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ITS-capable road weather station

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ABSTRACT

In this paper we present FMI (Finnish Meteorological Institute) approach to employ the combined Road Weather Station (RWS)/Road Side Unit (RSU) for supporting variety of research projects and initiatives related to vehicular networking and road weather service. The general idea in each of these projects is to develop and deploy "Road Weather Testbeds" with advanced communication applications in the interesting environments to test wireless networks and communications in public. In order to fulfil these tasks, FMI has constructed a special RWS to the Northern Finland, nearby its facilities in Sodankylä. The station is equipped with up-to-date road weather measurement instrumentation, compatible (but not limited to) with the equipment expected to be available also in the demonstration sites own, permanent and locally owned RWSs. The procedure is to design, develop and test both the local road weather service generation and the service data delivery between RWS and vehicles.

Keywords: Road weather station, vehicular networking, IEEE 802.11p.

1 INTRODUCTION

FMI combined RWS/ RSU in Sodankylä has been established to serve variety of research projects and initiatives related to vehicular networking and road weather service. The main projects currently ongoing in this sector are Celtic Plus project CoMoSeF, EU FP7 project FOTsis, Interreg project Intelligent Road, and NPP project SNAPS, respectively. The general idea in each of these projects is to develop and deploy "Road Weather Testbeds" with advanced communication applications in the interesting environments to test wireless networks and communications in public. The station is equipped with up-to-date road weather measurement instrumentation, with the wireless networking capabilities allowing data exchange with bypassing vehicles. The objective is to create and test both wireless vehicular networking and services tailored for this specific system. The aim is not only to service vehicles, but also exploit vehicle-originated data to enhance the very same services. Similarly, road-side units are not just serving the vehicles as connectivity point, but also host RWS capabilities to provide additional data for the services. In some cases, it may even be more important to have RWS capabilities, while compromising the wireless vehicular communications.

2 COMMUNICATION SYSTEMS

In the communication perspective the focus is on vehicle-to-vehicle (V2V) and vehicle-to-infrastructure (V2I) communication, and their combination, respectively. The underlying communication architecture has been developed earlier in the FMI [3]. In the RWS the focus is on V2I communication. The general view of the communication system is presented in the Figure 1. The vehicle bypassing the combined Road Weather Station and Road Side Unit (RWS/RSU) is supplemented wirelessly and automatically with up-to-date road weather related data and services, and at the same time possible vehicle-oriented measurement data is delivered upwards. IEEE 802.11p is the primary communication protocol, but also the traditional Wi-Fi communication is supported. The RWS/RSU is linked with IEEE 802.11p for communication attempting, but it has also internal Wi-Fi modem, and both of these communication channels are actively seeking the bypassing vehicle communication systems. The local server is also gathering measurement data from two different measurement entities, Vaisala

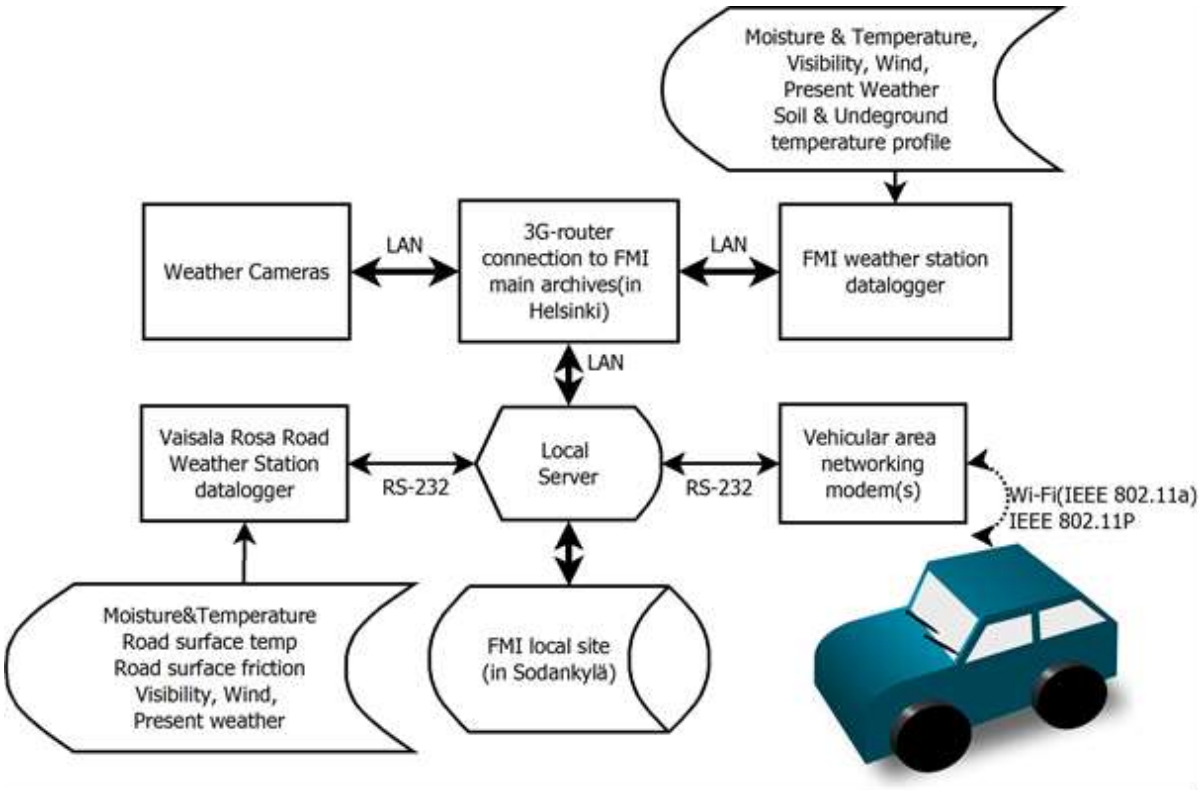

Figure 1. Communication entity of RWS/RSU.

Rosa road weather measurement system and FMI weather station measurements, respectively. The data from these sources, together with possible vehicle-oriented data is sorted and further delivered to FMI local facilities through 3G communication link. The advanced services are developed in FMI facilities and delivered back to the RWS/RSU, to be further delivered to vehicles. The same software entity maintains the data delivery between RWS and vehicles and RWS and FMI site, while gathering and updating the local weather data of RWS/RSU. More details about the RWS operation and services are presented in [2], and more detailed information about the weather services in [1], respectively

3 RWS SERVICES

The services provided to vehicles are two kinds, purely measurement data oriented and data analysis based. The measurement data provided to vehicle consists of friction, temperature (road surface and air), wind (speed and direction), road frost depth and visibility. The measurement data oriented services are gathered together, to be browsed through a single user interface application. This application can be used through the traditional Internet site located in http://sodrws.fmi.fi or with special smartphone application currently developed for Android phones and tablets, but in the future also offered for iPad and Jolla devices also. User interface is identical in both approaches, overviewed in the Figure 2. The main information is presented in the main page, while more details and some sophisticated data are found behind hyperlinks in the top brick and/or through the icon palette on the left. The data analysis services are not completed yet, but the expected services are snowdrift forecast and a special type of route weather service tailored for dedicated road stretch. These services incorporates a 3-dimensional Numerical Weather Prediction (NWP) model and the road weather model (RWM) developed by FMI to simulate road weather conditions [1]. The RWM model is a point model simulating road weather state by computing heat and moisture fluxes in the soil, asphalt and the near-surface atmospheric layer. The model also takes into account effects of the traffic on the road surface heat balance. As input the RWM requires initial road weather state that is typically obtained from weather observations. It also needs predicted values of external meteorological parameters, which are derived from NWP model forecasts. NWP models are the main tool for global and regional weather forecasting. It simulates major physical processes behind various weather phenomena. The route weather service for dedicated road stretch is already available as online version viewed in the Figure 3, through Intelligent Road project web site in http://www.intelligentroad.eu/.

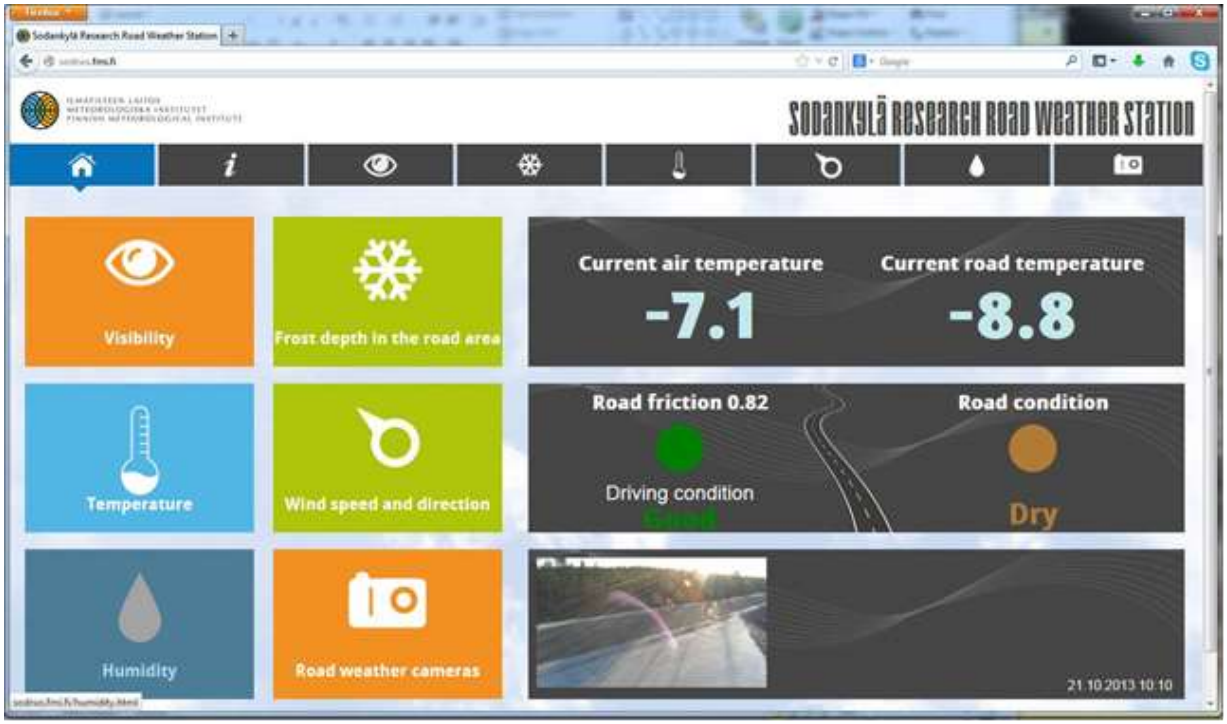

Figure 2. Road Weather Station user interface in the Internet (and in a smart phone).

4 CONCLUSIONS

FMI has constructed combined Road Weather Station (RWS)/Road Side Unit (RSU), with extensive set of road weather measurements, into Sodankylä, Finland. This station together with research vehicles in Sodankylä, form the pilot system in Sodankylä acting as real-life testbed for the demonstration systems yet to come. The extensive set of local weather data is offered to the vehicles capable of operating with IEEE 802.11p or traditional Wi-Fi communication. The vehicles possessing compatible measurements (in practice our research vehicles) also delivers their own measurements data to the RWS. The multi-standard communication system will be analyzed and tested entirely, to be tailored appropriate for the demonstration systems. As the system is on the development phase, the impact of having such a local road and route weather service would have on current incidents today is not easy to predict. In general, the system provides added value for the traffic convenience, allowing drivers to pre-plan the journey more in detail. However, in the special case of severe weather conditions emerging suddenly (e.g. sudden road freezing or melting), such system would provide the necessary real-time information to avoid chain accident of sliding vehicles. Avoidance of even one such kind of accident (and decreasing severity of the rest) provides priceless value impossible to measure just relying on financial basis.

5 REFERENCES

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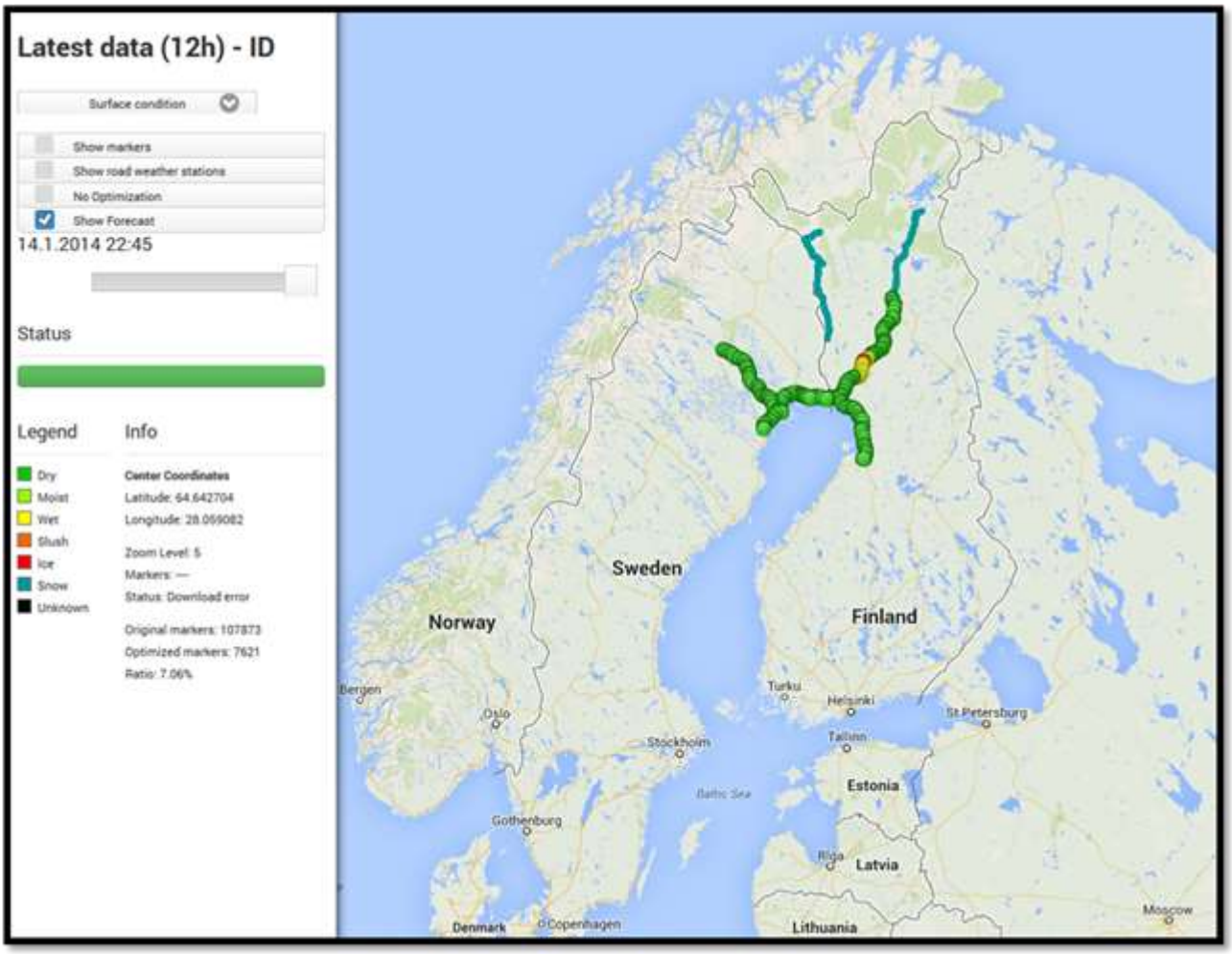

Figure 3. Latest data and the road weather forecast for the dedicated road stretches.