

Cartographic Concepts for Realizing a Location Based UMTS Service: Vienna City Guide "Lol@"

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Abstract

UMTS (universal mobile telecommunication system) is a soon coming new standard for wireless communication and information transmission. Considering the enormous increase of bandwidth potential with UMTS, the main concern of innovative applications has to be seen in the enabling of interactive applications with multimedia features and, as an issue of special interest for all branches dealing with geo-information, location-based services (LCS). In this context, maps play an important role, as they can be seen as the most effective tools for transmitting all kind of spatial information. While it is no matter of discussion, that spatial information are decisive for many parts of human life as well as for business decisions, the efficient transmission of spatial information includes not only the aspect of which graphical tools are appropriate, but also which conditions of accessing and browsing the information are available. In this context, mobile handheld devices, as they can be expected in an UMTS-environment, can be seen as an important step in the "digital revolution" of cartography, enabling a time- & space-independent access to all kind of digital forms of presentations of spatial information.

1 Mobile Internet and Cartography: TeleCartography

The Internet is changing the way maps are used. It acts as a stimulant for map production and map distribution. Applied web mapping techniques are often seen as a major step in the development of cartography (Peterson 1999). The main advantages of Internet Cartography are described as gaining better accessibility for the user, enabling higher actuality (van Elzakker 2000) or easier distribution of maps. But, the efficiency of the usage of Internet-based applications, as any other digital mapping application, is determined and restricted by the main attributes of the machines, which are used for accessing and interacting with mapping systems. As one of the main attributes, computers are usually not highly mobile. For a lot of cartographic applications this missing mobility and the fact, that the user has to find access to a machine in order to get his information or map, is not a major disadvantage. But for enabling cartographic information systems, which could serve products independent from the position/location of an user, in terms of "giving you the information right there where you need the information", the availability of mobile input/output machines and the availability of an infrastructure for wireless submission of information to any location are necessary preconditions (Gartner 1999, 2000).

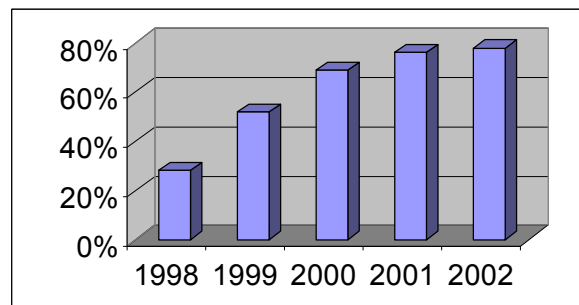


Fig. 1: Mobile Phones Penetration in Austria (<http://www.jet2web.at>)

The infrastructures and technologies of telecommunication systems are developing rapidly. They have reached a stage, where they are judged as a mass market industry. In Austria, more than 5 Mio. cellular phones are used by a total population of 8 Mio. (<http://www.handy.at>). Currently the penetration rate in Austria is one of the highest worldwide (Fig.1). The currently developing new protocols and network environments like WAP, GPRS or UMTS can be seen as first test areas for developing TeleCartography applications, because they enable high transfer rates, graphic or even multimedia data transfer and mobile client / server - interactivity. Together with the development of so called Wireless Information Devices (WID), mobile handheld devices with enriched functionalities (e.g. Smartphones, Communicators) (c.p. Gartner 2000), the fundamentals and pre-conditions for developing and testing TeleCartography applications are available in principle now.

2 UMTS and Location Based Services

In Europe, the first generation of mobile telephones appeared in the mid 1970^s in Scandinavia and were based on analogue techniques. The second generation of mobile handheld devices brought digital transfer technologies as GSM (Global System for Mobile Communications) and made the wireless phones a mass market phenomena. Today, multiple standards are used in worldwide mobile communications. Different standards serve different applications with different levels of mobility, capability, and service area (paging systems, cordless telephone, wireless local loop, private mobile radio, cellular systems, and mobile satellite systems). Many standards are used only in one country or region, and most are incompatible. GSM is the most successful family of cellular standards, supporting some 250 million of the world's 450 million cellular subscribers with international roaming in approximately 140 countries and 400 networks.

When WAP (Wireless application protocol) started some years ago it was for the first time ever that mobile devices have restricted access to the Internet, content that was prepared especially for the use on mobile clients with small displays. Although it does not allow the provision of graphics other than in a very basic presentation (Prague City Guide, <http://wap.checkit.cz/GWEWap/default.wml>), it has been used for first attempts. With 3rd generation technology UMTS it will be possible to give continuous access to most of the internet sites, graphical presentations included.

The new so called 3rd Generation (3G) of mobile phones features not only an IP-based technology but allows also for the first time so called "rich calls" transferring several user data streams simultaneously. This is also often referred to as "multimedia calls". It was a question of data transfer rates which did not allow other than voice calls up to now. But users and developers of wireless devices always had the idea not only to transmit "simple" voice calls but also all other forms of digital data. And the upcoming new technologies as GPRS (Global Packet Radio Switch) and the latest, proclaimed to go on air 2001, UMTS (Universal Mobile Transmission System) seem to make this idea become true first time in mobile communication. This will be possible only with the transmission rates proposed for the third generation of mobile devices as UMTS will be. The difference in speed between GSM and UMTS can be given by factor 50, in rare cases up to a factor of 200. This is a factor of 6 compared to ISDN and enables video transmission as well as audio files. Because UMTS technology enables the transfer of many different data formats in fast growing transmission rates, the development of complete new and attractive applications are initiated. Still, there are only very few ideas, prototypes and even less running applications trying to take advantage of the UMTS possibilities. But due to telecommunication companies this market will be one of the fastest growing ones and is currently highly focused in research and development (<http://www.nokia.com>).

One of the most promising applications in this context is seen of many as LCS, which stands for location based services (Gartner 2000). Such services can be characterized by the fact, that the position of the user is somehow identified. The information selection, as a result of the users requests, and the following presentation (e.g. the specific view on a map) is done due to the identified position. Methods used for position determination (Determination of Cell-Id, Measurement of Wavelength, Wave angles, Electric field strength, Combined Differential GPS) are producing a broad range of results in terms of quality (e.g.

Cell-Id-Determination: 100-300m in urban areas, approx. 2-5m in combined methods like DGPS/long wave measurements, depending on the build-up situation). This can be seen as a major problem for applying maps in LCS, because mapping of discrete positions requires scale-dependent accuracy.

The state-of-the-art LCS applications, most of them WAP-based, can be characterized by the fact, that in the most cases a non-graphic representation of results is used, the used positioning accuracy is poor, there is no usage of multimedia features, there are only low-level graphics used and the interface design and interactivity functionalities have to be adapted to the restricted possibilities of current available devices. A collection of WAP-based (UMTS environments are yet not available) LCS links can be found at http://www.ikr.tuwien.ac.at/links/wap_links.html. LCS for UMTS environments are in starting phases at the moment, including Lol@, a cartographic LCS-application for Vienna City Tourists, among others developed by the Department of Cartography of TU Vienna.

3 Lol@ - A Map Based LCS for an UMTS-Environment

3.1 The Project

The Department of Cartography of the Vienna University of Technology takes part in a research group (Forschungszentrum Telekommunikation Wien), where beneath other projects UMTS-applications are developed. As a joined issue of the FTW-project, the development of a prototype of a location-based service for an UMTS environment is in progress. The application "LOL@", a guided tour through Vienna's 1st district, is meant as a service for foreign tourists. The user is guided along a pre-defined route or due to individual input to some of the most interesting places in Vienna's city center, where he can get multimedia (audio and visual) information about the tourist attractions via the Internet portal of the service. The application requires a wireless handheld as input/output device. In order to be able to develop a location based service in an UMTS environment, the project has to deal with four main parts: specifications of technical prerequisites as well as conceptual and method development for localization, positioning and routing, application development and application implementation (FTW 2000).

The scope of the application includes the following main points:

- Automatic positioning is required by means of GPS and other methods, including user-supported localization.
- The entire route is displayed on maps including several map scales
- So-called "infopoints" depict the most important stops along the route. On these points multimedia information (audio, video, images, webcam) is offered for user-browsing.
- Routing from point to point and/or to starting points of the route is provided.
- User-defined queries for information retrieval are foreseen.

3.2 Cartographic Tasks

The main cartographic tasks of the Lol@ project, in the responsibility of the Department of Cartography of TU Vienna, include methodical and technical issues. For most of them the close context with the specific characteristics of Wireless Information Devices, the mobile usage situation and the general service set-up conditions of a TeleCartography application has to be considered.

A Preparation of Geo-Data and Visualization Concepts

The preparation of geo-data includes all map content needed for the basic maps, regardless whether it is given in a vector or raster format. A decision for two different scales has been made, an overview map that shows the complete route (app. 1:25.000) and a detailed map (1:7.500), showing all points of touristical interest and including routing functionalities.

Caused by the small size and resolution (120x320 pixel) and color restrictions (256 colors) assumed for the output devices all maps are adapted and prepared specifically. For the overview map this means in detail, that a distortion in the y-direction for enlarging the view area has been used. Beyond that silhouettes of significant points of touristical interest are added as well as the pre-defined route. All

detailed maps are designed for an on-the-fly production, including user-dependent display of information layers (route, point of interests) and a simplification of map elements in terms of considering the touristical focus of Lol@. The implementation of automated or semi-automated lettering algorithms has not been considered due to the fact, that an on-the-fly production has to be time-optimized. Therefore fixed positions of all map names are defined, but to a certain extent the usage of interactivity functionalities like tool tips is implemented.

For the symbolization of points of interests, landmarks and other topographical objects own symbols have been categorized and created. Their characteristics can be described as simple, determined for poor output device resolutions and as far as possible self-explanatory.

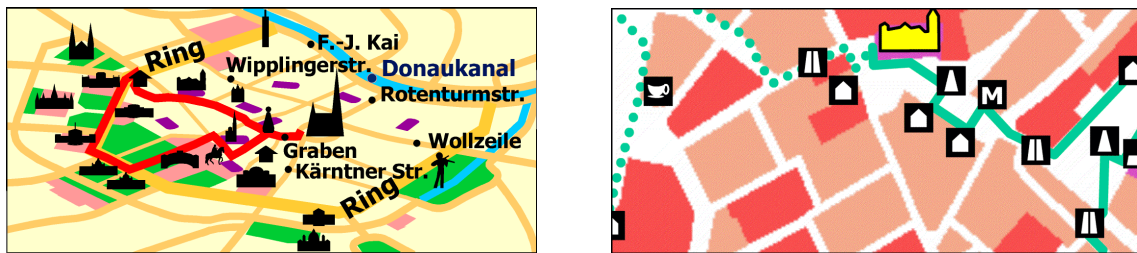


Fig. 2: Overview and Detail Map of Lol@

The maps itself are prepared in advance, containing all necessary information and covering the selected area. The information could be spread to several layers, depending on the client-side capacity of the system to handle a certain number of layers at once. The layer technology prevents the server from sending all possible information in advance to the client, which would slow down the client's speed and would consume a lot of the streaming capacity but enables the client to vary the displayed information without waiting for a complete refreshed map pushed by the server.

Referring to location features, which will be either by GPS-supported methods or client-based methods as signal strength measuring, it will be possible to "cut" the immediate area of the user's current position from the prepared map and send only the needed parts to the client. This saves data transfer time and capability and provides more flexibility in referring to the user's actual position. But it complicates some other features, first of all the lettering. For example it never allows to place street names in advance. All the lettering has to be done after the map detail to be displayed is fixed or will only be shown as "tool tips" (Brunner 2000, Ditz 1997).

B Preparation and Presentation of Multimedia Content Data

In order to gain knowledge about the applicability of multimedia cartography in an UMTS environment the usage of multimedia content data has been considered as an essential element of the project. As Lol@ is dedicated as an application for tourists a region of high touristical interest, the Vienna City, has been chosen. Usually such regions can be characterized by a rich assortment of places of interests, enabling also an easy access to all kind of information including also multimedia presentation forms.

In a first step a selection of points of interests (POI) due to their spatial relation to the pre-defined route and also a categorization into main POI, POI and region of interests (main POI and surrounding POI's) have been accomplished. The POI's have heterogeneous characteristics in terms of e.g. size, object type, and are used as access keys for exploring and browsing the multimedia content. In order to prepare the multimedia content data base the acquisition of multimedia data (images, text, video, animation, audio files), the creation of a data base concept (including adjustment possibilities due to additional data, user-defined data set entries and time-dependent data) and the adaptation of heterogeneous forms of multimedia presentations (due to the assumed device facilities) have been realized.

C Development of User Guiding Concepts

This part is connected to all questions of positioning, localization, accuracy and routing. Presently there is no satisfying method to localize a mobile device with the accuracy needed to usefully display the user's current position or even to route him within the presented area (see Chapter 2). In Lol@ the following methods are used: Cell-ID Determination, Combined GPS and User-defined Position Determination. These methods can be characterized by a very heterogeneous accuracy. In Lol@ the assumption has been made, that a poor accuracy (up to 100m) of the positioning result has to be used. This leads to the following consequences:

- There is no precise visualization of the user's current position possible.
The achieved coordinates of the measured position and their deviation and accuracy (depending on the used method of positioning which will not be described in this paper) have to be presented in a way that misinterpretations by the user are avoided and the reliability of the presentation is guaranteed. Due to the fact, that cartographic information transfer processes have to be efficient, the indication of the user's current position should be adapted to the actual scale presented on the display only. A symbol-indicated position is by convention interpreted as somehow correct, while a symbolization of the current position by a circle, which are usually interpreted by common users as an "approximate position", should be considered.
- The quality of the routing for pedestrians is restricted because of the used positioning accuracy (e.g. the routing to large objects can be realized, but a more precise routing to details of topographic objects will not be possible)
- Therefore presentation methods of the user's position have to be adapted. In Lol@ the user's position has been symbolized not by a precise point symbol but by highlighting an area or street segment and by center the actual displayed map (Fig.3).
- The usage of "push data", in terms of providing multimedia data to the display or checking and confirming "visited" points of interests triggered by the user's position, is because of the correlation of scale and positioning accuracy not applicable on the detailed maps of Lol@.

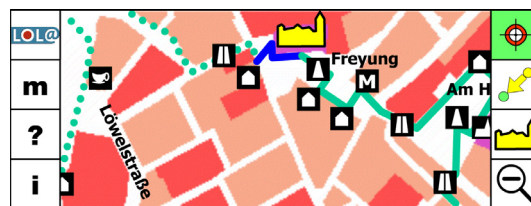


Fig. 3: Highlighting of a street segment for supporting the routing

The routing functionalities include a pre-defined route, user-defined routing from any point within the map area to any point, a support of routing by landmarks and offers a variety of multimedia presentation facilities, which are:

- graphical: highlighting and route segment display in the map
- textual: alphanumerical instructions in command lines
- audible: auditive instructions
- images: highlighting and display of "next point of interest" and/or "landmark" in an image
- video / 3D-model / VR-scene: highlighting, display of "next point of interest" and/or "landmark" or display or route segment

The user normally will orient himself in an urban area not by searching for the north direction, which is extremely difficult while walking through small lanes or between high buildings (Downs & Stea, 1982). Rather, he will identify significant buildings and silhouettes, which are easily detectable while moving along a route. Therefore research is focussed on the idea of improving the user's orientation by including such remarkable signs in the map. This can be performed by integrating 3D-silhouettes in 2D-maps or by stretching the map in one direction to receive a kind of "bird's-view-map". An example of such a stretching can be seen in figure 2.

The usage of landmarks is implemented in Lol@ for improving the user's orientation and therefore his guiding. Passive landmarks, i.e. significant buildings, are accompanied by selected active landmarks, which can be small senders (e.g. blue tooth technology) used for checking/improving the actual position of the wireless device and for uploading additional information about objects in the sender's surrounding area. The simultaneous or alternately usage of multimedia presentation forms is seen by the authors as a major improvement of LCS-services in an UMTS environment.

D Interactivity and User Interface Design

In order to make sure, that an efficient use of Lol@ can be realized, the design and creation of the user interface and an intelligent concept for navigation through the application is a major issue of the project. The interface design has been developed with the intention, that the browsing and exploring of Lol@ features should be based first of all on graphical metaphors and, if suitable, user interaction with or via maps should be used. This intention presupposes, that devices with softkey and/or touchscreen facilities are available.

The difference in map presentation in the Internet and on a handheld device is first of all caused by the limited size, resolution and color representation of current displays. At the moment, every graphical application has to deal with these restrictions. Because of that, one of the main advantages UMTS brings to mobile terminals, the feasibility of multimedia and interactive applications, is decisive for the realization of cartographic applications in UMTS-environments. By using interactive and multimedia-based information retrieval methods, the limitations of current displays in terms of their restricted representation potential for graphics, can be supported by other forms of information presentation. High data transmission rates and streaming mode allow the transfer of voice calls, graphics, photos, audio files and even video sequences. For this wide range of input formats a clear guidance is necessary.



Fig.4: Display with Multimedia Content

In general, the user interface is designed due to the principle, that it should be "simple", in terms of guaranteeing an easy and quick usability especially in mobile situations and it should be "consistent", in terms of considering the "consistency" of content presentation and interface issues in different scales and/or hierarchies, both vertically and horizontally (Fig.4). Beneath graphical buttons hierarchical menus are used. In Lol@ scrolling (exc. for browsing map tiles) is avoided in general, therefore the user interface and all content presentation is dedicated for the assumed device characteristics. An adaptive interface, in terms of adjusting and modulating interface features and presentation on the respective device facilities used, is not provided in the first stage of Lol@, but is intended to become a main issue of following-up projects, although the combination of first multimedia interface functionalities (speech control) is integrated already.

Interactivity functionalities with maps include the change from overview map to detail maps and v.v., the exploring of map tiles by scrolling, the use of tool tips for additional information to already displayed map elements (names, attributes) resp. the description of functionalities of graphical buttons, the access to

multimedia content data through map symbols, the clipping and centering of the map due to selected POI's resp. the actual user position and the definition of routing target points. UMTS also allows full online Internet access, thereby clearly exceeding the capabilities of today's WAP terminals. Online Internet access allows interactivity in form of linked information, but also interactivity within map space as it may be realized by hot spots or tool tips. The former is defined by an active, "clickable" area, which causes any reaction, if the user produces a click-event with his cursor. It is used to access additional information on specific points or areas on the map and/or that is not used at all the time and would overload the map presentation if shown constantly. The information given additionally needs not to be grouped or simplified to make it readable, it can be presented in its original form as it was written to the database.

"Tool tips" are mostly used to show short written information as lettering or short explanations of abbreviations or definitions. The advantage of this form of representation is as well not to overload the map graphics, which is very restricted in our application and therefore has to be used with care. It allows a differentiation between important information - that is what the cartographer select as an important information and which is therefore shown constantly - and less important information. "Tool tips" can be adapted to varying orientation of the displayed maps: the lettering is connected to a certain point but not to a certain direction. As it is not shown constantly, there are no conflicts with other map elements. As this tool can improve the flexibility of map presentation, it is an important factor in creating "maps-on-the-fly".

Different ways of implementation of interactivity have to be chosen in dependence on the given graphic data file format. Raster formats allow other methods of interactivity as vector formats do. The former have only restricted possibilities to implement interactivity. Raster formats allow "hot spots" to be individually defined as "hot areas". Vector formats enable a direct connection from the graphic object to the database and therefore many kinds of actions can be started by click-events. In Lol@ raster formats (gif and jpeg) as well as vector formats (activeCGM) are used.

The question of constantly refreshing the display of the given information is an important one in the environment of mobile handheld devices. The frequency of refreshing the displayed maps differs in dependence on the user's average moving speed and the chosen scale on the display. It should be adapted to the presented deviation (if the deviation is higher than the displayed area it seems to be useless to show the user a refreshed map detail with a new calculated current user's position). The more content (geo-data as well as additional information) is situated on the server side of the system, the more data flow is needed between server and client (i.e. the mobile device) and the more streaming capacity has to be available. This seems to give preference to a client-side system, that is configured to concentrate as much data and tools on the client-side of the system as possible. In a client-side oriented configuration some restrictions have to be considered, including the fact, that the processing software running on systems like assumed for our application often does not yet support as many browser software, applets and plug-ins as we are accustomed from a standard software.



Fig.5: Display with integrated soft-keys

This leads to another problem of restricted displays at all: To be mass-market compatible they have to be assumed as a low-level device. Such a device may not have all keyboard functions needed for an interactive application as thought of. A possible solution of this problem is to shift some functionalities of the keyboard to the display itself. This intends a touchable screen that serves in some certain areas as soft key for application specific features (e.g. zoom, scroll etc.) (Fig.6).

E Technical Implementation of Selected Application Parts

Due to the fact, that the technical implementation is the final step of the project, and possible device facilities are improving permanently due to new devices launched, the assumption has been made, that the following base conditions are available:

- Operating System: EPOC
- Browser Software: Opera

Based on these conditions the idea of developing a hybrid form of application implementation between (mobile) client and server is used, which includes the development of Java-written viewers for user-control and display of data processed by GeoMedia WebEnterprise.

4 Conclusion

New technologies like the Wireless Application Protocol (WAP) or the Universal Mobile Transfer System (UMTS) together with new functionalities of cellular phones and other wireless handheld devices allow now not only the display of graphics, the enabling of increasing client interactivity and multimedia information transfer but also together with applied methods of positioning the development of so-called location based services. This fact, together with the predicted merging of computer industries with telecommunication industries enables for the first time, that the vision of serving actual and interactive cartographic products independent from time and space could become true.

Therefore the authors of this paper argue, that the "regained mobility" of cartographic products and services can be seen as a major stage in the digital (r)evolution of cartography, although a number of restrictions in current state-of-the-art applications exist (e.g. resolution and size of displays, accuracy of positioning methods). But, equally to the development of digital cartography, future improvements can be assumed, especially in the field of displays, where the development of a high resolution "electronic paper" is a major research task at the moment (XEROX and 3M have launched a first prototype of electronic paper with a resolution of 100dpi (<http://www.xerox.parc.com>, <http://www.3M.com>)). Strategies to overcome restrictions in size and resolution of displays may therefore be seen in ten years or so as a specific problem of the first trials of TeleCartography applications like the described application "Lol@".

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