information. The WMS standardis ation effort is a more general step towards an open standard to give transparent access to heterogeneous geo-data and geo-processing resources in a networked environment, but has not yet been applied to mobile tourism services. Within CRUMPET, the work will take the use of geo-information technology one step beyond by developing an integrated spatially-enriched information architecture through the intensive use of distributed intelligent agent technology based on the FIPA standard. Within CRUMPET, FIPA agents will be developed that can access servers conforming to the WMS and such provide a bridge between OGC standards and FIPA standards allowing a very high degree of reusability and interoperability in spite of the use of such advanced technologies.

Route Server
A route server computes a path through a street network, given two or more locations on the network. A typical application of the Route Server is the ability to calculate

and display the best or shortest route between two specified points on a street network. There are many different routing algorithms. In cases where street addresses are specified as either the starting or ending points of the route, an address geo-coding service is required. At EML a route agent and a tour agent are being developed and integrated into a FIPA platform. The route agent provides the well known routing functionalities. The task of the tour agent is much more complex, as it tries to suggest individual sight seeing tours according to the tourists interest. Zipf and Roether (1999) presented a first prototypes using standard GIS software. New versions will have to find user-optimal tours respecting hard time constraint via different heuristic approaches. The underlying mathematical modeling - the so-called “profitable tour problem” - is closely related to the prize-collecting traveling salesman problem, a generalization of the traveling salesman problem (TSP). Since these problems are NP-hard, exact solution require too much computational effort.

Yellow page services
Two of the possibilities how to use yellow pages services in a mobile tourism scenario are the following:

?? *Nearest business*. Through a suitably equipped client, the user specifies the type and/or nature of the closest business that they are attempting to find.
?? *Pinpoint business*. Through a suitably equipped companion LS Client, the user identifies the *specific* business that they are attempting to locate, by specifying its name, phone number, or some other unique identifier.

5 Summary & Outlook

Mobile and wearable computing together with wireless multimedia communications enable new forms of user adaptive applications. Nomadic users of these information systems will either have their own devices on-line all the time or can make use public stationary devices to access an information infrastructure. Adaptive ubiquitous information systems allow access to public and personal information spaces from any device and can adapt information and services to the user and his/her current context. This brings up new challenges for user modelling and adaptivity. Until now, adaptive systems generally adapt the information selection and presentation to the user’s goals, preferences, knowledge, and interests. In most cases the user model acquisition is driven by monitoring the activities of users in the information space (user evaluation) or by an analysis of their connection and device characteristics (usage evaluation).

Fig. 5: Example of UMTS smart phone design study

Addressing security and privacy is critically important for location service success. User desire location services but they fear unwanted misuse of location information. Therefore security and privacy requirements have to be clearly specified for “home” and “roaming” environments.

Within this paper we have given an overview about some of the most important modules and services necessary to build personalised location based services for nomadic users within a tourism scenario and explained the importance of spatially enabled components in particular. In oder to achive a high degree of interoperability and reusability it is necessary that these components follow open standards. Within CRUMPET we evaluate for the first time how such standard-based geo-components can be integrated into an agent-based software architecture (“smartware”) to develop Personal Digital Tourism Guides based on the standards of FIPA and OGC.

6 References

(FIPA) Foundation for Physical Agents (2000): http://www.fipa.org/

(LIF) Location Interoperability Forum (2000): http://www.locationforum.org

Malaka, R. and Zipf, A. (2000): DEEP MAP - Challenging IT research in the framework of a tourist information system. In: Fesenmaier, D. Klein, S. and Buhalis, D. (Eds.): Information and Communication Technologies in Tourism 2000. Proceedings of ENTER 2000, Barcelona. Springer Computer Science, Wien, New York. p. 15-27.

Malaka, R., Porzel, R., Zipf, A. and Chandrasekhara, V. (2000): Integration of smart components for building your personal mobile guide. In: Proceedings of AIMS 2000. Workshop on Artificial Intelligence in mobile Systems. Workshop at ECAI 2000 (European Conference on Artificial Intelligence). Berlin.

(OpenLS) Open Location Services Initiative (2000): http://www.openls.org

(OpenGIS) Open GIS Consortium (1999): http://www.opengis.org

(POIX) Point Of Interest eXchange Language Specification (1999): http://www.w3.org/TR/poix/

Zipf, A. und Aras, H. (2001 accepted): Realisierung verteilter Geodatenserver mit der OpenGIS SFS für CORBA. In: GIS Geo-Informations-Systeme. Zeitschrift für raumbezogene Information und Entscheidungen. 03/2001.

Zipf, A and Roether, S. (2000) Tourenvorschläge für Stadttouristen mit dem ArcView Network Analyst, In: Liebig: ArcView Arbeitsbuch, Huethig Verlag.

Zipf, A., Häußler, J. and Jöst, M. (2001 submitted): Delivering innovative tourism services by Web and Wearables. EIUC 2001. ESRI International User Conference 2001. San Diego.

7 Acknowledgments

CRUMPET is a research project funded by the EU within the IST (Information Societies Technology) programme. The Consortium has the following partners:

- European Media Laboratory, EML, Heidelberg Germany
- Nortel Networks, Harlow Research Labs, Great Britain
- GMD National Research Center for Information Technology, Bonn, Germany
- Queen Mary College, University of London
- Inovação Portugal Telecom
- Sonera, Finland
- University of Helsinki, Finland