CO-031

PROJECT BASED GEOINFORMATION EDUCATION AT CUAS - EXPERIENCES FROM A PILOT PROJECT

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1 INTRODUCTION

At the 18th and 19th of September 2010 the Carinthia youth section of the Austrian Alpine Association (OeAV) organized the Event "Kärnten bewegt 2010" (translated literally: Carinthia stirs into action). 45 groups of the OeAV should walk around Carinthia on the 800 km long borderland trail. Students of the Bachelor program Geoinformation at the Carinthia University of Applied Science (CUAS), which are members of the OeAV, had the idea to develop maps about the borderland trail and also an online GPS-Tracking web service for monitoring all active OeAV groups at the event. At the end of November 2009 they asked if it would be possible to integrate this project into our curriculum of the summer term. There was no long discussion. The project matched well to our curriculum containing the lectures System Design and Cartography Project. In this paper we describe all the challenges, problems and successful results of this ambitious project. Within 6 month cartographic products for the event, a tracking system based on Android and a web portal (www.kaernten-bewegt.at) had to be developed.

2 CARTOGRAPHY

Responsible for the Cartography project was Dr. Lukas Birsak, business manager of the publisher Ed. Hölzel Gesellschaft m.b.H. Nfg KG from Vienna. In this lecture the students designed a project folder, maps, 3D visualizations and trail signs. The following products have been created: a synoptic table of the "Kärntner Grenzweg", two stage tables with a detailed description of the path, a folder containing basic information of the "Kärntner Grenzweg" and a postcard. All these products have been published on the web page www.kaernten-bewegt.at. The cartographical part of this project has been realized in the course "project 2 - cartography". A core team (Markus Holzinger, Timothy Weyrer and Ines Schnabl) has managed the arrangement of the class and the creation of the products. Furthermore, this section deals with the requirements, technical problems, methods of solution and the results of the cartographical part. This project enabled the students to get to know the creation of cartographical products and to apply their knowledge in this field. Practical experiences have been made in the following fields:

- Technical preparation of geo data (working with GIS Systems, Open Source GIS, SRTM Data)
- Creation of design-guidelines, which are significant for the whole teams (type colors and types)
- Cartographical editorial work, to include content (e.g. directions, images) in the products
- Practical usage of graphic- and desktop-publishing software (Macromedia Freehand, Adobe Photoshop CS 4, Adobe Illustrator CS 4, MS Word, MS Publisher)

Five teams were set up to work on the following tasks: Data Preparation, Synoptic Tables, Stage Tables, Folder, and Postcard.

- TEAM DATA PREPARATION

The tasks of the Team Data Preparation were the digitalization of the "Kärntner Grenzweg", the acquisition, the manipulation and the allocation of the data for the teams, and the creation of a 3D view of Carinthia. The basis for the digitalization was a KAGIS dataset, which was provided by Carinthia. The shp-files have been modified for the Synoptic Table and the Stage Tables. Gaps in the lines have been closed and non relevant data has been removed. The data for the 3D view has been provided by KAGIS. This included a 50m-DTM. The DTM was modified in SAGA GIS.

- TEAM SYNOPTIC TABLE

The challenge was the creation of a synoptic table of the "Kärntner Grenzweg". The table has a size of 2x1m and contains information in German, English, Italian and Slovenian. The table was created in Photoshop CS 4 and Macromedia Freehand. The finished table shows the 3D view of Carinthia, the "Kärntner Grenzweg", the most important cities, lakes and streets of Carinthia, a legend and general information of the "Kärntner Grenzweg".

- TEAM STAGE TABLES

The task of this team was to create stage tables about two parts of the "Kärntner Grenzwanderweg". These stage tables has a size of 841 x 1189mm (A0) and include a 3-dimensional overview from the trail, the points of interest on the trail, a high profile and a short summary about the history of the “Kärntner Grenzwanderweg”. The team was using programs like ArcGIS, Macromedia Freehand and Photoshop CS 4 to produce the stage tables. The results are placed at the “Plöckenhaus” in the karnischen Alps.

- TEAM FOLDER

In this project, an information folder about the “Kärntner Grenzwanderweg” should be designed. The challenge was to create a folder which is written in four languages and include all important information about the “Kärntner Grenzwanderweg”. In this project not only the design aspects were essential but also the linguistics skills. The team designed this A3 -folder with Macromedia Freehand and Microsoft Word. In general 1500 pieces were printed and distributed.

- TEAM POSTCARD

The postcards were part of a lottery which was planned for the main event in September 2010. The idea was to fly balloons and on each of them was a postcard mounted. When someone find the postcard and send it back, he/she could win a prize in the lottery. The challenge of this project was to put as many information as possible about the “Kärntner Grenzwanderweg” and the rules of the lottery on a card which has the typical postcard size (15x11cm).

For better readability the results of the cartography project are shown in appendix MAPS.

But not only the cartographic products had to be produced. Until 18th of September 2010 a complete online tracking system based on Android Smartphones had to be developed. This challenging work was done by Alexander Godschachner, Manuel Rainer, Michael Spöcklberger, and Timothy Weyrer. Before the students could start coding, they had to develop a complete system design, which was done in the lecture System Design.

3 SYSTEM DESIGN AND ARCHITECTURE

Responsible for the System Design lecture was Dr. Ingo Simonis head of Geospatial Research & Consulting. In this lecture they had to define all requirements of the software system and to design the system architecture with all components and interfaces (Figure 1). In the following we describe the results.

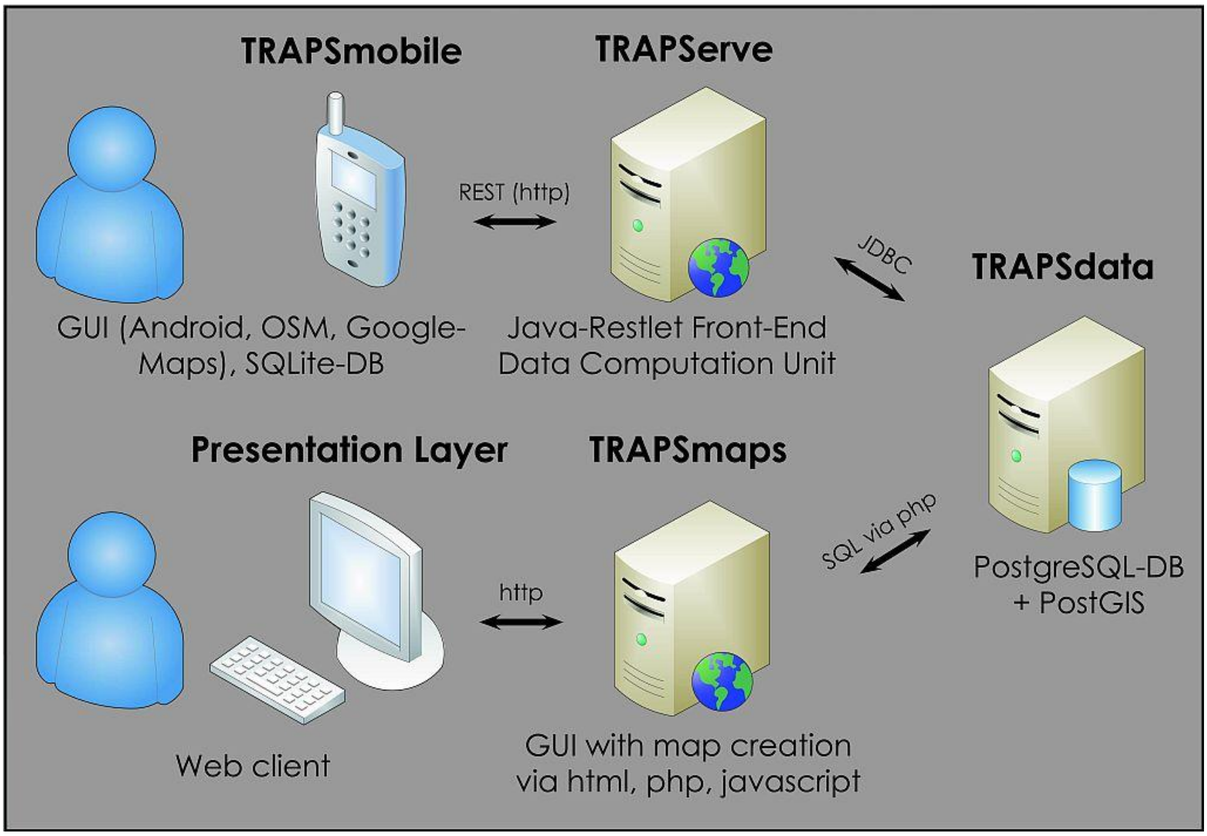

Figure 1: System architecture of the tracking system.

3.1 WEBSERVER

This Section discusses the core component of the gps tracking system, the “web server”. It connects the data capture layer with the data layer and is responsible for the decoding of receipt geometry data that are the basis for the depiction of cartographic elements on the map within the tracking system’s web interface.

Two versions of the web server are shown: the first non-extendable web server of “Kaernten bewegt” and the second re-designed web server “TRAPServe” which encompasses a line generalization module for three levels of detail.

3.1.1 WEB SERVER STRUCTURE

Both existing versions of the web server are programmed in Java and are using the library of the “Restlet” project [5] to provide REST based communication interfaces. The REST based communication approach is chosen due to its advantages of scalability [6]. This first version of the web server was designed only for the use during the “Kärntner Grenzweg” hiking event. No extensibility or scalability option for future development was considered.

The original Java based web server is a unit encompassing a login check module, an “event” receiving module and a GPS point data receiving module. The latter two modules compute and transfer the data to the existing data base without distinguishing GPS track points and points of interest. Every polyline is stored within the data base as a chronological collection of any GPS track related point. This equates to the most detailed grade for the purpose of visualization regardless of different map scales or levels of detail.

To add new cartographic objects for visualization a re-design of the web server’s architecture and its interfaces is done. The result is the new TRAPS server (TRAPServe). Its structure is similar to the concept of the GENDEM unit [2]. TRAPServe, as depicted by Figure 2, consists of a front end unit, a Data Base Communication Unit (DBU) and a Data Computation Unit (DCU). The goal is to differentiate the units of the web server related to their individual functions. This enables to scale and extend the TRAPS system when adding new customer-sided required features.

The front end unit guarantees the communication between the data capture layer (i.e. GPS mobile devices) and the web client, respectively, the DCU and the Multi Scale Data Base (MSDB). Every URI of the frond end unit represents a single module of this, i.e. a login check module, a GPS track receiving module, a point of interest receiving module and for instance a planned module to provide geometrical data in the form of a polyline data set. Future new functions are expendable by adding a new URI to the front end unit.

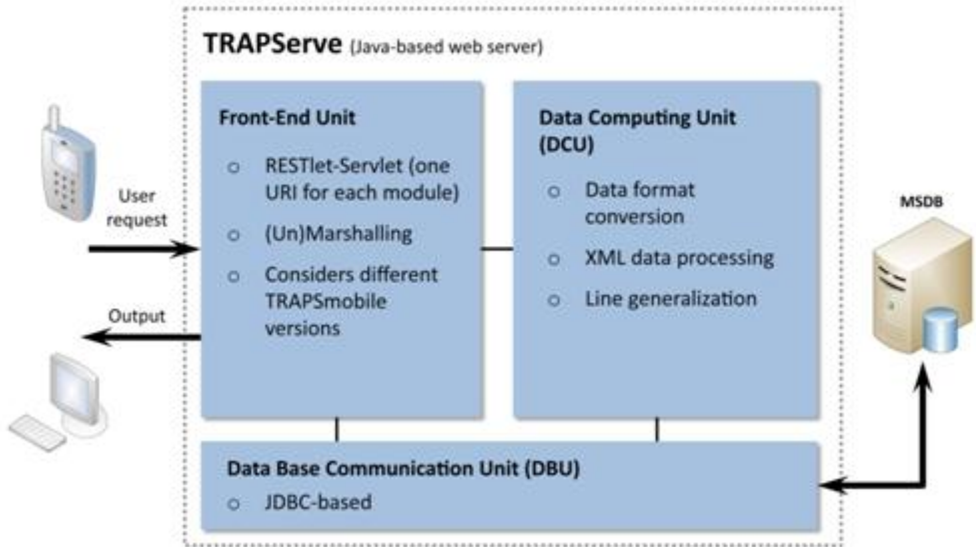

Figure 2: The new, adopted web server framework “TRAPServe” which encompasses three primary units that are divided into different function modules.

Furthermore, the front end unit modules have the capability to parse and encode eXtensible Markup Language (XML) [1] data streams. The latter function ensures the adaptability of the data structure referring to future application versions. The DCU is divided into modules: a data format conversion module, a polyline generalization module and a XML data processing module.

3.1.2 LINE GENERALIZATION MODULE

Due to the fact that typical scales were defined for published maps on paper [3] it has been decided to define three levels of detail on the basis of the “bird’s eye view height” of the application Google Earth. The defined heights are 25 km, 50 km and 150 km. The higher the bird’s eye view height the lower the level of detail respectively the higher the grade of generalization. The line generalization module of the DCU contains a Java implementation of the MDP [4]. This method applies the simplification and generalization algorithms on polylines. MDP takes a polyline, or a polygon, and a tolerance distance to compute a simplified line (or a simplified polygon).

The MDP uses a sequence of points (P1,...Pn) representing a polyline to compute an array of tolerance values from which the residual points of the simplified polyline will be selected. For that MDP recursively divides a polyline into two pieces by the point which has the biggest perpendicular distance to the line between the first and the last point of the related line. The MDP algorithm is described as follows [4]:

1. For each point, Pi, where s > i > e, calculate the perpendicular distance from Pi to the line segment (Ps, Pe).

2. Let Pmid be the point which has the greatest perpendicular distance dis to the line segment (Ps, Pe).

3. Let D[i] = min (dis, p) and set p = min (dis, p).

4. If mid > s + 1, call MDP (P, D, s, mid, p).

5. If mid > e - 1, call MDP (P, D, s, mid, p).

6. Return.

Once the above-mentioned array is obtained, it can be used to compute the simplified line for any scale. Figure 3 shows a polyline and a by the MDP computed value.

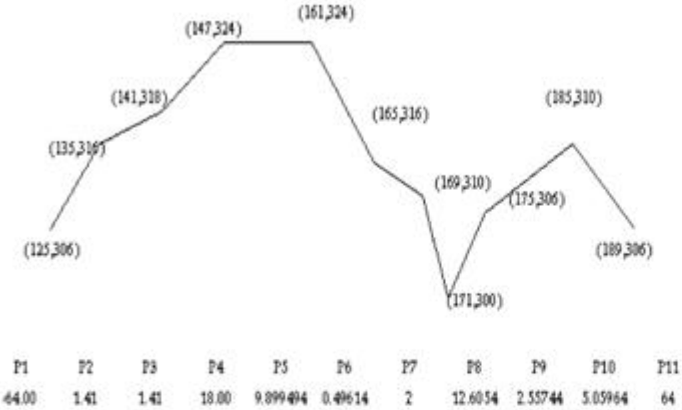

Figure 3: A polyline and the result value array returned by the MDP [4].

The basic idea is to run the generalization procedure as a single background thread. The start of the thread is triggered by a http GET request from a front end unit module to the TRAPServe internal DCU line generalization module. Every time a new gps track point is added, the front end module which receives this data calls the line generalization module by transmitting the related gps track id via http GET. This model makes it possible to transfer those TRAPServe units which have high computation costs to independent hardware units in the future.

3.2 DATABASE

Within this Section the basis for data storage and visualization, the database system of “Kärnten Bewegt”, divided into the database on the web server and the database on the mobile device, and furthermore, the refinement of the database system within the project TRAPS, are described. The database system of “Kärnten Bewegt” is designed to fulfill all specified requirements and on both, the web server and the mobile device, the same database schema is implemented. The saving of GPS tracks and Points-of-Interest (POI) are the main aspects that have to be ensured. Within the current version additional information to tracks and POI are taken together within one table named event. All associated GPS points are taken together within another one called waypoint. Altogether both databases consist of the three tables userdata, event and waypoint.

Aspects, such as user management or the management of different time zones are not considered. Due to the fact that the application is only used by members of the Austrian Alpine Association (OeAV) the necessity for a secure user login or the management of different time zones (Austria is only in one time zone) is not given. Although the system fulfills all requirements, the lack of time during the implementation of “Kärnten Bewegt” prohibited the consideration of aspects such as performance, scalability and multiple user access. Hence the requirements to the new database system within the project TRAPS are that it shall facilitate: a high performance, independent from the amount of data or number of requests; multiple user, so that each user can be linked with its collected tracks and POIs; the use of spatial data on the web server database, to enable the storage of features that are needed for the visualization within the web interface and the storage of data at different Levels of Detail (LoD). The different LoD´s are needed for the visualization on the 3D web map within the web interface. Storing different LoD`s allows the improvement of performance, because at a high scale number a lower LoD is needed, consequently less data have to be transferred from the database to the client for the visualization.

To deal with these requirements the database system of „Kärnten Bewegt“ is redesigned within the project TRAPS. Now the database schema on the web server differs from that on the mobile device. Nevertheless, the basic structure of both is the same. On both, tables such as user, gpstrack, pointofinterest, trackpoint and timezone exist. In contrast to the schema of “Kärnten Bewegt”, multiple users are supported, tracks and POIs are stored independent from each other within the database and different timezones are considered. Especially the timezone handling enables to use the application all over the world. Each time a track or POI is recorded, the corresponding time in GMT+0 is saved. In addition to that the time zone of the mobile device's system time preferences is saved including an additional remark whether the daylight saving time within the used time zone is activated ("true") or not ("false"). For time calculation purposes the difference between the system time zone and GMT+0 in milliseconds is stored, too.

Apart from the similarities both schemata have their own characteristics. The database on the mobile device has an additional table named break . Within this table all breaks made during recording a track are saved. After a track is finished the time of all breaks is summed up and saved within the table gpstrack so that it can be seen how much time the user needed for the track without any breaks. The special characteristic of the database on the web server is that it is enlarged to a Multi Scale Database (MSDB). A MSDB can be described as a combination of several datasets representing objects at different scales within the same theme, very similar to Multi-Representation/Resolution Databases, where objects can be of different themes [7]. For the enlargement the table multirepresenation is added in which tracks are saved in three different resolutions. This enlargement especially supports the performance concerning the web interface, because at high scale number a lower LoD is needed and less data have to be transferred. In case of a request this enables a short waiting time for the user. For the realization of the databases on the web server PostgreSQL [9] with its extension PostGIS [8] is taken. In contrast SQLite is taken on the mobile device [10].

3.3 ANDROID CLIENT

This Section deals with TRAPSmobile, the mobile application of TRacking mAP System. The purpose is to explain the methods for mobile GPS (Global Positioning System) tracking and positioning by using different maps on Android Smartphones. Android [11] is a mobile operating system for Smartphones, Netbooks and other mobile devices, such as tablet computers. TRAPSmobile provides user authentication and multi-lingual usage. Currently, English and German is available. An extended language support is already considered. Furthermore, there is also the possibility for more than one user to authenticate and use the app on the same Smartphone. The application, based on an intuitive data base design in the back, handles the different stored data and knows who is currently logged in and which data belongs to which user. TRAPSmobile comes along with a simple but intelligible user interface and powerful features. The following features are available:

3.3.1 GPS TRACKING WITH CHRONOMETER

The chronometer is the central control element of the tracking client. When the user presses the start button, a dialog for metadata input appears. After information input the chronometer is started together with a track. The Smartphone’s GPS sensor collects one point every minute and stores the data into the local data base. Moreover, a pause/resume/stop function enables an advanced track handling (Figure 4).

Figure 4: TRAPSmobile GPS tracking client with chronometer and information input.

3.3.2 POINT-OF-INTEREST RECORDING

Points-of-Interest represent any significant locations such as buildings, traveler's services, or user-defined waypoints [14]. TRAPSmobile offers an easy to use POI client that works on the same technical principle as the tracking client does. POI can also be recorded during an already running tracking process.

3.3.3 "YOU-ARE-HERE" MAPS

The intention was to expand the information content with the integration of independent two dimensional map interfaces. The services should provide different data sources and map details. So, if the user needs more information about his current location there is the possibility to switch between the given maps. The Google Maps mobile API was the first choice. The Google Maps external library for Android offers built-in downloading, rendering, and caching of Maps tiles, as well as a variety of display options and controls. After importing the library, Google Maps can easily be embedded into the application.

To provide a better positioning service to the user, a second map interface had to be found. The decision was clearly in favour of OpenStreetMap (OSM). Compared to Google Maps or Bing Maps, especially in rural and mountain areas OSM provides more detailed information and may have advantages because of its open data principle. But the user has to know, however, that the represented map information may be inaccurate or even false. OSM became a modern, open-source, reliable and scalable GIS with a light structure [13]. The online "slippy" map is available for everyone.

After some research, the project OSMDroid [12] was found. It is an almost free Android project, under the GNU Lesser General Public and Creative Commons 3.0 License. OSMDroid is still in development, updates and improvements are available every month. OSMDroid consist of a basic library project and the OpenStreetMapView, which is a replacement for Google's MapView class. OSMDroid provides tools with a wide function range. Developers can use and manipulate the entire source code. The overlay and tile catching features are mighty. Nearly every overlay type (e.g. mini map, scale bar) can be realized and other external map sources may be integrated. OSMDroid was the ideal component for the "You-are-Here" map and offers many functions which can be implemented in the future. A special feature of OSMDroid is the possibility to choose between different map sources, (e.g. Mapnik, CloudMade) with various overlays (e.g. public transport, cycle map). An offline mode is also provided. Therefore the map tiles are being saved on an external storage, e.g. a SD memory card. Google Maps provides to switch between satellite and street view.

Both "You-Are-Here" map interfaces display and highlight the current location of the user with a yellow image figure, automatically zoomed and centered to the map (Figure 5). The X/Y coordinates can be represented too. The fact, that the map sources as well as the GPS tracking client are available for world-wide position finding make TRAPSmobile to an all-purpose Location-based Service tool.

Figure 5: Differences between Google Maps and OpenStreetMap in mountain areas.

3.3.4 DATAMANAGER

The DataManager is a service for the logged in user, who can delete the local stored data manually form the SQLite data base. Both track and POI data are displayed in a list and can be selected for deletion.

3.4 WEBPORTAL

The overall aim of „Kärnten Bewegt“ is to allow the real time tracking of hiking groups. Therefore it is necessary to create an interactive map that can be easily accessed and used by anybody. So the decision was to create a web interface containing a map, because then it would be accessible from anywhere, by anybody and without the use of additional software then a browser.

Due to the fact that this project was done for the Austrian Alpine Association there is no user login required. Hence it was necessary to think about dealing with personal data. So it was decided to neither store nor depict personal data in the database or the web interface. All data that a hiking group provides by describing an event is given voluntarily.

As background map the Google Earth browser-plug-in was chosen which is freely available and shows a digital 3-dimensional globe that can be navigated with a mouse. Reasons for the choice were on the one hand that it offers an API (Application Programming Interface) that allows to directly draw into the digital globe in WGS84 coordinates, so no coordinate transformation must be done, and on the other hand that it offers extensive additional information such as satellite imagery from all over the world, a road network, state and administrative borders, a digital elevation model and 3-dimensional buildings. Further its handling can be learned within a couple of minutes and therefore it is expected to be easy to use also for users who are not familiar with computers.

The web interface (Figure 6) was entirely created during summer 2010 by Ermin Muratovic, a pupil of the HTL-Villach (school of informatics), who was doing an internship at CUAS (Carinthia University of Applied Sciences). It is based on standard web technologies such as PHP to get access to the database, and JavaScript to create the page content and to draw tracks in Google Earth.

When the URL geoweb03.cti.ac.at/muratovic/ is requested, the data from the tracking data base and the Google Earth client are loaded. Then a navigation segment is created that lists and sorts the available tracks and points of interest by date. The first step for the user is to choose a date and further click on the track or point of interest he wants to see. Then the chosen track is drawn and zoomed on in Google Earth. Additionally it provides a height-profile and some statistical facts such as duration, length, height-difference and information that the user recorded when describing the track. Finally it allows the user to fly along the track from a bird’s eye perspective.

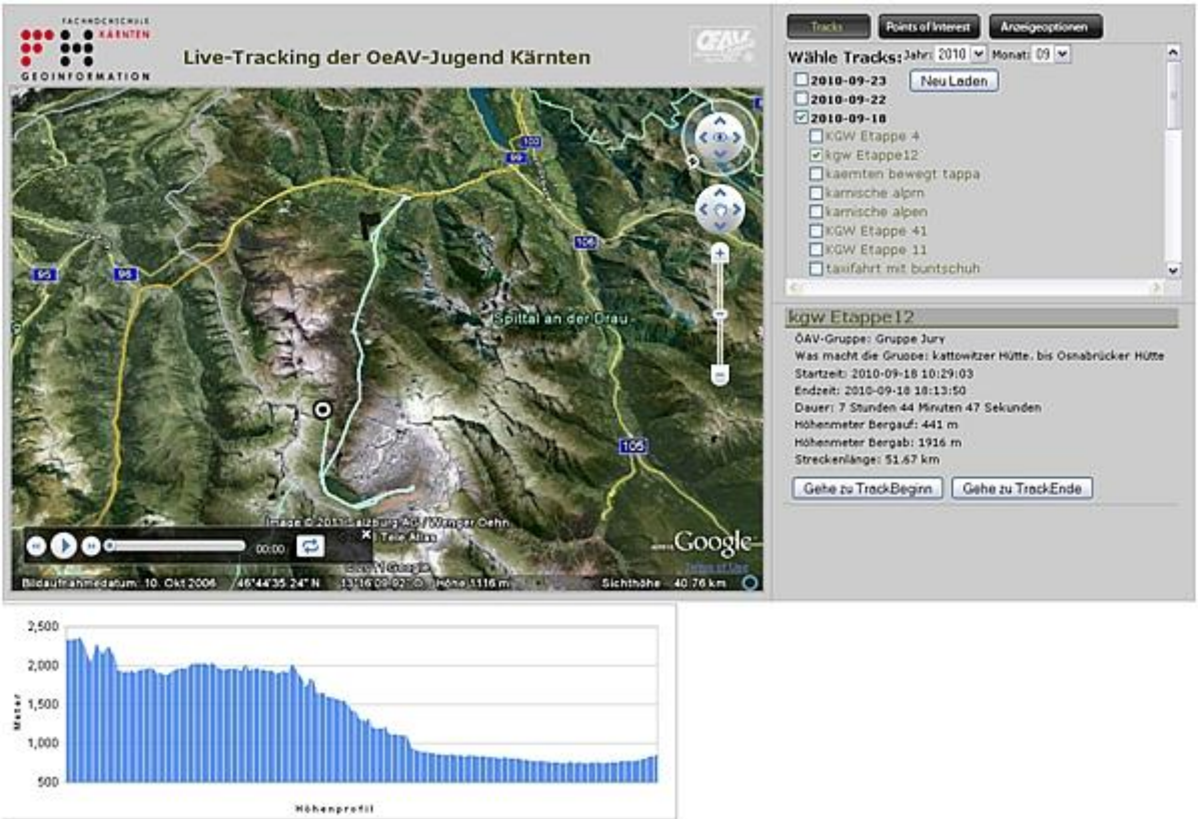

Figure 6: A screenshot of the Kärnten Bewegt web interface. The main window shows the GoogleEarth background with the selected track in light green. The black flag indicates the end of the track and the black and white point indicates the start. At the top of the right side the user can select the tracks to be shown in the map. Beneath the additional information and statistical facts about the track can be seen. At the bottom of the page a height profile is shown.

The data of tracks and points of interest is loaded when the user selects the year and month of which he wants to see the tracks. This allows the user to show and hide tracks without further data transmission. But this loading in advance does also have a big disadvantage; the more data is in the data base the longer it takes to load it which forces the user to wait until the loading is done. This problem was faced during the winter semester 2010 where a new version of the tracking system called TRAPS (Tracking mAP System) was created. The web interface was changed in a way that data is loaded asynchrony to the creation of the site using AJAX technology. So the data of a track is loaded just when it is required to be drawn. This reduced the loading time of the site from about 20 to usually less than 5 seconds and reloading a track requires less than a second.

4 CONCLUSION AND OUTLOOK

In the planning phase there was of course a risk that the complete project could fail because it would not be finished in time. But at the end it shows that the lectures right assessment about the skills and motivation of the students. The Bachelor Class of 2008, Geoinformation was able to realize cartographical products for the project "Kärnten bewegt". In cooperation with the Austrian Alpine Association (OeAV) and Mister Birsak from Ed. Hölzel Publisher Vienna it was possible to create:

- a Synoptic Table of the whole "Kärntner Grenzweg" (size: 2x1m)
- two Stage Tables (32. and 33. stage, size: 120x80cm)
- a Folder (size: 14,8x7cm, opened: DIN A3)
- a Postcard for a lottery (size: DIN A6)

Beside the cartographic products the students completely implemented an online tracking system based on Android on time. That was only possible by motivated students which spend a lot of free time in that project. Only the weather at the 18th and 19th September 2010 upset our plans. Due to heavy weather only some tracks could be capture. But in future the complete trail will be captured. The main conclusion is that it was really worth to integrate an interesting project into the lectures. The advantage for the lecturer is the high motivation of the students and the students themselves had the industrial experience to develop a complex software system.

Due to this success the project was further developed in the winter term 2010/2011 bachelor project and called TRAPS. The system is now more scalable and adaptable as described in the paper. Future work has to include usability research related to the chosen levels of detail considering cartographic aspects of visualization. Furthermore, upcoming versions of TRAPS will implement a URI accessible web feature service module of TRAPServe that provides LOD-related geometry data.

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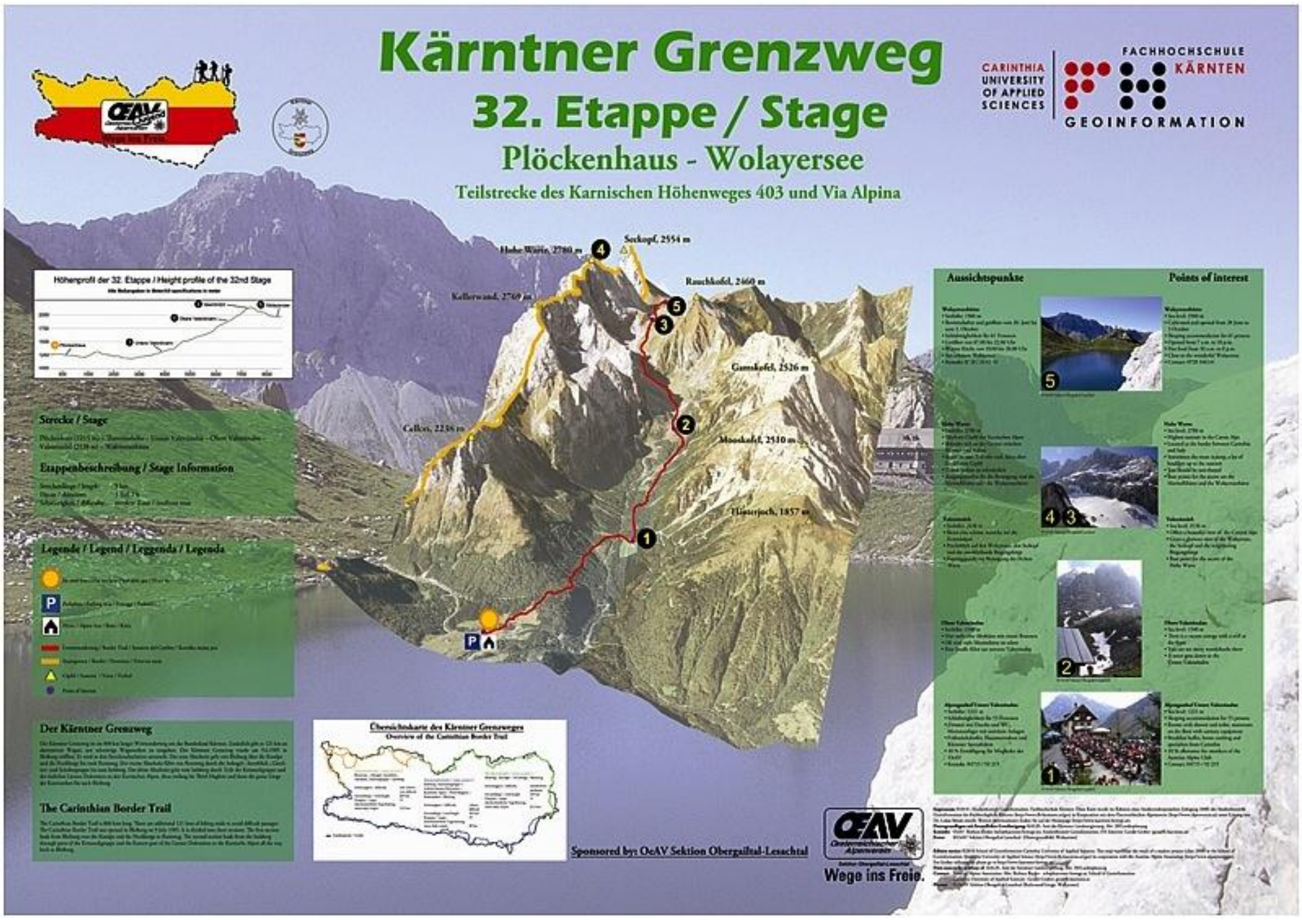
APPENDIX MAPS

Synoptic Table

Stage Table 32



Stage Table 33

The Back of the Folder

The Back of the Postcard

Der Kärntner Grenzweg (KGW) wurde am 9.6.1985 in Bleiburg eröffnet.
Carinthian Border Trail (KGW) was opened on 09-06-1985 in Bleiburg.

Länge des Weges: *(length of path)*	**812 km**	**Höhenmeter des Weges:** *(altitude difference of path)*	**42 800 m**
Länge im Schnitt je Etappe: *(length of path / average per stage)*	**18 km**	**Höhenmeter im Schnitt je Etappe:** *(altitude difference / average per stage)*	**950 m**
Etappenanzahl des Weges: *(number of stages)*	**45**	**Gehzeiten im Schnitt je Etappe:** *(walking times / average per stage)*	**6: 40 h**

EVENT

18. September 2010

45 Jugendgruppen des OeAV Kärnten begehen den Kärntner Grenzweg zu Fuß, per Mountainbike oder per Pferd. Der gesamte Wanderweg wird dabei in 45 Etappen unterteilt, jede der OeAV-Jugendgruppen bezwingt dabei eine Etappe.
15 Sektionen des OeAV Kärnten sind an der Aktion beteiligt.
(45 youth groups of the OeAV are celebrating the „Kärntner Grenzweg" on foot, by bike or on horseback. The entire trail is subdivided into 45 sections, each of the OeAV youth groups finishes one stage. 15 sections of the Carinthian OeAV are involved in the action.)

19. September 2010

Ganztägiges Treffen aller 45 Jugendgruppen in Kötschach-Mauthen ab 10.00 Uhr, großes Abschlussevent mit Rahmenprogramm.
(All-day meeting of all 45 youth groups in Kötschach-Mauthen 10.00 clock, final event includes entertainment.)

Karten werden im Zuge der „Kärntner Grenzweg" – Präsentation in Kötschach Mauthen mit dem Luftballon verschickt.
(During the "Kärntner Grenzweg" - presentation in Kötschach-Mauthen; postcards will be distributed with balloon.)

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