PARAMOUNT – A LBS prototype for Hikers

Sayda, F.; Wittmann, E.; Kandawasvika, A.; Wang, F.

Abstract

In the EC funded project PARAMOUNT, a Location Based Service (LBS) prototype for hikers has been developed and validated in test areas in the Alps and Pyrenees. Within PARAMOUNT (www.paramount-tours.com), three service packages are available, utilizing Satellite Navigation (GNSS), Telecommunication (GPRS) and GIS technologies. INFOTOUR provides different kinds of information and functionalities, such as topographic maps, routing functions, tourist information on points of interest (POIs), local weather forecast and so on. SAFETOUR aims at increasing the safety of its users. Therefore, it has been designed to receive emergency calls from the users and assist the search and rescue (SAR) organizations during their missions. DATATOUR allows users to contribute to the update of the GIS database (e.g. by capturing new POIs or trails). This paper will present results of the PARAMOUNT project like the users' requirements, system architecture, and results of tests.

Introduction

Hiking is one major recreational activity in mountainous areas, e.g. the Alps or the Pyrenees. Besides lots of printed material nowadays, more information for preparing a hike is available in digital format. For example there are countless websites providing information on trips and software is available for planning hikes, e.g. the TopTours CD for the German parts of the Alps.
Though during a hike the information necessary at the right moment, in many cases has to be brought together from different sources. The following example will illustrate a situation that can occur during a hike. Due to unexpected exhaustion of a member of the hiking party or sudden weather changes it may be is necessary to change the planned trip so that the next available hut can be reached to find shelter. Searching for the next available operational hut might, depending on the available equipment, require the following steps:

1. Determining the position with a handheld GPS.
2. Transferring position in a paper map.
3. Manually searching in the vicinity of the marked position in the map for huts.
4. Verifying in a hut register, whether the hut is currently open.
5. Planning a new route to the selected hut.

The small example clearly shows that there are several skills required by the hikers to fulfill this task. Different sources of error can be thought of in the above mentioned scenario, e.g. wrong transfer of the GPS position in the map or selecting the wrong hut as “nearest hut” (in this case the hut with the smallest linear distance might not be the easiest one to reach). Within a research project called PARAMOUNT a prototype of a Location Based Service for hikers has been developed. The objectives of this project have been to provide hikers information, offering navigation and guidance functionality as well as including a safety component

The PARAMOUNT (www.paramount-tours.com) project (Contract N° IST-2000-30158) was funded by the European Commission (EC) in the 5th Framework Program (http://www.cordis.lu/ist/ist-fp5.html) Information Society Technologies Program (IST) and was conducted by an international consortium consisting of IfEN GmbH in Poing, GIS lab at the University of the Bundeswehr Munich (AGIS), Institut Cartographic de Catalunya (ICC) in

Barcelona, Bayerische Bergwacht (Bavarian Mountain Search and Rescue (SAR) Service) and Oesterreichischer Bergrettungsdienst (Austrian Mountain SAR Service).

The general user requirements of hikers and mountaineers on such a service are, in general, the following:

- Visualization of the user position on a map
- Routing and Guidance capabilities
- Access to various kind of up-to-date information, e.g. weather information, huts, cable cars …
- Emergency call

In the following chapters the build up of the PARAMOUNT LBS prototype with the definition of user requirements and the precondition analysis, the system architecture used and available services are described in more detail. Furthermore results from the system analysis concerning the acceptance of such a system by potential users and the availability synthesis of the three major components required to run the service are explained.

User requirements

At the beginning initial general user requirements had to be refined to allow for designing a system that meets the customers needs. Therefore user requirements have been gathered, extended and verified using different ways. On the one hand, a web survey has been carried out to allow people interested in hiking to participate in the definition of the user and system requirements. During this survey, the participants have been asked about their preferences on the services and the content, e.g. which points of interest (POIs) should be included. In addition to they have been asked about available hardware like Personal Digital Assistants, mobile phones or GPS handheld devices and if they carry those devices during their hikes. From the commercial point of view the users also have been requested to specify how much they are willing to spend on a service meeting their requirements. The result of the last question is in shown in Figure 1. In this survey the users consider in average such a service to be worth around $42 p.a

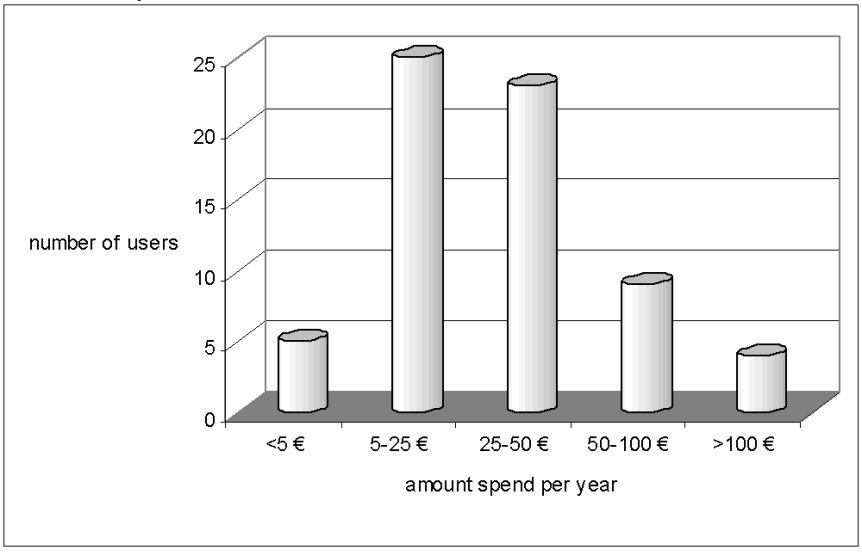

Figure 1: amount per year users are willing to spend,

On the other hand workshops with hikers and members of mountain SAR teams have been conducted. The direct involvement of two SAR teams in the project ensured that the user requirements on the system are inline with situations met in emergency scenarios as well as the user and system requirements for the whole system are verified by professionals involved in hiking

Provided Services

Based on the user and system requirements the system architecture has been set up. Figure 2 gives an overview of the overall PARAMOUNT system architecture with its three main service packages – INFOTOUR, SAFETOUR and DATATOUR.

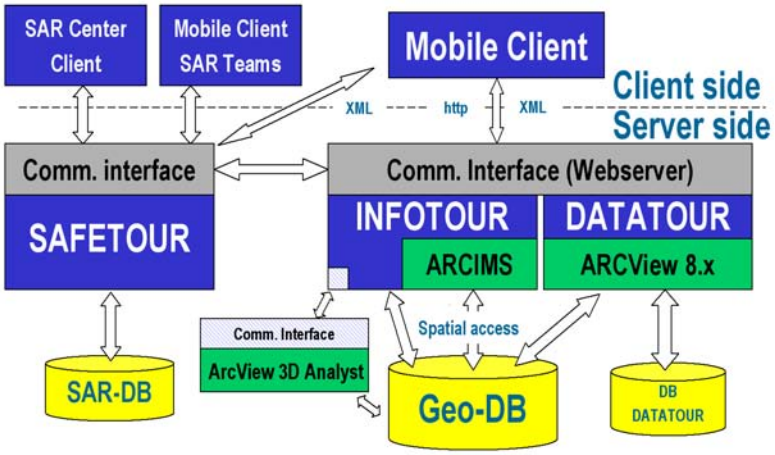

Figure 2: PARAMOUNT system architecture

Within the INFOTOUR service package all services related to information provision to the users are summarized. In detail these are:

- Provision of maps
- POIs + Information
- Routing (to a selected destination, back to next trail, to next shelter)
- Weather and tourism information
- Location Based Advertising
- 3D visualization (rendered images)

In addition to these services INFOTOUR directly provides maps and routing functionality to the SAFETOUR components.

The SAFETOUR service package on the one hand offers some safety-increasing functionality to the hiker and on the other hand provides support to Search-and-Rescue (SAR) teams during their SAR missions. The following features are included in the SAFETOUR service:

- Automated tracking of the user
- Receiving emergency calls including position
- Alerting the mountain rescue authorities
- SAR mission control panel (see Figure 3)
- Communication to the mobile clients of the SAR (position, text messages)

The DATATOUR service package has been designed to assist the service provider in the data acquisition and update process. As this normally is a very time and cost intensive task this package provides services, which incorporate the user in this process. The main approach here is to allow the user to collect data and submit them to a central server. The data collected from lots of different users should be processed automatically or semi automatically to allow for updating of the Geo-database. The basic idea is to use the information captured by multiple users to verify that this information is reliable and valid. In other words e.g. if 10 different users report that a phone number of a hut is wrong it is more likely that this information is valid than if just 1 user reports this. Further information on the DATATOUR services can be found below in the separate chapter on DATATOUR.

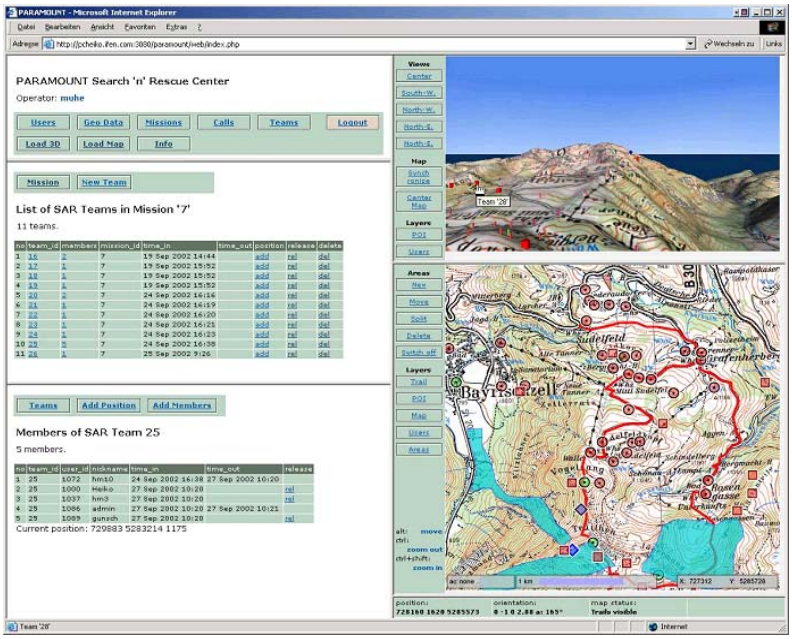

Figure 3: SARC-Client User Interface (web based)

System Architecture

The overall system architecture in PARAMOUNT (shown in Figure 2) clearly reflects the main system components as well as the three service packages. Horizontally the system is divided into three layers:

- Client Side
- Server side
- Database (DB)

On client side there are three different components: the mobile clients – called TourGuide – for the hikers and for the SAR field teams as well as the SAR Center Client.
The client hardware is based on commercial off-the-shelf (COTS) components to enable a flexible configuration. The basic "terminal" for the TourGuide application is a Pocket PC with additional modules for navigation (GPS) and communication (GPRS) tasks. These modules can be attached to the Pocket PC or may already be integrated (for example, a smart phone with integrated GPS receiver module). The following components are required for the TourGuide:

- *Pocket PC (or Pocket PC Phone)*: Depending on the model, an additional expansion pack may be necessary for inserting the external modules
- *GPRS communication unit*, either already integrated in the Pocket PC or as separate device. This can be, for example, a mobile phone with Bluetooth interface or a GPRS modem card to be plugged into the Pocket PC.
- *Navigation unit*: A standard GPS receiver in CompactFlash or SD card format as well as a separate Bluetooth GPS receiver may be used.

A detailed capability description of these components can be found in the corresponding chapters.
The communication between the clients and servers utilizes GSM-GPRS as physical layer. As transport layer the Hypertext Transfer Protocol (http) is used while the content to be transferred between the client and server and visa versa is encoded using xml. Figure 4 shows a small route as generated by the routing service. The clients use this result to display the route on the map and to guide the users along this route.

```
<?xml version="1.0" encoding="UTF-8" ?>
- <ROUTETOPOI>
    <STARTPOINT x="715484.57" y="5281544.28" />
  - <ROUTE>
      <COORDS x="715488.26" y="5281547.29" n="0" />
      <COORDS x="715593.25" y="5281418.70" n="3" />
      <COORDS x="715598.45" y="5281334.37" n="0" />
      <COORDS x="715627.81" y="5281256.51" n="0" />
      <COORDS x="715655.89" y="5281220.14" n="0" />
      <COORDS x="715674.39" y="5281186.31" n="0" />
      <COORDS x="715706.30" y="5281171.63" n="0" />
      <COORDS x="715720.34" y="5281148.02" n="0" />
      <COORDS x="715715.24" y="5281116.11" n="0" />
      <COORDS x="715716.25" y="5281088.58" n="3" />
      <COORDS x="715777.28" y="5281093.25" n="0" />
      <COORDS x="715788.73" y="5281093.64" n="3" />
    </ROUTE>
  </ROUTETOPOI>
```

Figure 4: Result of routing service encoded in xml

The INFOTOUR service has been implemented using ASP (Active Server Pages) combined with ARCIMS 3.1 functionality. Additionally ArcView 8.x with the 3D Analyst extension is used to provide 3D rendered images of the hiking area to the users (see Figure 5).

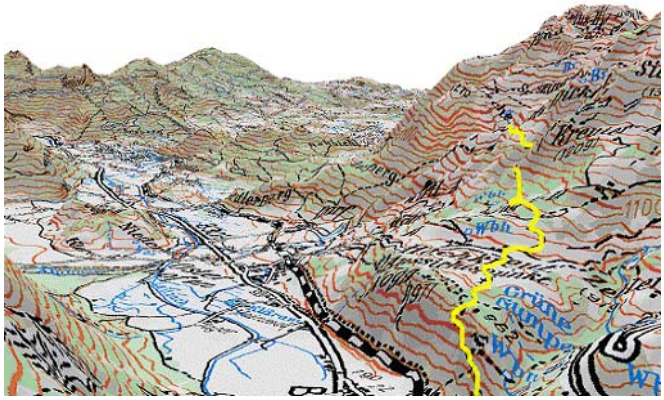

Figure 5: 3D rendered image in the Alps test area with proposed route (yellow)

Within DATATOUR also ASP has been used in the data acquisition and update component. The algorithms for processing the data (see chapter DATATOUR) collected by the users and updating the Geo-DB with this data have been implemented in ArcView 8.x.
To access the PARAMOUNT services with the SAR Centre Client the user just needs a standard web browser and some common plug-ins. The SAFETOUR service has been implemented using PHP.

The SAR centre client sends a request to SAFETOUR server as an HTTP request via TCP/IP connection. The output or response is written in HTML, XML, SVG or VRML and sent to the client.

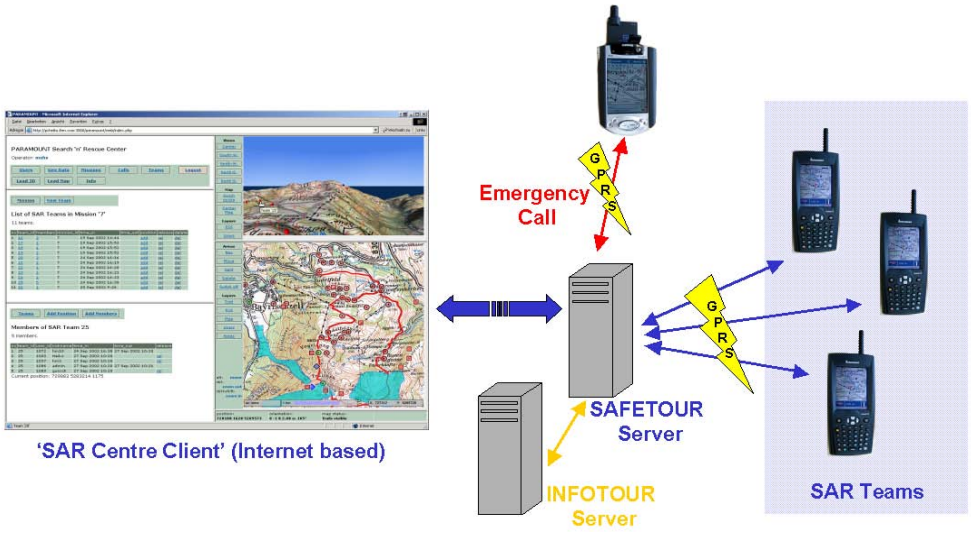

Figure 6: SAFETOUR interaction overview

Besides the data in the Geo-database containing data for the INFOTOUR services (see chapter availability synthesis for details), there are two other databases. One for the SAFETOUR component containing information on SAR teams and user specific information and another one for storing the information delivered by the users to the DATATOUR service package for further processing.

PARAMOUNT from the users point of view

Mobile client - hikers

The following functionality is provided to the user through the mobile client:

- Displaying topographic maps
- Map interaction like zoom, pan
- Displaying POIs + providing Information on them like type, name, business hours, link to webpage
- Server based routing (to a selected destination, back to next trail, to next shelter)
- Guidance along the route
- Local/regional weather and tourism information
- Location Based Advertising (optional)
- 3D visualization of the current surrounding (rendered images, see Figure 5)
- Track logging
- Sending an emergency call with position reference; this alert is automatically forwarded, e.g. via an SMS server to the SAR commanders

The following figure provides an example of the TourGuide graphical user interface.

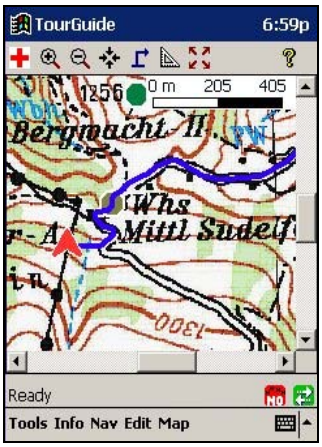

Figure 7: TouGuide software user interface

Mobile client – SAR teams

Rescue teams can also use all the INFOTOUR features, e.g. for routing and guidance, as mentioned above. In addition, the position of the person in distress (if available) as well as the current positions of the other SAR teams equipped with TourGuide devices are displayed in the map. Furthermore the SAR Centre Client and the field teams can communicate via text messages, e.g. in order to exchange information about the state of health of the casualty.

Figure 8 shows two sample configurations of the TourGuide clients that have been tested within PARAMOUNT. The standard hardware for leisure hikers consists of an iPAQ, a GPRS modem, and GPS receiver CompactFlash card, as it is depicted on the left hand. One the right, a device for professional use for the search and rescue teams is shown together with a small Bluetooth GPS receiver which can be put in a pocket or backpack. The robust PDA with integrated GPRS modem is shock- and waterproof.

Figure 8: Samples of mobile client devices for hikers (left) and SAR teams (right)

SAR Centre

Using this application, a coordinator in the SAR center can track the movements of rescue teams on a map as well as in a 3D environment, and access further relevant data, i.e.:

- SAR mission status
- Names and background of SAR team members
- History of messages exchanged between field teams and SAR Center client
- Map areas that have already been searched

- Medical history of a registered user (if he has stored it before on the server) for a fast, efficient first aid

After the completion of the SAR mission a detailed report can be automatically generated including the relevant information and activities recorded during the operation.

DATATOUR

As explained earlier this service package intents to involve the users in the data acquisition and update process. Within PARAMOUNT there are mainly three types of data the users could contribute to:

- Attribute information on trails and POIs
- The location of a POI
- Trails, meaning the geometry of a trails

Depending on the type of data, which should be captured or updated involving the users different algorithms have to be applied to perform this. Besides all these have one thing in common, thus to prevent inserting wrong information in to the Geo-database. For this reason the following questions have to be considered:

- Does the user capture valid data?
- How can the information captured by different users on the same object be processed? This information will describe the same object but it will not be exactly the same.
- How reliable is the user?

It is not possible to give answers and present algorithms on all these questions within this paper, however just a general approach and first results for updating the trails will be presented here.
Allowing the user to update the attribute information of existing objects requires a quite simple algorithm. The users will provide or update information on an object identified by a unique identifier. This information is stored in a temporary database. The Geo-database administrator later on just has to find information on the same object and update the Geo-database according to this information.
Capturing a new POI is also not that difficult. For example the user simply submits the coordinates and the type of the new POI. Later on, just newly submitted POIs within the same area have to be compared to find out if several users have reported the same new POI. It is necessary to search for similar POIs in a certain area, e.g. due to the positioning accuracy of GPS, the same POI will always have slightly different coordinates.
Deriving new trails from the data captured by the users is the main challenging task here. The data captured by the users are simply list of points representing the trail they have been hiking.
The problem should be explained with the following simple example. Assumed five users provide their hiked trails as shown in Figure 9 it clearly can be seen that the five users are not necessarily using the same trail all the time. They are just partially using the same part of the trail. Besides even for this common part, the coordinates of the points representing this trail will not be exactly the same, e.g. due to the positioning accuracy of GPS.

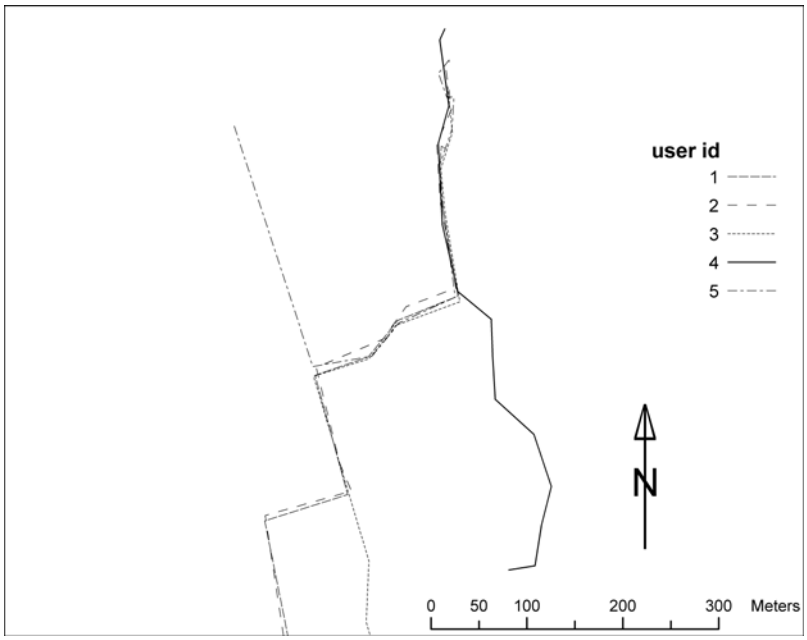

Figure 9: Example routes of five users

Within the project algorithms have been developed for solving the above-described tasks automatically as far as possible and further research is still going on. Additional information on these concepts and algorithms can be found at [Say05].

Availability synthesis

Within PARAMOUNT, three essential components for operating the envisaged system have been identified:

- Positioning availability, here GPS
- Communication availability, here GSM based, i.e. GPRS
- Data availability: The data are a core component for the system, as most of the services especially from the INFOTOUR service package cannot provide the requested information without a proper data basis. To make the services described in the previous chapter available to the user, the following data are used:
  - Topographic maps (raster)
  - Trail network (vector), including hiking trails, roads, cable cars, …
  - Points of Interest (POIs) (vector), e.g. mountain huts, summits, cable cars …
  - Digital Terrain Model (DTM)
  - Attribute information, e.g. additional textural information on POI

To determine areas within the Alps and Pyrenees where all three components are available, an availability study for each component has been carried out. In the availability synthesis, the result of the three independent studies have been merged to determine areas where all three components are available together. Using the result of the availability synthesis feasible areas for service provision as well as to pre-select the training or field-test areas for PARAMOUNT system in the Alps and Pyrenees regions have been identified. Other objectives were to identify possible data providers e.g. governmental agencies, private or public organizations within the countries covering the hiking parts of these mountains and to identify procedures for acquiring available data and information. Figure10 shows the overall result of the availability synthesis as map.

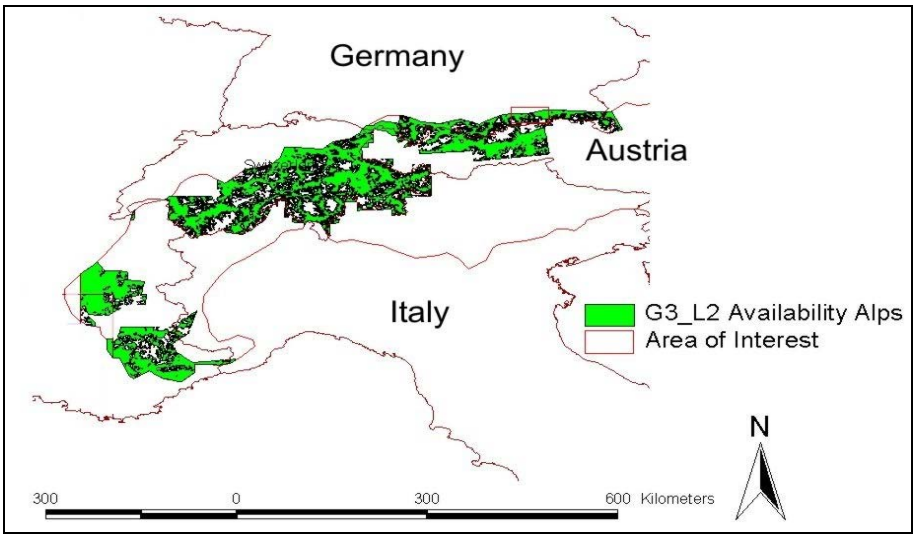

Figure10: Result of availability synthesis.

Summary and Conclusions

Within the PARAMOUNT project the services necessary for an LBS for hikers and mountaineers are provided on a prototype basis within test areas in the Alps and Pyrenees. The whole system offers three service packages: INFOTOUR, SAFETOUR and DATATOUR. Using the system architecture as described these service packages can contribute to increase the safety of the user, his or her ability to access the various kind of up-to-date information and also anticipates reduction in the maintenance costs of the Geo data.

Users of the different components have been involved during the test and demonstration phase. All core services proved to operate very well and have been well-accepted by the users. The mobile client for the hikers proved to be easy-to-use and allowed for applying PARAMOUNT during a hike without extensive training in advance. Knowledge and experience could be gained on the acceptance, usability and performance of the services and hardware in the field. One issue here for example would be to improve the rendering speed of the 3D rendering service, which was however not the primary intent within the project. Another one in this context is that the costs of the data, especially a high resolution DTM, necessary to provide rendered images in high quality would make such a service very expensive for the user.

A first implementation of the DATATOUR concept has been done and it produces quite promising results. Still the process of evaluating the data collected by the users automatically to retrieve reliable information to be inserted into the Geo-database is a topic of further research.

The project has been successfully completed at the beginning of 2004 and the services are currently used for demonstration purposes. Further information on the project can be found at www.paramount-tours.com. Among several publications and documentation on the project a demonstration video shown on German television can be viewed there.

As acknowledgement, all members of the PARAMOUNT consortium would like to express their gratitude to the European Commission (EC) for funding this project.

References

[Say05] Sayda, F.: Involving LBS users in data acquisition and update. In: 8th AGILE Conference on Geographic Information Science - Proceedings. 2005

Authors Information

Florian Sayda
AGIS (GIS lab)
University of the Bundeswehr Munich
85577 Neubiberg
Germany

florian.sayda@unibw-muenchen.de
Phone: +49 89 6004 2597
Fax: +49 89 6004 3906

Elmar Wittmann
IfEN GmbH
Alte Gruber Strasse 6
85586 Poing
Germany

E.Wittmann@ifen.com
Phone: +49 8121 2238 27
Fax: +49 8121 2238 11

Fei Wang
AGIS (GIS lab)
University of the Bundeswehr Munich
85577 Neubiberg
Germany

fei.wang@unibw-muenchen.de
Phone: +49 89 6004 2716
Fax: +49 89 6004 3906

Admire Kandawasvika
AGIS (GIS lab)
University of the Bundeswehr Munich
85577 Neubiberg
Germany

admire.kandawasvika@unibw-muenchen.de
Phone: +49 89 6004 3873
Fax: +49 89 6004 3906