Planning, development and implementation of a Mobile Winter Maintenance Centre

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ABSTRACT

In order to reduce costs and improve efficiency in the winter maintenance, City of Copenhagen has decided to develop a Mobile Winter Maintenance Centre in addition to the existing stationary Winter Maintenance Centre.

Until now all winter maintenance actions has been ordered a supervised from a stationary Winter Maintenance enter. The Centre is manned 24 hours a day the whole winter with at minimum one person. For periods with demands for regular and heavy winter actions this is for sure the optimal solution.

But for a number of situations there is a demand for more information about road conditions, than measuring stations and webcams can give. In these situation is has been standard to call in additional maintenance people to drive around on the roads and make observations and report observed conditions to the Winter Maintenance Centre.

In other situations with low risk of slippery roads due to ice or snow, it is not needed to have a person situated in the Winter Maintenance Centre both day and night.

For both situations City of Copenhagen has concluded that a Mobile Winter Maintenance Centre would be a suitable solution.

To solve the issue about objective observations instead of “what you see” the vehicle must have instruments to detect road conditions and device to continuously present the measurements to the driver in a very simple manner. This must due to traffic safety be done in a very simple and uncomplicated manner.

To fulfil the tasks about ordering and supervision of winter service, the vehicle must be equipped with a complete system for winter management (Vinterman) and a complete system for presentation of observations and forecast of the weather (VejVejr).

1. INTRODUCTION

During 2008 and 2009 The Danish Road Institute has developed a concept for a Mobile Winter Maintenance Centre for the road authorities in Copenhagen, the capital of Denmark.

It is important to mention that the mobile control centre is an addition and not a substitution of the existing Winter Maintenance Centre. And the staff in the 2 centres is the same group of persons.

An addition to the purposes mentioned in the abstract above is to give the operators in the Mobile Winter Maintenance Centre an opportunity to experience the condition for the drivers on the roads both in normal situations and under slippery conditions. In the long term these experiences will give a better interpretation and understanding of the measurements from the normal road weather stations.

The following paragraphs describe the blocks, which together forms the complete mobile maintenance centre.

Paragraph 2 is describing the measuring equipment and paragraph 3 is describing the involved software, hardware and the communication system.

2. Measuring equipment.

The purpose of measuring on-line in the Mobile Winter Maintenance Centre is to have a complete image of all relevant parameters for the pavement surface, with special focus on slippery road due to ice or hoar frost. The parameters are road conditions, which are

- Surface temperature.
- Surface state (dry, wet….).
- Type of moisture (water, snow…).

An other possibility is to measure the grip directly, but in this situation the detailed information about moisture type and thickness is missing.

From maintenance point of view is also interesting to know the actual amount of residual de-icer on the pavement surface. This amount is needed in situation with both dry and wet surfaces.

It is relative easy to measure the amount of remaining de-icer independent of type. But unfortunately all known methods are in manual, and this is not an acceptable method for the function of this vehicle.

For this reason the vehicle is for the time being not equipped with any instrument for measuring residual de-icer on the pavement surface.

2.1 Measurement of surface condition of the pavement.

The surface condition can be measured in several different ways. We have here studied a contactless measuring system from Vaisala - DSC 111.

2.1.1. DSC 111 sensor.

The method is a contactless measurement of the surface of the pavement. Results from the sensor is detection of presence of

- Water
- Ice
- Slush
- Snow or Frost

And based on these values and the amount of moisture or precipitation, the sensor is capable of calculate a grip factor for the actual pavement surface.

Installation of the sensor on a vehicle is easy, and the sensor has no influence on the behaviour of the vehicle when driving on the roads.

The grip-factor is of course a relevant parameter for detection of slippery roads. But since this value is dependent of detection of both moisture type and thickness level, it is very important to have correct values for these parameters.

Figure 1 DSC111 sensor

We have unfortunately not until now been able to obtain probabilities for correct detection in various situations. Correct detection is the best, but a warning or description telling about dubious situation is acceptable.

2.2. Measurement of surface temperature of the pavement.

The standard for contactless temperature measurement is detection of the infrared radiation from the pavement surface.

2.2.1 DST 111 sensor.

The most important result from the sensor is the pavement surface temperature. But due to the measuring principle which is dependent on the air humidity, the sensor is also internally equipped with an air temperature and an air humidity sensor.

Installation of the sensor on a vehicle is easy, and the sensor has no influence on the behaviour of the vehicle when driving on the roads.

The resolution of the sensor is $0{,}1^0$ C, which is very good. Unfortunately we have not been able to obtain information about accuracy of the sensor in different temperature ranges. But from a large number of comparisons with a standard surface temperature sensor we have concluded that the accuracy is acceptable around 0^0 C, which is the interesting range for winter conditions.

Figure 2 DST 111 sensor

3. Software packages, PC hardware structure and communication system in the Mobile Winter Maintenance Centre

In the vehicle are installed software packages for 3 different systems

- VejVejr (Road weather), the Danish system for presentation of observations from Road Weather Information Systems, observations from other meteorological systems and forecasts from the Danish Meteorological Institute.
- Vinterman, the Danish management system for managing winter services.
- The mobile Vaisala DSC 111 software for managing measurements from DSC111 and DST111, including a GPS positioning system.
- A special developed communication program which regularly transmit the measured data from DSC 111, DST 111 and the GPS system, to the global Vinterman database for on-line documentation of road conditions.

Basically it is possible to execute all programs on one PC at the same time. But due to the usability of the Systems City of Copenhagen chose to use 3 Personal Computers with 2 working places. One fully functional working place in the passenger room and one working places without user interaction and with low functionality placed so it is visible from the driver's seat.

As it can be seen from the above descriptions there is a demand for communication from VejVejr to the Danish Meteorological Institute, between Vinterman client and the global database and from DSC 111/DST 111 to the global Vinterman database. The solution made for this system is a multiple wireless connection based on 3G communication.

In total this gives the system in the vehicle following structure

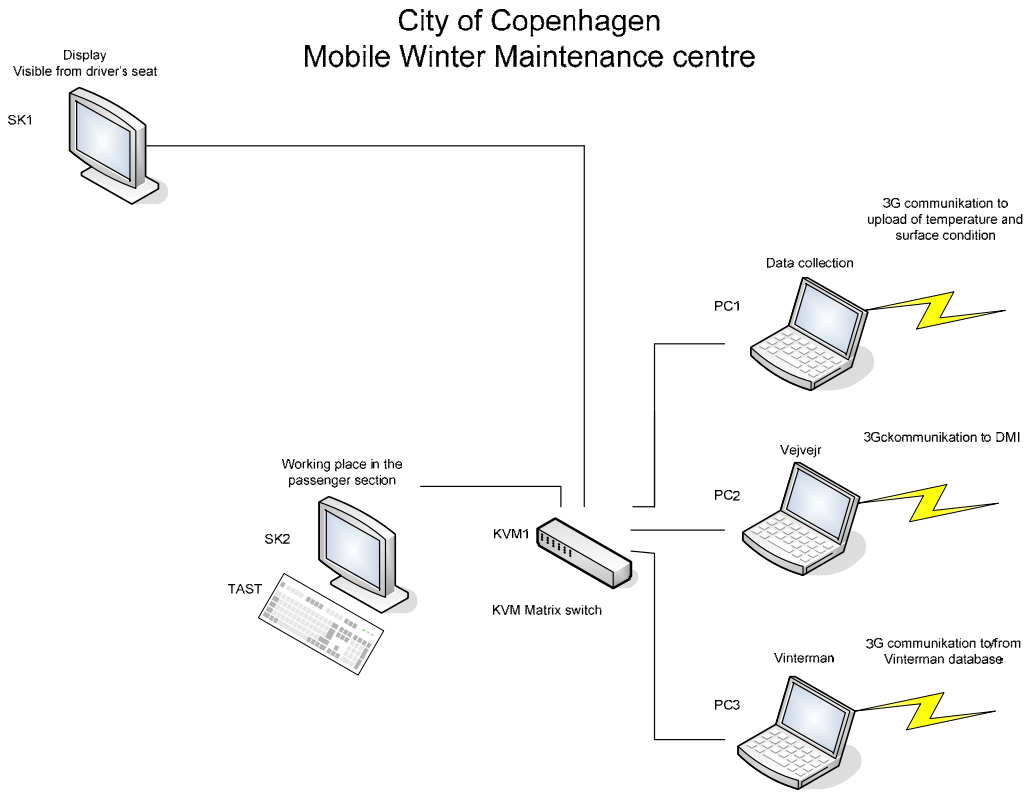

Figure 3 Mobile Winter Maintenance centre structure

4. Advantage of the Mobile Winter Maintenance Centre.

With the functionality described City of Copenhagen will have following advantages of the Mobile Winter Maintenance centre.

- The maintenance responsible can be on the spot in critical situations, and make decisions based on objective measurements.
- Repeated logging of grip data from specific salting routes will give indication of how decomposition of de-icing material is progressing.
- Documentation for the surface state is created automatically.

These advantages should in the long terms give following profit for the investment

- Less time spent in discussion with insurance companies about accident due to slippery roads.
- Optimized used of de-icer based on experiences from grip measurements.
- Shorter reaction time for de-icing, when decision and action are taken immediately when slipperiness is observed.