WHITE PAPER

IS YOUR TRAFFIC MANAGEMENT FUTURE-PROOF?

Contents

What's this paper about?

In the following, the author examines the trends in traffic management, explains which monitoring solutions are currently available in the market and which requirements they meet. In addition, some application examples are presented, and possible future traffic management developments are forecasted.

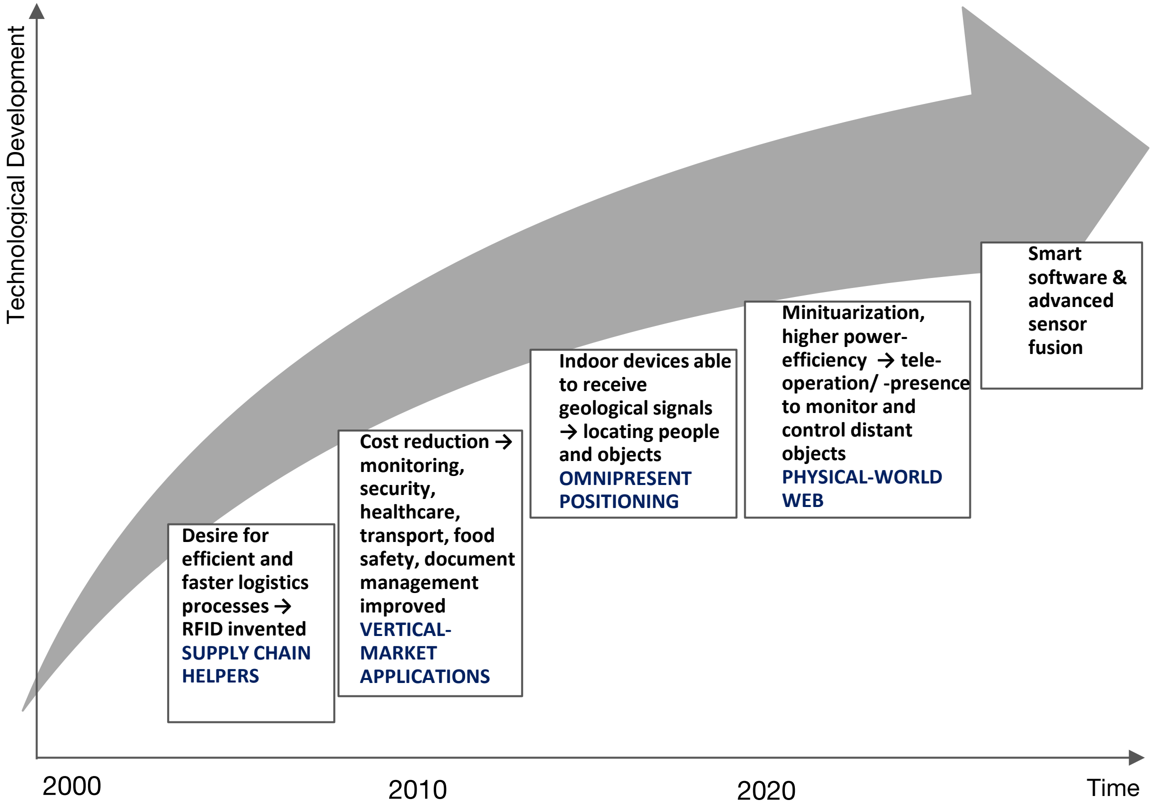

Fig. 1: Internet of things development roadmap

Recent market trends: Digitalization and IoT[1]

Digitalization, by definition, is the change from physical to digital processes by means of information and communication technology.

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[1] Internet of things

About 94% of global technological information capacity was digital in 2007 – compared to only 3% in 1993. From about 2002 onwards more information was stored digitally than analog. This was the beginning of the "**Digital Age**".

Connected devices[2]

More and more products are connected to the internet or to each other and are capable of thinking. Examples are sensors and actuators. They are responsible for recording states or executing actions. The combination of artificially intelligent sensors and actuators with digital operational procedures entail **great support in almost all parts of our lives** such as:

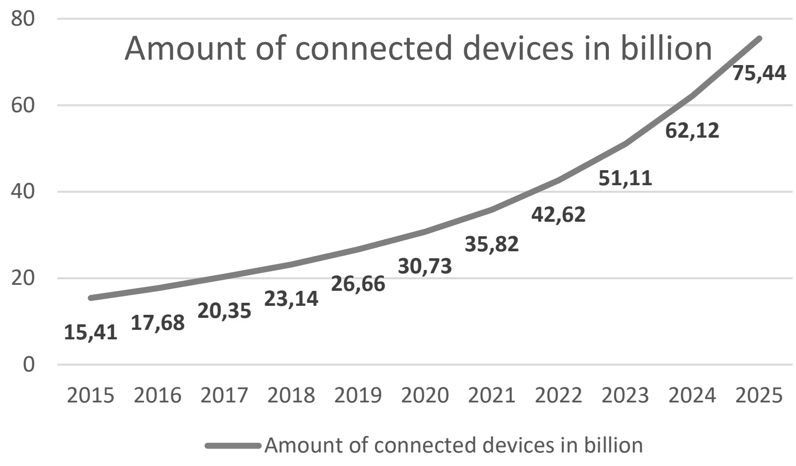

Fig. 2: Forecast of connected devices development (© IHS 2016)

- **Education**
- **Economy in terms of new business models & investments**
- **Culture**
- **Politics**
- **Everyday life**

Sensors are consequently a main component of digitalized networks in terms of the sensory organs of our infrastructure. They form the base for bidirectional systems integrating people and processes for **better decision-making**, as their interaction creates smart new applications and services, e.g. connected devices. Fig. 2 shows the general development of connected devices.

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[2] *Smartphones, navigational systems, fleets, smart grids, telematic components, meters, sensors, fitness tracker etc.*

Consequences for traffic management in cities and highways

Based on this development, city administrations strive to become digitalized in terms of systematically employing new information and communication technologies to:

- **Move towards a post-fossil society**
- **Reduce the consumption of resources**
- **Enhance quality of urban services**
- **Increase the quality of citizens' life**
- **Increase the competitiveness of the resident economy on a sustained basis**
- **And thus, improve the future viability of the city**

For this, at least the areas of **energy, mobility, planning and governance** are affected. The basic characteristic of a **Smart City** is the **integration and networking** of these areas to realize the **environmental and social improvement potentials** that can be achieved in this way. A comprehensive integration of social aspects of the city society as well as a participatory approach is essential.

Why especially **traffic flow optimizations** are essential for the attractiveness of cities becomes apparent by the fact that e.g. Manila loses about 4% of its economic output due to traffic jams. Other reasons and statistics can be found in Fig. 3.

Possible solution approaches are:

» Smart urban planning (e.g. in Curitiba, Brazil since 1960)
» Improve public transport (private cars exhaust 4 times more CO_2 emissions per passenger kilometer than buses or rail transport)
» Support of private transport by hybrid cars, e-cars, bike and foot e.g. expansion of charging stations
» Stop subsidy of fossil fuels and thus eliminate false incentives

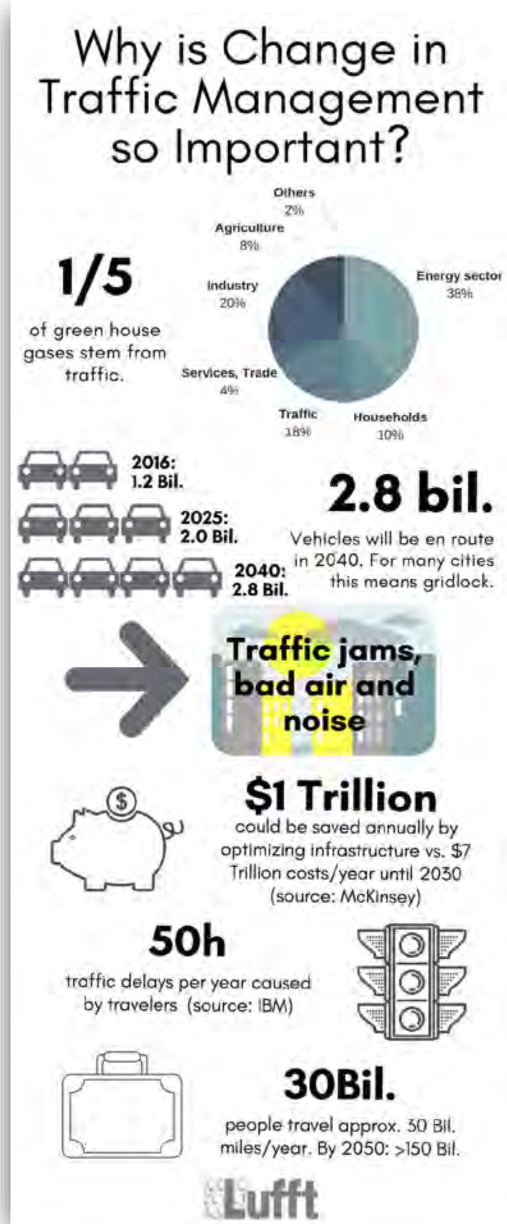

Fig. 3: Traffic facts and Figures

- Restrictions of car traffic, e.g. through environmental badges, high parking fees or a city toll
- Taxes on external costs such as air pollution, noise and greenhouse gas emissions
- Provide mixture of different transport modes to stabilize the system and make it more cost-efficient.
- Access to mobility for different population and income levels

Fig. 4: Smart cities and smart traffic management include (extract):

Connected cars

communicating with each other to alert on traffic jams or bad road conditions are a hot topic. Plans are to realize complete end-to-end journeys without any driver intervention by 2030

Intelligent navigational systems

including weather and traffic jam warnings for most accurate travel time planning

Efficient and environmental friendly winter service

by means of high-quality forecasts, smart road weather sensors and controllers regulating the needed amount of de-icing materials. Thus, the negative impact on the environment can be and spendings on de-icing agents such as road salt can be reduced.

Variable traffic signs

alerting on e.g. slippery road surfaces or low visibilty

Public info screens

displaying real-time info of forecasts on weather, air quality and traffic conditions

Fig. 4 shows some smart city solutions based on sensor systems.

Efficient traffic management thus relies on environmental values. This information is processed by software of control systems or actors themselves. To do so, they are dependent on data-processing hardware. The requirements for such hardware are **high reliability** accompanied by **low maintenance**, since a high failure rate causes maintenance work of many devices that are sometimes spatially separated or difficult to reach. In addition, the **energy consumption** should be very low or based on renewable resources, because such components usually run all around the clock. Likewise, the **purchase costs** should be as low as possible to be able to equip as many physical entities as possible to get a whole picture.

Summary

City and road management relies on smart sensor and analyzing systems, such as (road) weather sensors delivering (big) data feeding future-proof digital services to facilitate life, improve safety and become environment friendly.

But which sensors meet these requirements?

Suitable Sensor Solutions

Road / Runway Conditions

	IRS31 pro	ARS31 pro	NIRS31	StaRWIS	MARWIS
Mobile					■
Stationary	■	■	■	■	
Installed in asphalt	■	■			
Non-contact measurement			■	■	■
Freezing temperature	■	■	■	■	
Surface temperature	■	■	■	■	■
Depth temperature sensor(s)	■				
Condition	■		■	■	■
Water film	■		■	■	■
Friction	■		■	■	■
Air temperature / humidity				■	■

Fig. 5: Lufft road and runway sensor matrix

Integrated solutions, such as a system-on-a-chip, cope with these demands. Fig. 5 shows the available multiparameter sensors from Lufft with their core features: the passive IRS and the active ARS31Pro are placed in the roadbed and are based on contact measurements. NIRS31, StaRWIS and MARWIS are spectroscopic sensors placed several meters above the road surface. MARWIS was introduced in 2014 and has been the first completely mobile Lufft sensor. It can be installed on different kinds of vehicles and measures while driving. The smart mobile sensor can detect ambient and surface temperature and water film heights. It distinguishes different contaminations (dryness, dampness, water, slush, snow & ice), informs on critical or chemical wetness (residual de-icing chemical) and calculates ice percentage, dew point as well as weather-related friction. The stationary MARWIS pendant StaRWIS has the same properties and offers a cheaper alternative to the NIRS31 – with some restrictions regarding the installation height.

Fig. 6: Mobile sensor MARWIS

Mobile sensor systems are extraordinary helpful because they easily collect gapless weather data and transfer them to a control center wirelessly and in real time. Thus, fast decisions can be made and protocols can be saved automatically.

MARWIS and StaRWIS transfer the data via Bluetooth, via RS458 and, if required, via CAN-bus. They issue the data in the open UMB[3] format. Therefore, the sensor integration into measurement networks is quite easy to implement.

The combination of fixed road weather information systems (RWIS) at critical spots with mobile sensor systems realizes an almost gapless weather map and big data which are valuable for many applications.

Road Weather Applications and Consideration

Winter service and road maintenance

One of the first-time users was a small city in South Germany called Waiblingen. The city depot which is responsible for, amongst others, winter service, opted for the mobile sensor system MARWIS combined with the ViewMondo monitoring software to improve their winter service efficiency. In particular, the road temperature, water film height and friction are important

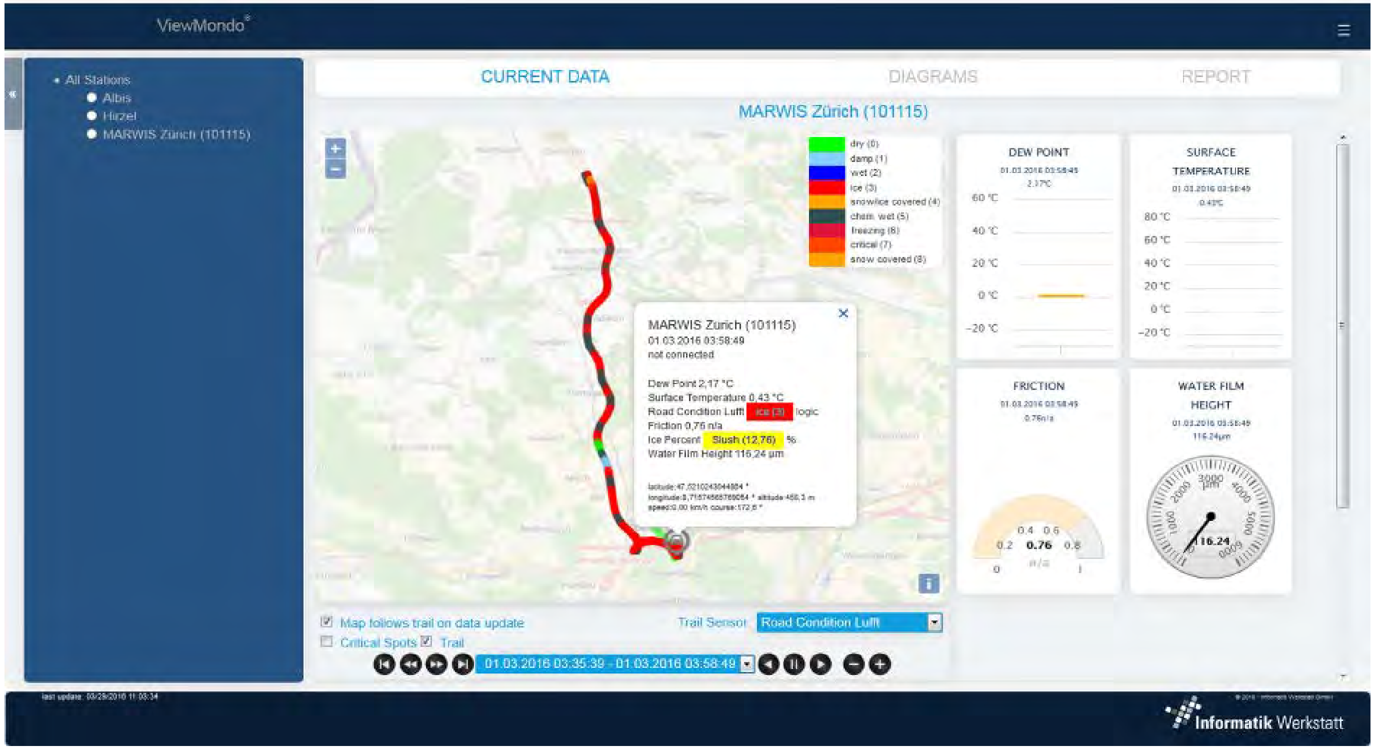

Fig. 7: ViewMondo Dashboard of Zurich operating one MARWIS and two RWIS

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[3] Universal Measurement Bus

to the winter service in order to organize and plan the day efficiently, as the delivered road surface data exactly shows if and how much de-icing is necessary and how long the de-icing effect lasts. It also identifies critical spots (microclimates).

In Waiblingen a patrol car is the first one to tour the city. It delivers feedback on the road conditions by means of the sensor measurements. It helps to decide whether a winter maintenance fleet needs to follow and treat the roads or not.

“We try to optimize the actually quite complex winter service process by means of preventive measures. Thereby we were able to save 15 - 20% of our costs so far” explains depot team leader Achim Wieler. “Our first driver of the day performs a tour to check the road conditions. He now has the chance to quickly notice a need for de-icing. Through this, we are able to react much faster than before and send out gritting vehicles to the right spots".

“We were able to save 15 - 20% of our costs so far.”

In the depot of Offenburg, Germany, mobile sensor technology even helped to avoid prosecution: The recorded data gave evidence that the team attended to their winter service duty.

"We use MARWIS on the 60 kilometers of our winter maintenance routes including federal roads, feeder roads, residential and urban areas. Especially bridges are important measurement spots during the tours. […] MARWIS is a useful decision-making tool and supplies me at the data center with real time weather data. By using these data, I make quick decisions whether to scatter road salt or not. If you consider that before the times of MARWIS winter service drivers needed to stop on the street and test its slipperiness with a shoe, the new process is a huge relief for us. We plan to equip our fleet with further MARWIS devices which, among other things, will also be used on bicycle and foot paths. The MARWIS then will additionally help to avoid bicycle accidents and pedestrian falls" says reports operations manager Raphael Lehmann.

“MARWIS is a useful decision-making tool and supplies me at the data center with real time weather data. By using these data, I make quick decisions whether to scatter road salt or not.”

Connected cars on autopilot

Fig. 8: Typical winter service workflow from measurement to data evaluation

Mobile sensors deliver necessary values for future autonomous and connected cars. Road weather data is required for the calculation of braking distances and steering behavior. For example, it informs on high water which can cause aquaplaning or, on frozen surfaces, skidding.

Tests are running with **Daimler, Bosch and Porsche** so far. In future, such sensors will provide both helpful and safety-relevant data for autonomous car control as well as navigational systems.

Variable traffic signs and public info screens

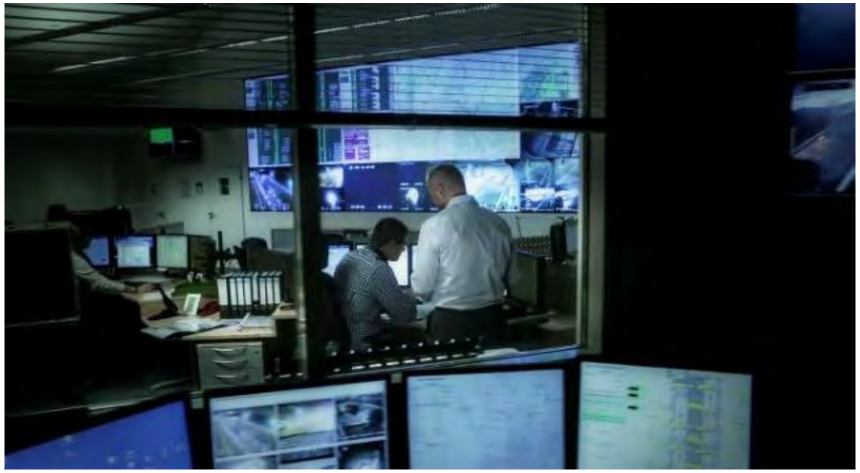

Fig. 9: Control Center of motorway direction in North Bavaria, DE

Comprehensive data from networks consisting of stationary and mobile weather information sensors can be included in weather forecast models and real-time monitoring dashboards. Examples for these applications are the **motorway directorate of North Bavaria** and **the City of Zurich** using Lufft-equipped RWIS whose real-time data feed the control center. From there, the traffic managers monitor the traffic conditions, can alert on risky situations and send emergency calls.

Further Road Weather Management References

Fig. 10: Forsyth County Schools, Winston-Salem, US / Application: Safety

Fig. 11: Depot in Tuttlingen, Germany / Application: winter service

Fig. 12: Department of Transportation Indiana, US / Application: Winter Service

Fig. 13: DIR Norths West, France / Application: Winter Service

Fig. 14: Expressway Corporation, Seoul, South Korea / Application: Safety

Fig. 15: Autovie Venete, Italy / Application: Winter Service

Conclusion and Benefits of networks of mobile sensors at a glance

Finally, the Pros and Cons of mobile sensor devices to be used in traffic management tasks, such as winter maintenance, are to be discussed (see Fig. 16). Here it becomes clear, that the benefits are bigger than the negative aspects. The latter needs to be mainly overcome by transparency and fair employee management.

- ✓ **Cost-effective (mobile sensor is cheaper than fixed)**
- ✓ **Saving of de-icing agents and thus budget**
- ✓ **Easier and faster decision-making**
- ✓ **Wireless data transmission**
- ✓ **Environmental Protection**
- ✓ **Seamless weather data**
- ✓ **Fast measurements**
- ✓ **Flexible**

Fig. 16: Benefits of mobile sensors

The integration of smart sensors into workflow not only eases the burden off decision makers, but also optimizes processes by digitalizing them. It’s obvious that this is the next step in the environmentally friendly, efficient and highly technologized coping of the future traffic volume.

G. Lufft Mess- und Regeltechnik GmbH

Gutenbergstr. 20

70736 Fellbach

Germany

E-Mail: info@lufft.de

Tel: +49 711 51822 0

Fax: +49 711 51822 41

For further details visit the MARWIS product page

www.lufft-marwis.com

or contact us at www.lufft.com/contact/