The software behind the interactive display of the Swiss avalanche bulletin

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ABSTRACT: The step towards interactively displaying the avalanche bulletins twice a day in four languages raised the need for specifically designed software tools to support the avalanche forecasters in their daily work of producing the avalanche bulletin and make them publicly accessible. Due to the various forms of visualization and location specific bulletins, the final products (printed reports, interactive web-pages, interactive mobile applications) cannot be produced manually. Data entry graphical user interfaces are required to provide the avalanche forecasters with a platform to define and describe the current situation and store the abstracted data into a database. Based on this abstracted data, other software tools will then produce the intermediate (maps, web-page fragments, text blocks) and final products. Finally, web technology and mobile applications present the generated avalanche bulletin in an interactive form to the end user. We present a technical insight into the specifically developed software required to generate and publish the avalanche bulletin, starting with the data entry and ending with the visualization of the final products to the end user.

KEYWORDS: avalanche forecasting, software tools, avalanche bulletin, mobile applications

1 INTRODUCTION

The introduction of the new avalanche bulletin changed the way of communicating avalanche dangers in Switzerland completely (Winkler, 2012). Before, the avalanche bulletin was a summary of different static documents consisting of specific text and specific images. Specifically, it was mainly a text based national avalanche report, a static danger map for the whole of Switzerland and regional reports for seven different regions of Switzerland (Russi et al., 1998). Were the national product was provided in four languages (German, French, Italian and English), the regional products were only monolingual, either in German or French. In order to generate these products, each of them needed manual operations by the avalanche forecasters.

The new avalanche bulletin represents more an interactive way of communicating avalanche danger. The same content is used in a dynamic (interactive bulletin) and a great many of different static products (e.g. region specific printouts). In the new bulletin, there is a dynamic map, which visualizes the different danger areas and allows the user to interactively select an area of interest to get the related danger description. But besides all advantages of an interactive bulletin, static documents are still needed for print outs. Depending on the number of defined danger areas, there can be more than two hundred static products per bulletin (per danger area, in color and black-and-white and all in German, French, Italian and English). Based on abstracted source information, software tools take over the job of generating all final products. Obviously, with this amount of products the avalanche forecasters cannot handle every product manually anymore. Therefore, the software tools changed from a product centered approach, in which every final product needed interaction by the avalanche forecasters, to an approach, where they define the actual avalanche danger in a more abstracted way.

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2 SYSTEM ARCHITECTURE OVERVIEW

To provide the interactive avalanche bulletin, a system was created composed of several specifically developed software tools (Figure 1).

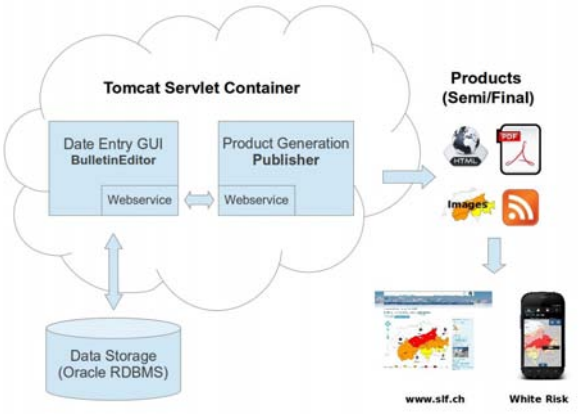

Figure 1. Architecture of the software system used to create the new Swiss avalanche bulletin

A relational database management system (RDBMS) marks the central point of the whole system, where all the information defining the avalanche danger situation is stored in an abstracted form. A data entry graphical user interface (BulletinEditor) was developed in form of a Java web application in order to provide the avalanche forecasters with a tool to enter the current avalanche danger situation into the RDBMS. A second web application (Publisher) takes over the part of generating all necessary semi and final products based on the source data stored in the RDBMS.

In order to visualize the avalanche bulletin to the end user, an interactive web page was developed based on JavaScript technology. This web page manages the presentation of the several hundred semi products and presents them in an interactive way.

3 DATA ENTRY

Because the data are stored in an abstracted format in the central RDBMS, we need to provide the avalanche forecasters with a graphical user interface (GUI) to enter the actual avalanche danger definitions into the central data storage. This data entry GUI (BulletinEditor) was implemented as a Java based web application depending on frameworks like Hibernate, Spring and JSF (Figure 2).

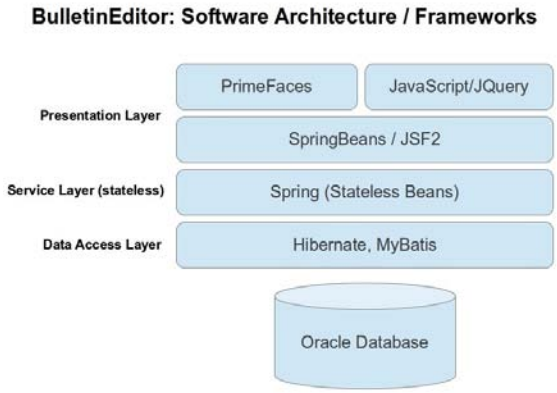

Figure 2. Software architecture of the BulletinEditor

The BulletinEditor also supports the avalanche forecasters in defining a structured working process. The following paragraphs describe the necessary steps to enter all information required for a complete avalanche bulletin.

3.1 Danger areas

There is a graphical representation of Switzerland inside the BulletinEditor subdivided into 124 subareas (as of winter 2012-13), in which the avalanche forecasters define variable danger areas. In a danger area, avalanche danger level, aspect, elevation range and danger description are all the same. The number of areas is technically not limited, however in winter 2012-13 a maximum of six areas was used by the forecasters. A hierarchical tree of subareas, subregions and regions simplifies the process of defining the areas. In a first step the forecasters have to specify danger level, aspect and elevation range, before they can enter the related danger descriptions in a second step.

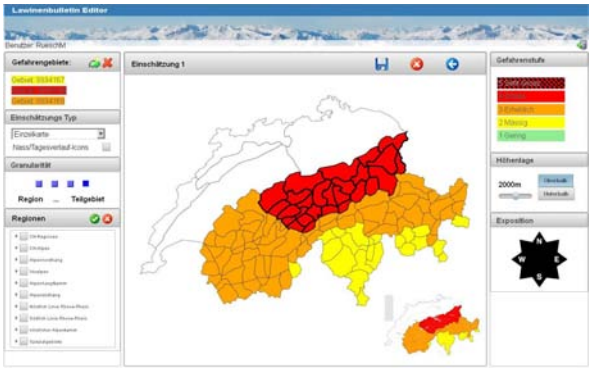

Figure 2. BulletinEditor: GUI to define the danger areas.

3.2 Danger descriptions

The danger description for each area consists of one or multiple danger patterns plus a textual description of the current avalanche danger within a area. The text describes the main danger and can additionally include other parts such as a description of an additional danger or specific information only visible to local safety services. The specialty about the danger description is, that it is not freely written text but chosen from a catalogue of standard phrases. The individual sentences are not static but consist of a succession of up to ten segments. In each segment of the phrase, the forecasters can select from a pull-down menu of predetermined options for a segment. These options can likewise consist of a series of sub-segments with selectable options, and as part of the sub-segments even sub-sub-segments are possible. Based on these phrases a fully automated real-time translation system has been developed (Winkler et al., 2013).

A search engine as a module within the editor was developed to allow the avalanche forecasters to easily retrieve the matching standard phrases out of the catalogue. Furthermore, it allows them to configure the sub-segments as well as to easily arrange the order of the different chosen sentences. The search engine loads the phrase catalogue only once during initialization and subsequently works without interaction with the RDBMS. This approach was crucial for reaching the necessary performance. The search engine works with a full text search. A keyword search is also implemented but currently not used within the used catalogue. Sub-segment options, which are included in the search string are automatically either marked within the result set or directly selected if the search string limits the result set to only one possible option (Figure 3). This sophisticated search engine makes it possible for the avalanche forecasters to create the danger descriptions within the limited time frame.

Another key-feature is a copy/paste mechanism, which allows the copying of existing descriptions of the same or the most recent bulletins on different levels (complete danger description of an area, part of a description or a single sentence) and use them as a base for the upcoming bulletin. Especially in case of an unchanging avalanche danger this feature speeds up the creation of the avalanche bulletin significantly.

3.3 Map editor

The map editor module within the BulletinEditor renders the map representing the current avalanche situation. The map itself is generated by a specifically developed Java library called gisTools (Stoffel and Niederer, 2013) and is provided as a scalar vector graphic

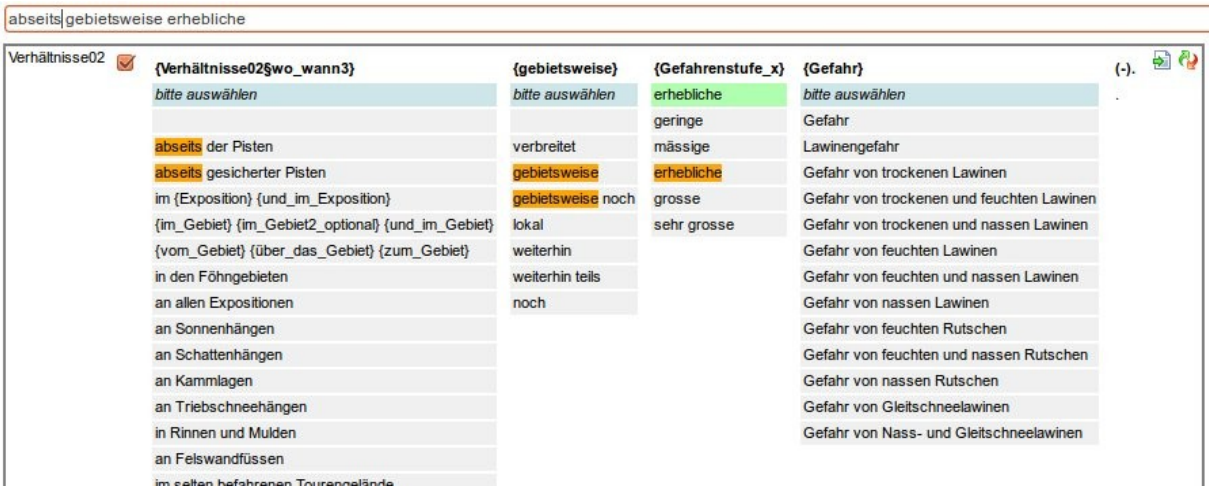

Figure 3. Search engine module to retrieve a sentence out of the catalogue of phrases.

(SVG). The map editor then allows to position plots on the map, which are representing the aspect and the elevation range. Moreover, one can draw lines to connect the plots to the according areas. The configuration of the danger map is stored in an Extensible Markup Language (XML) format representing the position of the plots and lines on the map in Swiss coordinates.

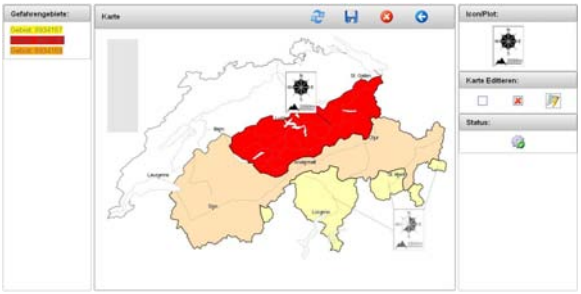

Figure 4. Map editor module to place danger plots and connection lines.

3.4 Textual editor

Parts of the new avalanche bulletin are still freely written text passages instead of catalogue based ones. This includes the snow cover and weather report as well as avalanche bulletins written off-season (summer bulletin), where there is only a written report without any graphical products.

Although the textual editor module allows entering freely written text, it still enforces a certain structure of predefined paragraphs. Additionally, one can define listings and sub-paragraphs within the predefined main paragraphs.

Because this part of the bulletin is not based on a catalogue it needs to be translated manually and is therefore only done once a day for the evening issue. The BulletinEditor has a function to send the German text with just one click to the translators. Every single translation returned is easily imported back into the database. The imported translation delivered by the translators is proof-read by the forecasters and can be changed if needed.

3.5 Initiation of the product generation

The BulletinEditor has an interface to the Publisher to generate all semi and final products needed to visualize the avalanche bulletin for the end user. There is the option of generating only certain groups of products or all products for which the underlying source data has been entered completely. The generation and the publishing of the final products is a two-step process. Firstly, the generation of the products is initiated and the products are placed on a verification system. The avalanche forecasters then have the possibility to verify the products. Due to a lack of time and as the technical systems proofed to work highly reliable, this proof-read is not done anymore in operational service. Secondly, after this optional verification, the content of the verification system is copied to the productive servers.

4 DATA STORAGE

The complete avalanche bulletin is stored in an RDBMS as abstracted data. Compared to the old avalanche bulletin, no text documents or other proprietary file formats are used to store information any longer. Even all the geographic data are available in the database. The approach of a central data storage also allows easier data analysis and statistical evaluations of the avalanche bulletins.

5 PRODUCT GENERATION

To visualize the new Swiss avalanche bulletin in an interactive way on the web and on mobile applications, there are hundreds of semi products (text-fragments, images etc.) necessary. Additionally, there are over one hundred static products used for printouts. All of these semi and final products are built automatically by the specifically developed Java based web application called Publisher. In order to build a product, the Publisher receives the data through a web-service interface from the BulletinEditor. Then, it processes the data in a sequential chain of predefined tasks. Each task performs a single piece of work, e.g. rasterizing vector graphics into raster graphics, transforming data from an XML format into HyperText Markup Language (HTML) by Extensible Stylesheet Language Transformations (XSLT), creating PDF documents by using XSL-Formating Objects (XSL-FO) or doing simple file operations such as copying, moving or deleting.

Another frequently used task is rendering abstracted geographical information into a map in the format of a scalar vector graphic (SVG). This transformation is done by an in-house

developed Java based library called gisTools. The library contains the logic to produce all map varieties needed in the avalanche bulletin and to create the image fragments used by the interactive versions of the avalanche bulletin. The SVG are mostly rasterized before they are delivered to the end user. Only in that way we are in control of the rasterization process to ensure an identical presentation to the end user.

Even though the Publisher performs mainly batch processing of tasks, it has a web interface to observe the progress of the initiated tasks and to verify their error-free completion. In case of an error, each task can be restarted by the forecasters directly from the web interface.

6 DISTRIBUTION AND VISUALIZATION

There are three main channels to communicate the avalanche bulletin to the end user. The most commonly used are the web page with the interactive avalanche bulletin integrated into the SLF website and the app “White Risk” for mobile devices. Over one hundred thousand app downloads underline the raising importance of this communication channel. As a third channel different versions of print products are available for download on the SLF website. Beside these three main communication channels, the avalanche bulletin is announced by RSS-Feed, distributed in custom specific formats to medias, newspapers, authorities responsible for natural hazards, tourism and rescue organizations to name just a few.

6.1 SLF website

The SLF website is one of the main communication channels for the present avalanche situation. The avalanche danger is shown on an interactive map of Switzerland with three fixed zoom levels and an overlay of the defined danger areas and their corresponding danger plots. By clicking on a area the according danger descriptions for this area appears in a pop-up window (Figure 5).

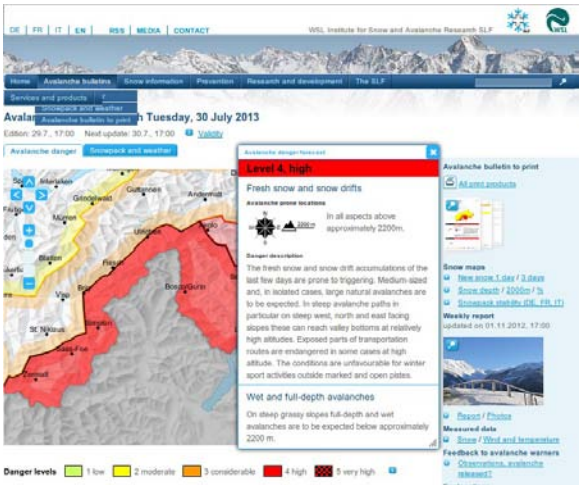

Figure 5. SLF-Webpage with interactive avalanche bulletin.

For performance reasons, the interactive map is implemented with JavaScript technology rather than using a map server. With this approach the client resources are used to control the user interactions on the map, instead of server side resources. With this, large amounts of parallel hits on the web page can be handled without performance loss. First the Publisher tool needs to prepare different semi products in form of image segments, which show parts of the interactive map (e.g. shape of an area, plots, lines. Figure 6). The JavaScript implementation then controls the visibility of the different segments and provides a highly responsive interactive map visualizing the current avalanche situation.

The web page containing the interactive map was accessed a few million times during the winter season 2012-13.

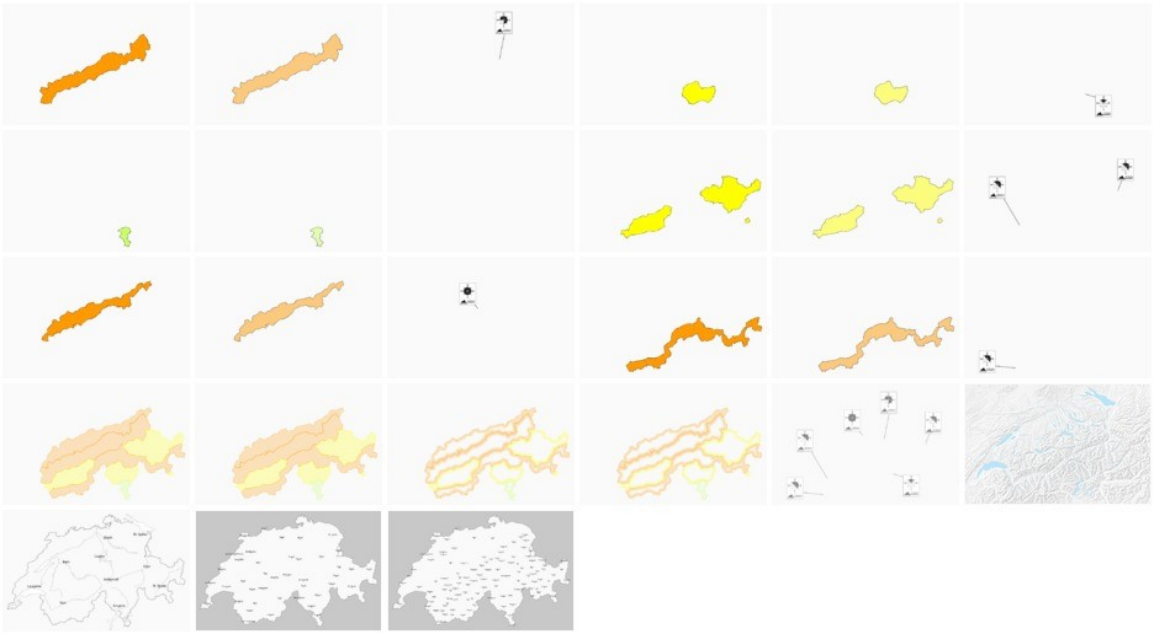

Figure 6. Individual parts of the interactive avalanche danger map.

6.2 Mobile application "White Risk"

To allow a proper visualization on mobile devices, the mobile application "White Risk" has been developed for Android and iOS (Figure 7).

Figure 7. Mobile Application "White Risk" for iOS.

These mobile apps access the latest available avalanche information in form of a file bundle built by the Publisher. The mobile device only downloads the file bundle from a public server if it is more recent than the one currently located on the device. The file bundle contains fragments of web pages and image segments representing parts of the interactive avalanche map. The mobile application natively implements a similar logic to the JavaScript implementation used on the web page and thus optimizes the interactive danger map for mobile devices. Making use of the GPS antenna in smartphones, the end user is presented with his location on the interactive danger map (only iOS so far). All other information contained in the avalanche bulletin is also optimized for mobile devices.

7 BRINGING INTO SERVICE

The operational start of a complex software system is always a critical moment. Dealing with avalanche bulletins made things even more challenging and a fallback was almost impossible because:

- The avalanche bulletin is a safety-relevant warning. Thus, the availability and accuracy must be guaranteed from the first day on.
- The new avalanche bulletin can only be visualized by a new version of the mobile app "White Risk". But the new mobile app cannot visualize the old avalanche bulletin anymore, so after the release there was no way back.

- Many partner organizations had to adapt their infrastructure to the new bulletin.
- The start of the operational service during high season in winter was not an option, but rather had to take place at the very beginning of winter and depended on the avalanche situation.
- At the same time as the new software was introduced, the avalanche forecasters had to adapt their working process significantly.

Finally, the first new avalanche bulletin was published in text form (summer bulletin) on 26 November 2012. As the avalanche danger escalated to level four just on the following day, the first complete avalanche bulletin including an interactive danger map and using the phrase catalogue was issued.

The operational start of the new software system proceeded without any problems worth mentioning. One reason is, that parts of the new software system were already used in the last years for the old avalanche bulletin and then were adapted to the new bulletin. This way we already had operational experience with some portion of the new software and the forecasters got partly used to the new software tools. Still, on the day of the operational start, many new modules were used for the first time.

The slightly decreased number of incidents when the internal on-call service was used during winter 2012-13 shows that the new system is already running stably and reliably in the first season.

8 CONCLUSIONS

- The use of a central data storage and an automatic product generation has been proven successful.
- The performance of the server used for visualization proofed to be sufficient even in peak times. We were only able to handle the heavy load with just a slim and economic server system by outsourcing the computation power to the client browser.
- It was very important to involve end user groups at an early stage. Thus, the new avalanche bulletin was very positively received by them.
- The technical reliability as well as the usability of the software system were convincing and could only be reached by a close cooperation between system engineers and avalanche forecasters.
- The approach of using some of the new software tools for the old bulletin and to adapt them in a second step for the new bulletin increased the short term work load, but in the end it was a crucial element to a trouble-free start of the new avalanche bulletin.

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