PM on Road Weather information and the "internet of things" (IOT)

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By Jonas Jonsson, Project Manager. Email: jonas.jonsson@trafikverket.se Mobile: +46707245056

https://en.wikipedia.org/wiki/File:Internet_of_Things.jpg

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Introduction

This PM cover a brief overview of IOT in relation to Road Weather Information Systems.

IOT enables that everything connects to internet and cloud services, and new ways to *gather and receive data*. There is also a need of *authorization and validation of data.* Furthermore processing of *data to information* to make sense in road winter maintenance.

This is a major challenge when talking of sensor networks and IOT. Even if there are, evolving big-data functions and usable artificial neural network function it still need a clear definition of the needs and benefits not completely let the technical possibilities drive the needs.

Limitations

The PM does not cover state of the art RWIS and its sensors, or advanced mobile road survey solutions. It does not either care much on the potential use for road user information.

It does not dig much into the possibilities of photos/video, but they serve both as a sensor input for automated image analysis – but also as a visual support and as situation awareness for operators.

General discussion of IOT and RWIS

When you think of IOT you might think of connected refrigerators, home alarm, televisions etc. Electronic stuff you keep close to home. But the general spread and domain development of IOT push also the professional business. Connected road side stuff, as road signs, road lights, bridges, guard rails can deliver data straight from where an RWIS manager like it to be.

Most potential is connected cars that deliver road status values along the road. Like friction values (from wheel sensors), indication of precipitation (from window wiper control), air temperature, pollutions, sight etc. Advanced cars also have a number smart camera that can make image analysis. Over all cars can produce enormous amounts of data and challenges data handling and business models.

We also see a maturing market for small and simple weather stations for homes and agriculture. The suppliers, products and gadgets grows and competes globally with technology and price. Their offers ranging from semi-professional weather stations to smartphone gadgets.

This PM identifies three main areas of significant impact on RWIS governance:

1. Road status and weather sensors in *connected cars*, and autonomous cars.
2. Large (and growing) number of *smartphones and third part weather stations*
3. Advanced *global services for weather information* and forecasts

This PM believe that RWIS infrastructures will still play an important role in a future - as a quality ensured backbone and reference to other inputs. Although the RWIS management needs to develop strategies and support for new inputs and services especially information from/to cars services.

This is role challenging and requires new business models:

- Who is going to provide the services, public agencies or private industry?
- What is the responsibilities, how to handle accuracy and service levels?
- The business. What are the costs and benefits - and who is going to pay?

What is the business for the car manufacturers, their clients and third parties?

The car - and the car owner - wants road status information for a quick and safe trip. It is clear incentives in sharing road status data, so the car owner probably won´t (or can´t) mind sharing his ride data. The road agencies also like more real time data long the road network.

There are third party solutions for using the cars build in sensors to calculate the friction and push the information forward to a service, as NIRA Road Surface Information. Existing built in sensors is a part of IOT – while specific mobile sensors as Teconer, Marwis or MetRoadMobile is not.

Nira´s solution developed over the past years and tried in full-scale projects in Sweden winter 2019. But the technology to sense road friction by car sensors actually been available for +20 years. Projects to develop the technology has been made by the Swedish Road Agency since late -90:ies (ex. MoRRS, SRiS and RSI).

Technology made things more feasible over the years, but if the services had a clear business, they would have been vastly used already. It is still not clear who is going to pay, how much and to whom.

Look at some adjacent examples for traffic data where the business model has been more obvious (Inrix,Tomtom travel and Tomtom Traffic Index).

Here, the road agencies have a great responsibility facilitate a fair and competitive market. Start buying data - the technology is there already. Interesting questions will follow – will cars be cheaper if they provide valuable data? Alternatively, will the third part take it all? Moreover, where is the carmakers up side?

Also, mind that the change from private cars to Mobility As A Service (MAAS) will influence the future. Uber already changed travel behaviour in large cities around the world, and fleets with automated vehicles will change more. Automated vehicles are technically advanced and homogenous - and potential to use for a continuous road status input. At least within large cities.

In addition, new actors push the car industry. Companies from the information business, as Google and Apple are new to cars – but know how to manage and sell information. Smartphones and cars merge; cars gets open platforms with software as any other hardware – and phones gets apps for using roads/transports.

Smartphones and grids of connected micro weather stations?

Smartphones will merge with cars but also provide solutions with its own apps. Look at the navigator market; - smartphones satisfy most needs without a car integration. Smartphones will also play an important role to bridge gaps, as not all vehicles will have their own computer platforms.

Connected weather stations is a competitive market and the number of manufacturers seem to grow. They offer most things a professional RWIS-station can provide (Appendix 1).

The gap narrows from consumer offer – to what only a professional can afford. They also connect to data clouds of weather forecast companies. Again, the key is the business model – not the technology.

AI and learning algorithms

There are allot of interesting happenings with learning algorithms and the technology gets more accessible. One driving force is Google AI by and their Tensorflow. Other resources are https://openai.com/ and https://deepmind.com/.

These functions enables to discover patterns and combine data that is very complex to program in a traditional way. It does not solve any problem without a clear definition, but more actors can play with complex data sets from IOT, smartphones, vehicles and traditional RWIS.

Global weather services?

In history of information technology, many important IT-functions were initiated and maintained by the government. Then they were outsourced. Public institutions became state owned companies challenged on a commercial market. After time a global market matured – with a few global actors. Theses global actors are offensive and wide spread through global service providers and integrated in every ones smartphone.

It might not be exactly as the weather business – but similar. National weather institutions need to find their role or risk to fade away. There will still be a need for national weather radars and knowledge - but it will be hard to compete with consumer services.

In the context of IOT in RWIS, some global weather service providers might offer to provide weather data for any given location. However, this PM consider that RWIS-stations still will be needed as a quality ensured backbone for state road operators. They will be infrastructure and support of weather forecasts, and still play an important role in winter maintenance management and road weather information.

Different needs - and different solutions

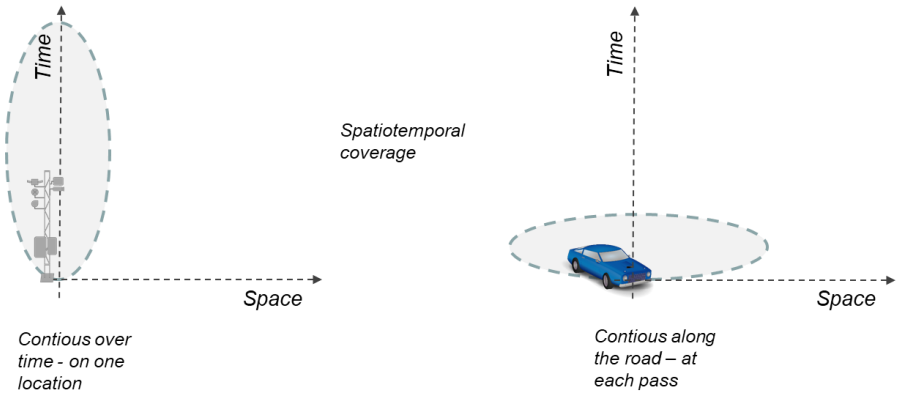
This PM identify different three different user cases, with different needs and solutions:

a) the city (urban congested streets with mixed traffic in relatively low speed - dense IOT)
b) intercity/interregional (much traffic in high speed - IOT infrastructure available)
c) rural (few cars, high speeds and harsh weather - no IOT infrastructure)

City street challenges is anti-icing, difficult snow removal in limited space and lots of mixed traffic. Even if there are many potential IOT-sensor grids, a city geographically have similar weather situations. Speeds are relatively low – and accidents is costly by delays rather than casualties. Remote awareness is important from images. The PM does not see huge benefits with dense urban weather sensor networks. But we will see more stationary, mobile and airborne cameras – used both for traffic management and maintenance actions.

A great potential for IOT and Road Weather is on the **intercity/interregional roads**. They got a physical stationary infrastructure to gather data and important: ways to directly *control* traffic by Motorway Control Systems (MCS) and Variable Message Signs (VMS). They also got lots of traffic - making vehicle based data collection feasible. Speeds are high - and impact of accidents is severe – causing both casualties and delays.

Rural roads represent large distances and time consuming and expensive maintenance actions. The speeds are high so accidents are severe. This PM consider it's a limited benefits to add more stationary sensors (as possibly IOT could provide). Current RWIS infrastructure and forecast models already cover large areas.



Even if the cars are few, vehicle-borne road status sensors will be more important. Both for maintenance management and road user information to avoid accidents.

The figure to the left aims to illustrate how car data can complete RWIS.

The PM underline that the key function for an RWIS is not to tell what the weather is like right now, but to forecast what going to happen in an area over the near future.

RWIS enable preventive maintenance actions - as salting before it gets icy or to get the snow removal machines ready before a snowfall. Reporting the friction from a location might be too late in a maintenance perspective. It can be useful for follow up – but maybe not for the planning.

Conclusion

Hyped words as IOT should not carry away RWIS managers. There is not a stress too hook up device networks. IOT will keep push the technology development and the overall situation will benefit from there. New and important information will reach the road users. Winter maintenance can improve from more information, anti-icing vehicle drivers can get more advanced decision support and salt use decreased.

However, this PM is confident that data from a backbone of traditional and accurate RWIS still will guide the overall winter maintenance actions. They provide a 24-7 continuous input from representative spots along the road and is essential for forecasting. Especially for the rural areas where important weather changes happens in the night when it is simply no traffic or IOTs.

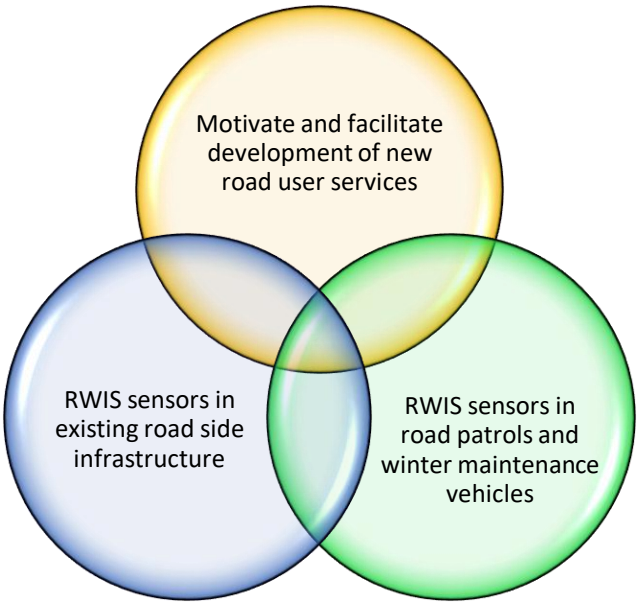
Mobile IOT and crowd sourced input from car sensors will complete - but not replace - RWIS stations. Mobile data will provide a dynamic input along the road links and important values is to follow up on maintenance actions - but also road user information.

Three key recommendations for a government RWIS role from this PM:

1) Look more at service providers - rather than at technology. Look at the services weather companies, carmakers, phone makers or information technology companies already provide - or plan to provide. Motivate the supplement of new road oriented services to facilitate the development. Procure, test and evaluate services. Require the services to align with information standards as Datex2, RDS-TMC and AlertC. Avoid technology development and to operate services yourself.

2) Add RWIS sensors to existing roadside ITS infrastructure and interact more with other ITS. One low hanging fruit is to add road status sensors to the Motorway Control Systems. It got an excellent infrastructure for traffic control already, but no weather/road status input. RWIS should overall initiate more joint ventures with existing ITS, as bridge control/monitoring, cameras and VMS.

3) Add mobile RWIS sensors to existing road patrols and winter maintenance vehicles. Hundreds of them are already out there on mission of the road agencies. Equip them with road status sensors and real time transmission of data. Learn how to use mobile data and the benefits from it. This is a controllable and valuable experience. Learn about mobile data before using crowd data from tens- or hundreds of thousands vehicles.



Appendix A:

RWIS:

https://en.wikipedia.org/wiki/Road_Weather_Information_System

IOT:

- https://en.wikipedia.org/wiki/Internet_of_things
- https://www.micrium.com/iot/devices/
- http://www.iec.ch/whitepaper/pdf/iecWP-internetofthings-LR-en.pdf
- https://en.wikipedia.org/wiki/Mobile_wireless_sensor_network
- https://en.wikipedia.org/wiki/Wireless_sensor_network

Weather forecasts:

Here happens big things, and a few global actors seems to solve all needs in a future. National actors will have tough competitions, even if they possess local knowledge and important infrastructure in terms of radar and stationary weather information systems.

- http://www.accuweather.com
- http://www.msn.com/en-us/weather (Microsoft)
- https://weather.com (IBM)
- https://www.wunderground.com/ (crowd sourced weather info)
- http://www.weather-forecast.com/
- https://openweathermap.org/
- www.theweathernetwork.com

Micro weather stations

- WeatherFlow (smartphone/smart home): http://weatherflow.com
- Nauticexpo (smartphone plugin): http://trends.nauticexpo.com/project-35397.html
- Widoo (smartphone plugin): http://windoo.ch/
- Newmountian: http://www.newmountain.com/product/nm150-ultra-sonic-weather-station/
- Netatmo (smartphone connected): https://www.netatmo.com/en-US/product/weather/

Small/medium weather stations

- Ambient: http://www.ambientweather.com/
- Acurite: https://www.acurite.com/environments/weather-stations.html
- Davis: http://www.davisnet.com/weather-monitoring/#solutions
- Specmeters: http://www.specmeters.com/weather-monitoring/weather-stations/
- Edaphic: http://www.edaphic.com.au/meteorology/microstations/
- Dynamax: http://www.dynamax.com/products
- Hunter: https://www.hunterindustries.com/product-line/Sensors
- WeatherShack: http://www.weathershack.com/category/weather-stations.html
- Global: http://www.globalw.com/products/weather.html
- Onset: http://www.onsetcomp.com/products/data-loggers/weather-stations
- Kestrel: https://kestrelmeters.com/collections/all-kestrel-meters
- POC: http://www.poc.com/media/23743/mws_sm_10.16.2013.pdf
- Columbia: https://columbiaweather.com/products/weather-stations/

Examples of weather cam services:

- www.earthcam.com
- http://webbkameror.se/ (Sweden)
- http://www.weatherusa.net/skycamnet (USA)