



ROAD WEATHER INFORMATION SYSTEMS (RWIS) IN SLOVENIA

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Abstract

A few years ago, Slovenian motorways were equipped with dozens of Road Meteorological Stations differing in age, installed sensors and manufacturers. Only few stations were locally integrated and others not. Therefore, at that time the road maintenance relied on a relatively small amount of weather data. Subsequently, a decision was made to include all weather stations and create an integrated and comprehensive Road Weather Information System. It was a challenge to create services that support different protocols, establish a unique data model and database and set up a web-based application supporting the final user and diverse road maintenance activities. The system consists of three main parts:

Collection – services for collecting data from different weather stations and their conversion into the appropriate form for the input to the central system.

Evaluation and processing – a service for evaluating the data against different thresholds and alarm conditions, the input of data into the central database, informing the contractors about the triggered alarms.

Presentation – a web-based application for reviewing the data (current and past weather data, detailed previews with charts, previews of weather stations equipment and its condition, system administration and tools for statistical forecasts and data exchange).

For general users, the most important information is shown on electronic information boards. Therefore, the GeoRSS syndication was developed, which includes the current weather data and alarm situations.

Keywords: road weather information system (RWIS), road weather station (RWS), winter maintenance decision support system (MDSS)

1 Introduction

Road Weather Stations have been utilized to assist Traffic Management Services in Slovenia for many years. The need for this assistance is particularly pronounced in winter time since Slovenia is located in a meteorologically diverse territory between the western Alps, northern Adriatic and Pannonian Plain. With a growing number of RW stations, their integration into a comprehensive road weather information system (RWIS) became inevitable. Management and maintenance of the road network in Slovenia is divided between the Slovenian Roads Agency (DRSC), primarily responsible for main and regional roads, and the Motorway Company in the Republic of Slovenia (DARS), responsible for motorways. Each of the two has its own network of RW stations, installed on representative road sections or constructions.

Owing to a gradual and long-term network construction process, the RWIS systems of both road management companies differs substantially in their age, installed sensors, manufactu-

ers and other characteristics. The Slovenian Roads Agency was the first organization to begin the integration, followed shortly by the Motorway Company in the Republic of Slovenia. For this particular reason, we have now two partly different systems that are likely to be integrated in a comprehensive RWIS in the future. Nevertheless, due to many similar characteristics, the functionality of the two systems can now be described as a uniform and comprehensive system.



Figure 1 Winter conditions on a highway. [Source: cgs plus d.o.o.]

2 System Architecture

The system architecture is divided into three parts performing three main functions of the system.

The first part consists of modules in the form of Windows services intended for data collection from individual basic (Black Box) systems, and basic inspection and adjustment of the data to a uniform standard. Only after this procedure the weather data is forwarded to the second part of the system – the Data Collection Web Service.

The second, central part of the system consists of a Data Collection Web Service, which enables independent execution of the procedures for inputting the data into a database.

At the data input stage, the system performs verifications of logical conditions to establish accuracy of the measurements and conditions for triggering warnings and alarms. After the verification, all the necessary entries in the relational database tables are performed. At the same time, the contractors are informed by email and SMS about the measurement errors and triggered alarms.

The function of the third part of the system is to present the data to all users of the RWIS. The data is available through the RWIS web site application and RSS notifications. The web application enables the display of data and complete control over the systems operation. It

is possible to add new road weather stations, to add and modify the installed sensors and to set other parameters such as the conditions of alarms, types of measurements recorded, classification of measurements, conditions for informing the contractors, etc.

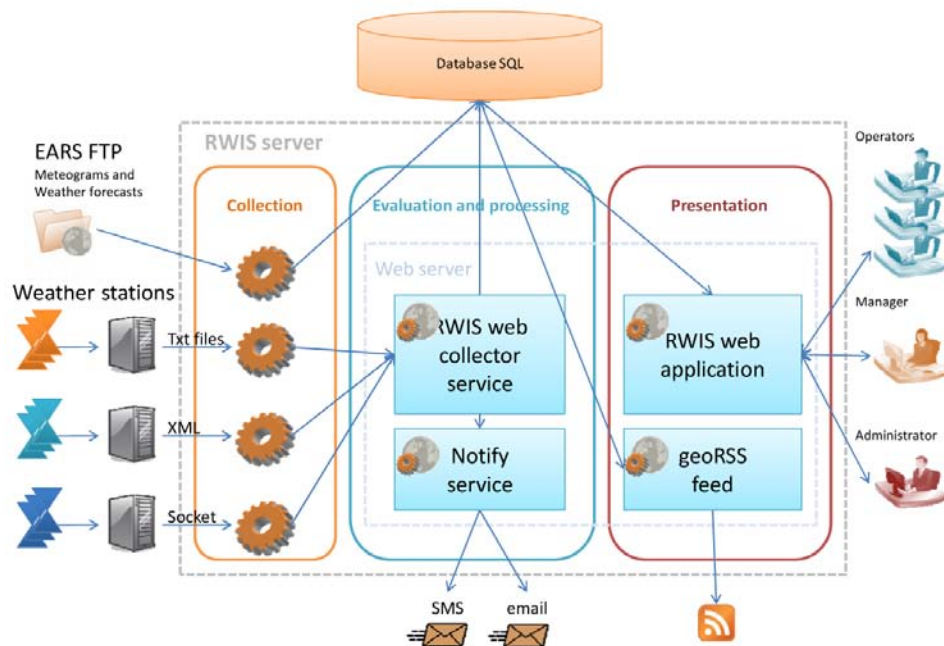


Figure 2 RWIS Windows Services. [Source: cgs plus d.o.o.]

2.1 Data Collection – Windows Service Part

RW stations of different manufacturers differ in the measurement data formats (txt files, web XML services, socket listener, FTP, etc.). For the purpose of the data input to a uniform system it was necessary to develop different services that access the data in the basic system, verify the data, and forward the data to the RWIS web collector service.

A special emphasis is placed on the verification, unification and conversion of individual types of data into a form that enables comparison and gives a uniform view of the weather situation.

Table 1 An example of conversion station data to a unique standard.

Measurement	Original value	Insert to RWIS
Wind velocity	km/h	m/s
Wind direction	N, NE, E, ...	0, 45, 90, ...
Weather condition	Precipitation type	SYNOP
	Precipitation intensity	

In addition to the services for data collection from RWS, special services for graphic and textual weather forecasting were developed.

2.2 Database Server

The central part of RWIS is a database server where all data from station sensors are directed. The relational database is organized in the MS SQL Server 2005 environment and it comprises all data about the weather stations, sensor types, maintenance, alarms, etc. Most tables in the data model are used for the dynamic implementation of applications, while the most extensive tables are those containing the weather data.

The administrative section contains all data about a RW station, e.g. the producer, type of weather station, year of installation, location, mileage of traffic sections, installed sensors, types of sensors, last calibration, etc.

In the weather data section, all data from the measuring network are recorded and stored at between 3 and 10 minute intervals. Different types of data are recorded: data on air temperature, road surface temperature, temperature at 5 and 30 centimetres under the road surface, humidity, visibility, salinity, road condition, weather conditions and other data gathered by the installed sensors.

2.3 RWIS Web Server

The web part of the RWIS is designed on Microsoft web server (IIS) in Microsoft.NET framework 3.5 technology.

2.4 Data Collection – Web Part

The web service enables independent data collection by the RWIS. An individual windows service forwards the collected data from RWS to a web service, which verifies logical conditions upon the entry of data:

- Boundary values of measurements (minimum, maximum) – to detect rough errors.
- Warning and alarm values – for alarm triggering.

3 RWIS Application

The web application is designed to allow for role-based access control. There are several groups of users:

- User can access the current weather information, weather forecasts and the archive.
- Manager has a broader access, also to various types of reports, RWS metadata, data on the installed sensors, data on maintenance, and permission to import or export different data.
- Administrator can, in addition to the above described permissions, manage the whole administration of users, measurements, sensors, etc.

3.1 End User's View

The basic part of the application is intended for the AC database users, who monitor conditions on their specific road section, neighbouring sections or across the country. The basic user window gives numeric data relating to temperature, humidity, wind gusts, weather and road conditions, and also the overview of all active and confirmed alarms. In periods of dynamic weather, it is particularly important that a user can access all key information in one place.

A click on an individual RW station activates a detailed view of current measurements and a linear diagram of measurements over a period of time. The current data are displayed on the left side of the screen. In the centre there is a collection diagram with data for the last 24, 12, 6 or 3 hours. The size of measurement units is adjusted automatically. On the left uppermost side of the user's window, the newly triggered alarms are displayed. After confirmation, they

move lower, under the history of switched and confirmed alarms. Under the diagram, it is possible to monitor weather and road conditions for the whole period. Above the diagram, the alarms about the beginning and the end of various conditions such as slippery ice, wind, and visibility are displayed.

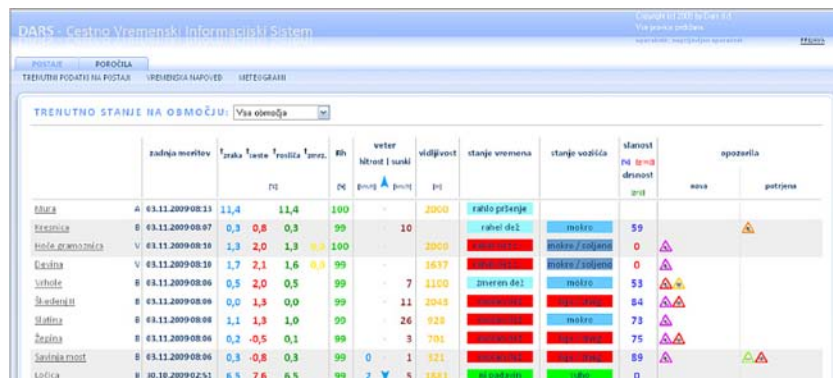


Figure 3 Basic user window with the current data on weather at a specified road section. [Source: DARS d.d. - RWIS]



Figure 4 Detailed overview of events at a chosen Road Weather Station. [Source: DARS d.d. - RWIS]

In addition to the graphical display of data, it is possible to view a table with all data recorded in any chosen period in the past.

3.2 Operator's View

To enable reliable operation of the system, it is important to monitor the installed equipment. In addition to the data overview tool, the operator of the RWIS has tools for the inspection and maintenance works, check the calibration validity and perform other interventions on the installed equipment. Picture A gives an example of the information provided by three sensors

for a chosen weather station. The first sensor on the picture could be forwarding incorrect data and has to be calibrated. The second sensor is at the end of its operational lifetime and will have to be replaced within a month. The third sensor operates correctly, there are no interventions scheduled.

Also available are tools for: process management, control of records, and editing lists.

3.3 Administrator's View

The system administrator has permission to use additional tools for comprehensive system management. There are tools available for adding new RW stations; RWS management; measurement selection management; selection of parameters of data display, lists display, and classification tables display. One of the most important tools is the alarm management tool. It enables alarm categories to be set, the conditions for alarms to be triggered, the form of alarm display and the lists of contractors to be informed.

3.4 Weather Forecast Integration

Besides the current road weather data obtained from the weather stations owned by an individual road manager (DRSC or DARS) there is also a specialized weather forecast, provided by the national meteorological service within the Environmental Agency of the Republic of Slovenia. For central Slovenia (Ljubljana) there is a 10-day weather forecast, while for other regions (other 20 towns), detailed forecasts are made for a period of 48 hours in advance.

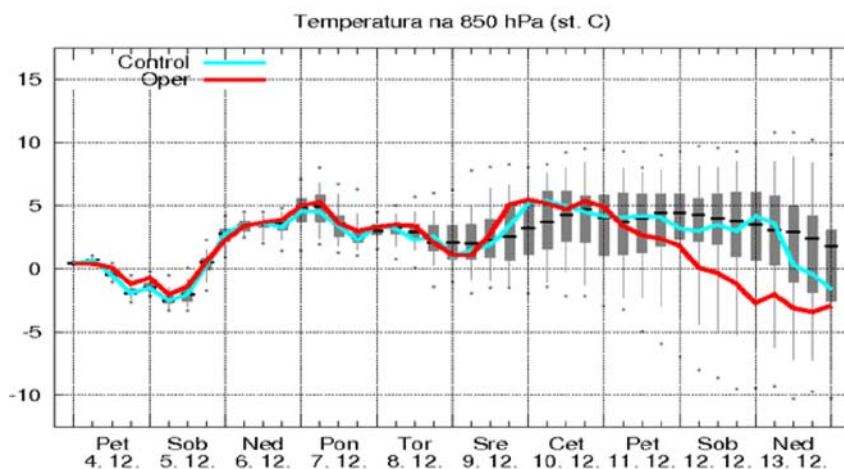


Figure 5 Example of a 10 day weather forecast for temperatures in central Slovenia. [Source: ARSO]

3.5 Cooperation with Other Users

The RWIS data service called GeoRSS was developed to facilitate the cooperation with other systems within the Motorway Company in the Republic of Slovenia. The service forwards the data on a given geolocation to the users. The basic structure of the GeoRSS server was extended with more detailed current data and active alarms for the purpose of obtaining detailed weather data information on road information boards, GIS intranet sites and other public applications.

4 Conclusions and Future Improvements of the System

The established RWIS has improvements in storing, maintenance and accessing the RW data from the central database. Now it is possible to view different data that come from the RW stations in a unique and standardized form.

Next winter, further progress will be made, namely the modelling weather forecasts, integration with supervisory control and data acquisition system - Scada. Moreover, it has been planned to integrate an additional module for the visualization of GIS data.

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