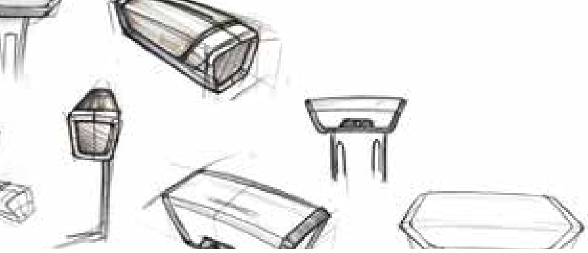
02.2018 | EN

Ultimate Rail

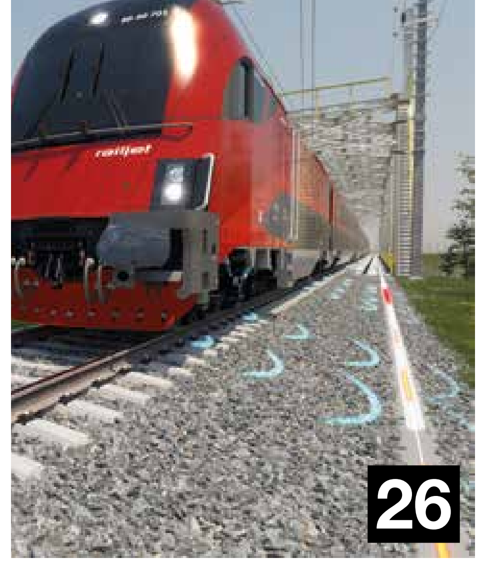
MAGAZINE FOR RAILWAY TRACKING

DIGITALISATION IS ON TRACK

FRAUSCHER
SENSOR TECHNOLOGY



CONTENT



TRENDS & PERSPECTIVES

SECTIONS

TECHNOLOGY & INNOVATION

FROM PRACTICE

Dear reader,

It has now become clear that digital solutions are the driving force that will bring the railway industry into the future. These digital solutions need accurate, up-to-date and reliable data. Until now, trackside sensors have represented the state of the art for generating this kind of data. The challenge now is to relay the acquired information in the most efficient way possible. There are various trends that show ways in which this can be successfully achieved.

Proven sensors that collect data at specific points on the track may, for instance, be provided with logic functions. This would enable data analysis to be carried out directly on the track, and indoor equipment can therefore be streamlined. Concepts such as the Internet of Things can turn such sensors into intelligent devices that communicate with their surroundings.

Linear sensors already generate enormous volumes of real-time data along entire sections of track. The processing of this data is based on intelligent algorithms and approaches to automated pattern recognition. Ongoing progress depends on close collaboration between development partners and platform providers. Rail operators too can play their part in developing new systems by providing input to practical requirements in the course of field trials.

The objective of these developments is to disseminate large amounts of information beyond system limits. And if inanimate objects are expected to communicate, all the more reason to expect railway operators and the railway industry to do so. On that note, in this issue of Ultimate Rail we set out to report on the latest innovations in the field of trackside sensors – and we will be more than happy to discuss this topic further at InnoTrans 2018.

Michael Thiel
CEO, Frauscher Sensor Technology

“WE NEED TO TALK”

MIXED NEWS

Constantly on the move: Trade fairs and conferences, international projects, new locations and partners, ongoing research and developments, sporting events – Frauscher never stands still.

578

CUSTOMER DISCUSSIONS

that Frauscher staff held in 2016 with customers from 47 different countries around the world on their stand at the trade fair in Berlin. New trends and proven technologies were discussed throughout the four days of the event. Frauscher's specialists are looking forward once more to plenty of discussions and interesting projects at this year's edition of InnoTrans. Further information on our exhibition stand's highlights can be found at innotrans.frauscher.com

8x

INNOTRANS

Frauscher has already exhibited eight times at this trade fair. Our stand occupies an area of over 140 m^2. In 2018 we will once again be presenting our innovations for wheel sensors, axle counters and tracking solutions.

312

RAILWAY EXPERTS

from Taiwan and Japan that Frauscher was privileged to welcome at an industry event in Taipei. Frauscher organised the "Railway Industries Technology & Railway Signaling Systems Conference" in partnership with the Chinese Institute of Engineers (CIE) and the Alfa Transit Enterprise Corporation. For Frauscher, this represented the first milestone in the continued development of our activities in south-east Asia.

600+

COUNTING HEADS

have been installed in a new project in Taiwan. The "South-Link" line is operated by the Taiwan Railways Administration (TRA) and is to be equipped with the Frauscher Advanced Counter FAdC and RSR123 wheel sensors. This is the first project on this scale that Frauscher is implementing in Taiwan.

1,000,000+

METRES

of fibre-optic cable in a variety of installations around the world are now being monitored using FTS. The applications focus on continuous train detection and monitoring of the track condition.

2

LOCATIONS

have been added to the Frauscher family since last year. With representative offices in Toronto and Dubai, Frauscher is also able to provide expertise at first hand in Canada and the Arabian region. Details can be found online at: www.frauscher.com

45

EMPLOYEES

are working in the Frauscher Tracking Solutions FTS developer team, collaborating on new opportunities and application areas. Eighteen of these specialised employees are based in Austria, while the remainder are divided between Great Britain and India.

350

WORDS

is the maximum length for an abstract for WDF 2019. The theme for the fifth edition of this industry event is “Intelligent sensing and tracking”. Further details of the conference, which is being held in Vienna from 5 to 7 June 2019, can be found at: www.wheeldetectionforum.com

162

KILOMETRES

was the total distance covered by the Frauscher running team in this year’s Wings for Life World Run.

WHERE WILL THIS JOURNEY END?

Digitalisation is now firmly established in the railway industry, and has also well and truly arrived in signalling technology. In this interview Christian Pucher, Chief Marketing Officer for Frauscher Sensor Technology, talks about the solutions with which Frauscher wants to remain technology leader.

Christian, do railways need digitalisation?
Yes, they most certainly do! Railways must exploit the potentials of digitalisation to maintain their status in the future as an attractive mode of transport – above all in the face of increasing expectations. Intervals between trains are being reduced all the time, the route networks are being used ever closer to capacity, maintenance of the infrastructure is becoming more complex, and cost pressures are rising. Digitalisation can provide a remedy by enabling systems to be implemented that can make rail transport perform at a higher capacity, more efficiently and more safely. I believe the industry has recognised this. It is becoming more flexible as well as a little more creative. New ways of doing things are being tried out. Ideas are being weighed up and evaluated. If an approach appears promising, then it is given a chance.

But when things start to open up as you describe, aren't there a few risks in the background?
I would say that the greatest risk lies in failing to keep up with ongoing developments. When it comes to the generation, transfer, storage and processing of data, the technical possibilities are continuing to develop at a breathtaking pace. They are becoming ever ↘

more powerful and in some cases more affordable at the same time. Trends or developments that were inconceivable just five years ago can no longer be categorically regarded as unachievable. And it is the opportunities here that prevail: the entire rail system can transform itself through these means. To some extent this will certainly involve new and disruptive ideas that we can't yet even begin to imagine. But when all is said and done, these developments will also make rail into an attractive mode of transport that will remain competitive in the future.

Would you say then that digitisation is really just the starting point?

If the railway industry wants to be able to cope with future demands, then it needs to overcome the complexity that has developed within it. Systems, control and safety engineering coupled with maintenance are extremely stretching for both technology and personnel. When systems are utilised more heavily, a point is reached at which these essentials become barely affordable. The necessary modernisation of existing systems is very cost-intensive. After all, some of the interlockings that need to be refurbished are over 100 years old. All such work has an impact on rail's competitiveness with other forms of transport. Needless to say, the enormous complexity of the infrastructure poses a major challenge when it comes to migration strategies. Digitalisation is, however, most certainly a tool that can be utilised for changing tack.

But not everything that digitalisation enables is suitable for rail.

That's right. But there are already various railway applications in which clear trends can be recognised regarding approaches that are especially suited to this industry. 3D printers are being used more and more frequently to produce spare parts or prototypes for development processes. Central cloud data centres analyse data from the sensors. There are algorithms for interpreting the data. Artificial intelligence, deep learning and automatic pattern detection systems are

THE WORLD OF CONNECTED RAIL

Digital interlinking in the Internet of Things opens up new possibilities in the railway industry too – such as train tracking or maintenance strategies.

constantly opening up new possibilities. Operations controllers, route operators, safety personnel and passengers receive exactly the information they need – in real time. The running costs are decreasing at the same time. In order for this system to work, however, it still requires up-to-date data and information. This is where I see huge potential for installing intelligent trackside sensor systems.

What do you mean by intelligent sensor systems?

Over years, indeed decades, our sensors have been developed and optimised for specific tasks. Within their particular fields they now often represent the state of the art. Digitalisation spells the end for such specialisation. Progress in technology produces components that are constantly increasing in capability. We have taken advantage of such components to develop a sensor that combines a number of different functions. We have also succeeded in incorporating analysis logic in it. The result is a sensor that collects data across a large bandwidth and instantly processes the data into different forms of information. With the help of elements of the Internet of Things concept, the sensor furthermore turns into a communicating device. The interface that passes the information on to other systems via a variety of networks is integrated in the track, and the sensor system behind it becomes intelligent and more efficient.

But many rail operators are striving to reduce trackside infrastructure.

That is essentially the right idea. For this reason we discuss in depth with them the challenges that they face. We analyse what data and information they need. And we optimise our existing products in order to meet this requirement. We achieve this by exploiting the possibilities offered by digitalisation – for instance by implementing the concept of the Internet of Things. Whilst the volume of acquired information is increasing, the cost involved is decreasing. The space requirement, maintenance costs, and other ongoing costs can all be reduced. This is made possible by more compact designs and more versatile components.

So systems such as wheel sensors and axle counters are not becoming obsolete?

Digitalisation and the opening up of the railway industry clearly bring a large number of alternatives into play. All the same, I am convinced that safety-related applications in particular will continue in future to rely on tried-and-tested systems. All the more so as they likewise continue to develop. Sensors installed trackside capture the requisite data where it originates. They do this entirely irrespective of the origin and design of the railway vehicles. For decades already, manufacturers have been maximising the resilience of these devices in the face of mechanical, electromagnetic and environmental influences. These properties can now be combined with new possibilities. This turns wheel sensors and axle counters into future-proof and indispensable components of rail infrastructure for the future.

Can the sensor you mentioned manage to bridge this gap?

It is certainly a huge step in the right direction. At InnoTrans 2018 we will be presenting the prototype of the new SENSiS system. It has been developed based on the design of our existing sensors. Its structure has of course been adapted. We have also implemented certain mechanical improvements. This new generation of sensor is capable of digitising the signal directly at the trackside. What's more, it can also generate data on temperature and acceleration. Software updates can be downloaded to the sensor in the field directly via the indoor equipment. We are also planning to launch a dedicated app that will make maintenance easier. A bus system is used to establish a ring architecture in place of the star-shaped connection; this permits significant savings on cabling. And what's more, our plans don't stop here. SENSiS is certain to set a new benchmark and further consolidate our position in the market.

What do you regard as your position?

We see ourselves as the technology leader and pioneer. Our explicit objective is to become the leading provider of track vacancy detection systems in all markets.

"OUR EXPLICIT OBJECTIVE IS TO BECOME THE LEADING PROVIDER OF TRACK VACANCY DETECTION SYSTEMS IN ALL MARKETS."

So, you are aiming to turn your wheel sensors into intelligent trackside devices that collect a wide range of information and perform a variety of functions. But is ↘

Frauscher nonetheless also still working on other technologies?

Our sensors are designed in such a way that they detect metallic objects reliably and precisely at specific points. The information we obtain from this is essential for an entire range of applications – especially in the field of safety. Track vacancy detection remains as always one of the most important applications. The railway industry is currently going through a transformation which requires a greater range of data. Systems based on Distributed Acoustic Sensing (DAS) are capable of providing such data. They enable rail vehicles to be continuously tracked and the infrastructure to be monitored in the long term; they also supply important security-related information.

Why is this technology so ideally suited for the railway industry of the future?

Because it allows data to be collected for different applications using just one system. Only one fibre-optic cable is required by the track. This is in line with today's requirements: more information, fewer components, lower costs. The fibre is practically maintenance-free and is only fed with laser pulses. This has the effect of transforming it into a sensor. The sensor captures acoustic influences in real time along the entire length of the monitored section. These influences may stem from a variety of sources: railway vehicles, rail defects, environmental influences or steps, to name but a few. Some of the collected signatures can already be classified now. Nonetheless, we can still see plenty more development potential for this exciting technology.

"SYSTEMS BASED ON DAS DELIVER REAL-TIME DATA ON TRAIN MOVEMENTS, CHANGES IN CONDITION AND OTHER ASPECTS."

↑ Christian Pucher, CMO at Frauscher Sensor Technology, explains the company's digitisation strategy.

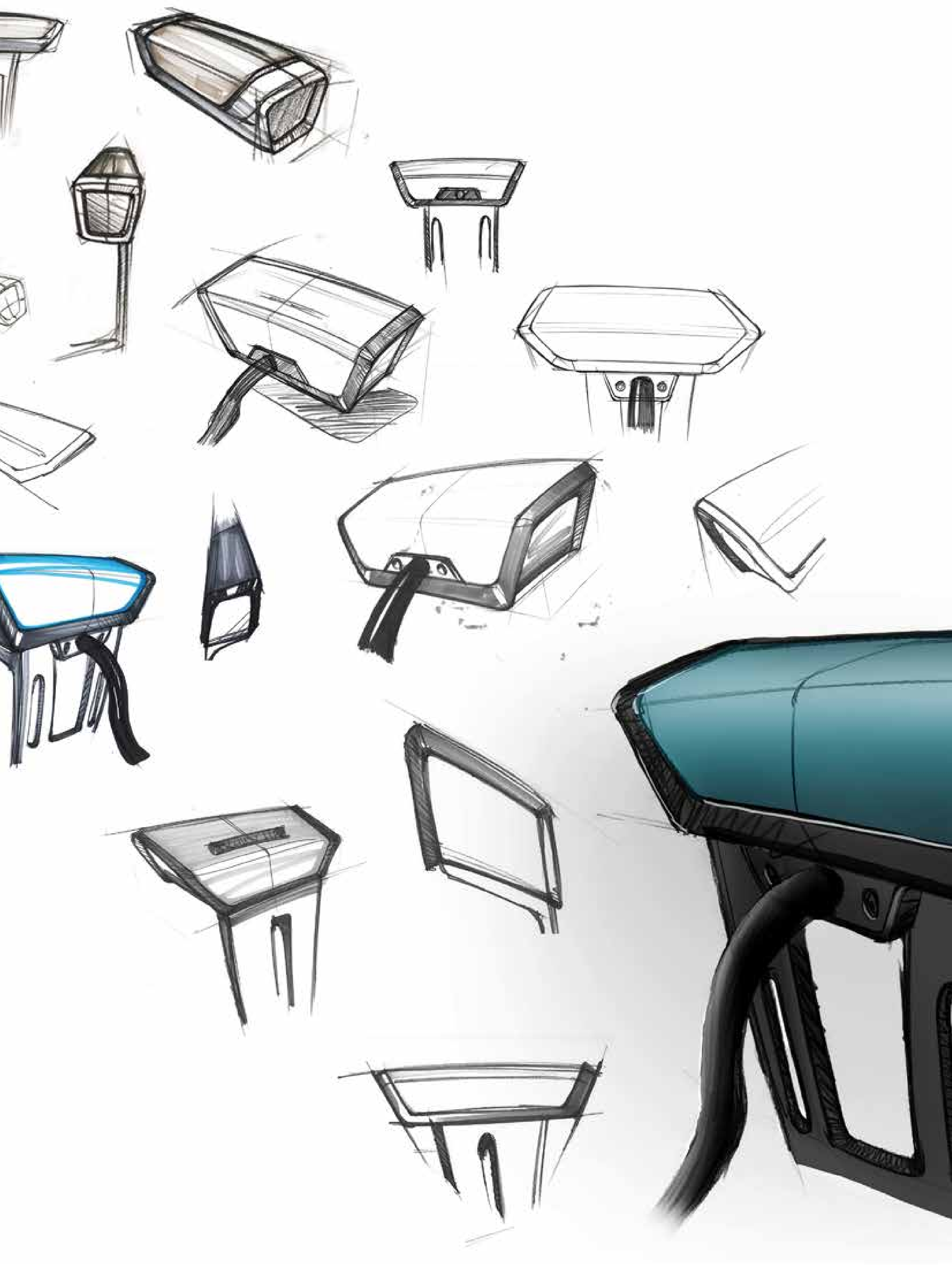
So have you been working intensively on developing this system further since its launch in 2016?
Yes, as we stated at the time we are pursuing two parallel strategies in developing the FTS: firstly, we are using the existing hardware and enhancing it. We have also implemented optimised analysis algorithms and improved logic. In this way we have been able to work alongside operators on the ongoing development of the system. Secondly, the concepts for implementing the next generation of FTS are in place already. Railway-specific requirements are taken into account on various different levels. This version is also already available in prototypes and is beginning to supply data.

Does this mean that track vacancy detection using DAS is already possible?
The system we offer at present enables access to a large amount of information. Trains can now already be localised and their position tracked extremely precisely in real time. However, train localisation to SIL 4 can currently only be implemented in combination with tried-and-tested wheel sensors and axle counters.

Are there any other key applications for the latest installations?
Yes, without a doubt, the condition monitoring of track installations. In the course of recent months we have also made the greatest amount of progress in this area. By continuously monitoring the contact between wheel and rail, it has proved possible to detect any changes to the infrastructure at a very early stage. As a result, maintenance operations can be planned and controlled more effectively. The FTS thus supports the trend towards a future-proof maintenance strategy.

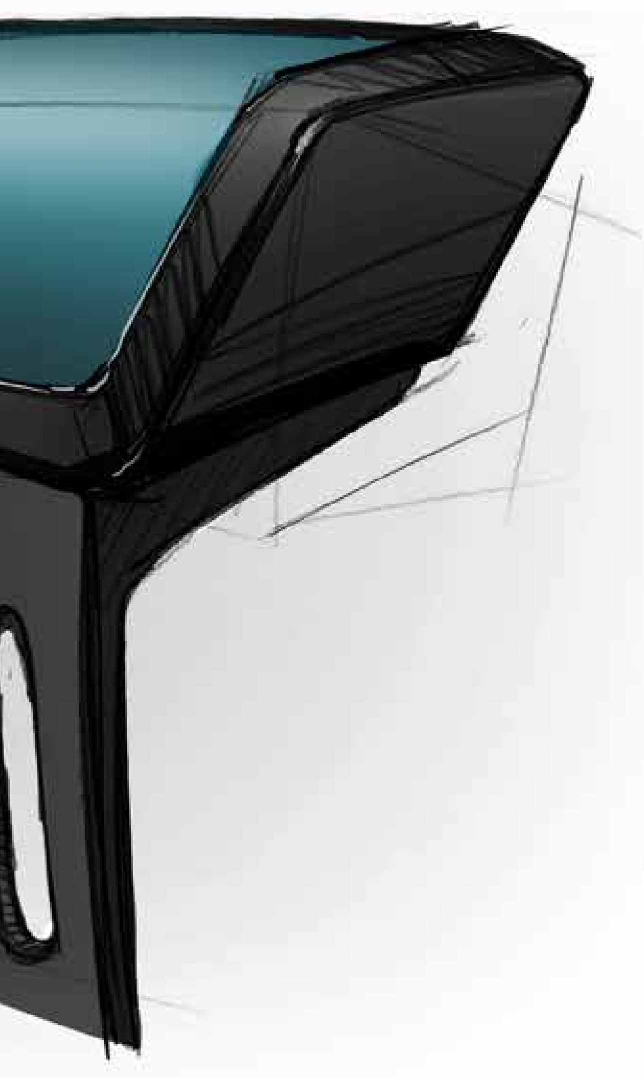
So, are there already any overall concrete results from the ongoing development of this system?
Yes, and we will soon be presenting some of them at InnoTrans 2018. ●

↑ Digital systems turn tracks into extensive sources of data.



INTELLIGENT SENSORS: ON TRACK & ONLINE

New sensors that gather, analyse and pass on a variety of information all at the same time. Electronic units that become a data hub. SENSiS from Frauscher exploits the potential that digitalisation opens up even for proven signalling technology components.



Even in railway infrastructure there is a major trend emerging: more and more objects are communicating with one another via a variety of channels. This is made possible by new concepts such as the Internet of Things (IoT) and the implementation of digital interfaces. Information needed for operational management, monitoring or maintenance is thus instantly available. At the same time the economic viability of entire railway systems can be significantly improved.

To be sure that this is the case and depend on it, innovative solutions must be highly available, should provide a wide range of data and at the same time reduce costs and expenditure. What might sound contradictory is in fact achievable. For instance, when tried-and-tested wheel sensors are combined with completely new possibilities. Under the most extreme climatic, mechanical and electromagnetic conditions, these can reliably collect extremely accurate data and forward it to higher-level systems via different interfaces. With its new SENSiS system, Frauscher is taking this development one step further. Frauscher is combining the reliability and availability of existing devices with ↘

the demand to reduce the cost of hardware and cabling. At the same time, the volume of information being generated and the available functions are increasing by implementing new components and IoT concepts.

Sense it, SENSiS!

The development of SENSiS started with the objective of using innovative approaches to achieve even better solutions to the latest demands of the railway industry. The developers applied themselves to this task by asking themselves some very specific questions: How can the greatest range of data be generated with minimal expense? How can information be passed on in real time to the systems that need it? The answer: New sensors must function as intelligent devices on the track. This will enable them to take the data gathered locally and process it into valuable information which they can then immediately output as such.

This was made possible by integrating the analysis of data directly into the new Frauscher sensor model. The inductive operating principle, which has already been tried and tested with the current sensor models, remained unchanged. Experience from decades of using existing sensor models was directly incorporated into the development. In spite of its more compact design, it was still possible to integrate additional sensor technology. This generates additional information which is relevant to both system integrators and railway operators. Until now, it had only been possible to collect the corresponding data through the installation of specific systems and respective cabling.

↑ The requirements on the new generation of sensors have been defined by an interdisciplinary team.

Innovative development methods

The starting point for development was existing sensor models. Their characteristics were summarised in a comprehensive and integral design-thinking process. Frauscher then took specific objectives from this for the new sensor. This allowed various points to be identified in order to facilitate operation in the field. For further computer-based development of the workings, the research team used finite-element calculations and different simulation models. This also includes, for instance, models which originated as a result of Frauscher's involvement in the ECUC project. The layout of the structure in the actual device was also optimised to reduce the size and weight despite integrating additional functions.

Existing knowhow of the materials being used, like the potting compound, was also put to use. Since wheel sensors are installed in an extremely demanding environment, these components are crucial for long service life and reliability. The first prototypes of the sensor were produced directly within the company using 3D printing. Lessons learned from this process were able to be incorporated directly into the development. In the field of electronics, tried-and-tested characteristics are being combined with new technologies. The device itself was fitted with a digital interface. A hub in the indoor equipment enables data to be made available to higher-level systems, Cloud solutions or mobile end devices.

Operating principle and evaluation logic

As with the tried-and-tested sensor models by Frauscher, the new device is also fitted with two sensor systems, consisting of the transmitters and receivers, in a housing along the track. The wheel flange is detected inductively as before. The transmission coil is stimulated by a certain frequency. The layout of the transmitters and receivers creates an inductive coupling, which is determined by the course of the magnetic field lines. These field lines are influenced by passing railway wheels.

Since the sensor takes over the digitisation of the signal, there is no longer the need for a separate evaluation board in the trackside connection box or indoor equipment. A newly developed board there receives and gathers the information from the sensors (for further information see the article “Clear track

– clear journey” on page 18 of this issue of Ultimate Rail). It communicates this information to the railway operator's system.

More information

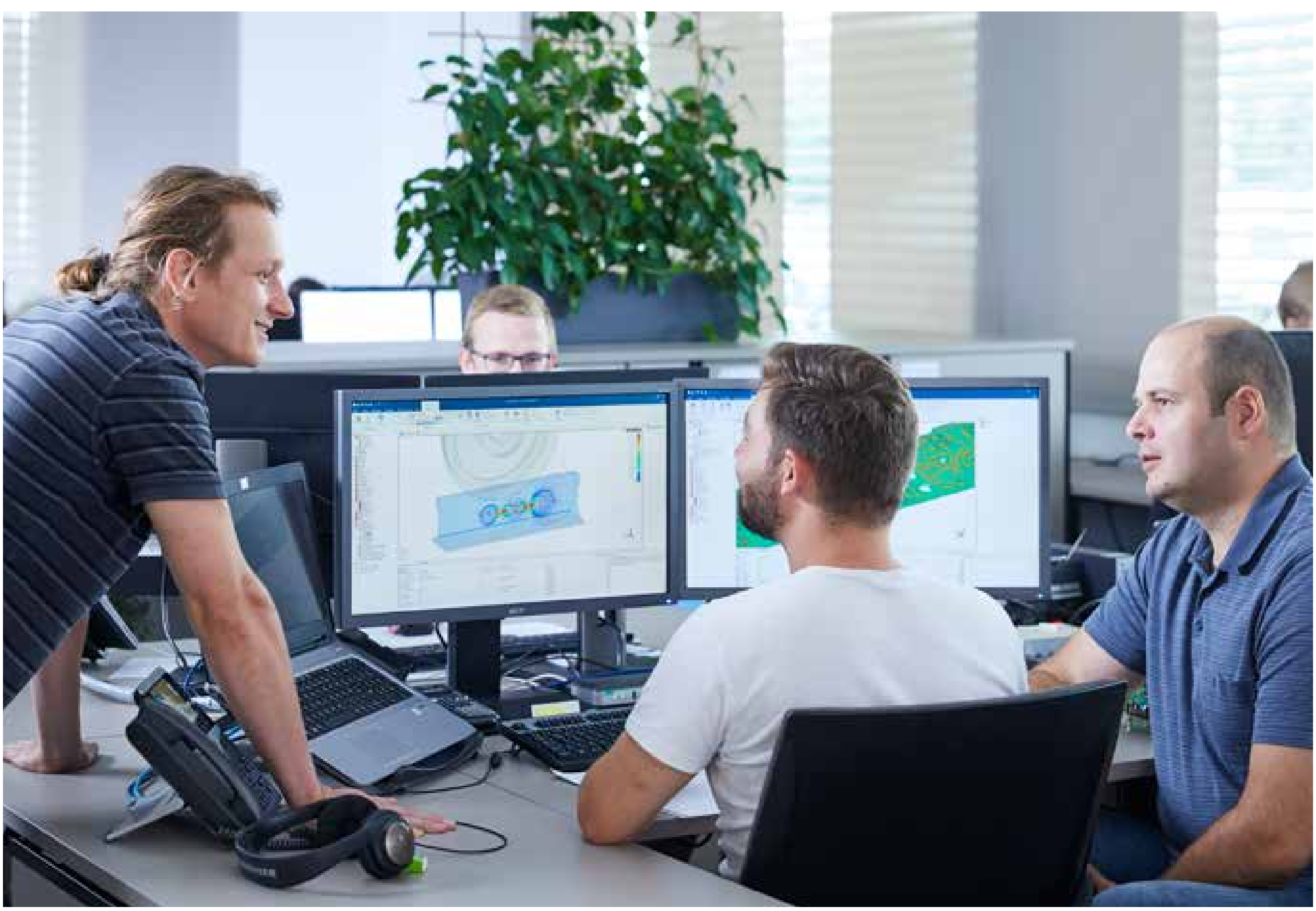
In addition to being able to detect the presence of a train, the new generation of sensors also detects its speed and direction of travel. Wheel centre pulse and wheel diameter are also output. The additional integrated sensor technology allows accelerations and temperature to be determined. This used to be an expensive and laborious task, since separate systems, including all the necessary cabling, had to be installed.

Data from the acceleration sensor is used to draw conclusions about changes in condition of the infrastructure – like the rail, rail connection or track bed. In order for this to happen, sensors must be installed directly on designated parts of the track, for instance near points. This provides information about the mechanical environmental conditions. The temperature measurement of the sensor shows whether it is operating within its specific and safe range. There are also heat-related speed restrictions in some markets. They are activated based on temperature data and are intended to prevent damage to the infrastructure. Measuring the intrinsic temperature enables the newly developed sensor to increase the accuracy of these systems.

In view of the requirements in the railway industry described at the start, to generate more information for less outlay, the collection and evaluation of such information is the basis for such innovative systems. Efficient transmission and if necessary the option to usefully merge datasets is however also crucial here. The integration of additional interfaces enables information to be transmitted together with GPS data stored in the sensor. This significantly increases the efficiency of maintenance teams. ↘

VIRTUAL TESTING PROCESSES

By using a variety of simulation models, it was possible to test different options in advance of the actual implementation.



Simple and easy: mounting and commissioning

Usability and efficiency play a key role in the development of new sensor solutions. The design-thinking process described therefore opened doors to various possibilities. Namely by further simplifying the operation of the sensor and claw for accelerated mounting and commissioning.

Not only does the reduced weight of the sensor and rail claw make installation easier, it also reduces the extent of inherent vibrations when a railway vehicle passes by. Improvements were made to the claw itself around the mounting plate. The plug-in connection no longer requires a flange and is screwed directly to the rail claw, into which the sensor is then simply screwed.

Commissioning is carried out using the indoor equipment. The sensors are also calibrated from here. Software updates can be transmitted directly from here to the devices on the track. A unique Frauscher app, which can be installed onto different mobile devices, also simplifies the process. Connection to the system should be possible via Bluetooth or USB. The relevant security concepts must therefore be developed in accordance with the new possibilities and functionalities.

Outlook

Further developments are possible and are definitely planned for the technical areas. These include using solar panels and batteries to supply power to the sensors. Connecting the sensors to the indoor equipment via radio communication should further increase flexibility and fully exploit the potential of the Internet of Things concept. Furthermore, different variants, types and solutions are possible for specific applications. Integration with Frauscher Tracking Solutions FTS is already being considered.

The prototype of the new Frauscher system is being presented at InnoTrans 2018 in Berlin. It will

INNOVATIVE PROTOTYPING

Prototypes produced on the 3D printer helped the developers with designing and configuring the new sensor.

be available from the beginning of 2019 for non-fail-safe applications. Approval should also be granted in accordance with CENELEC SIL 4 during the course of that year. ●

AUTHOR
Martin Rosenberger,
CTO, Frauscher Sensor Technology

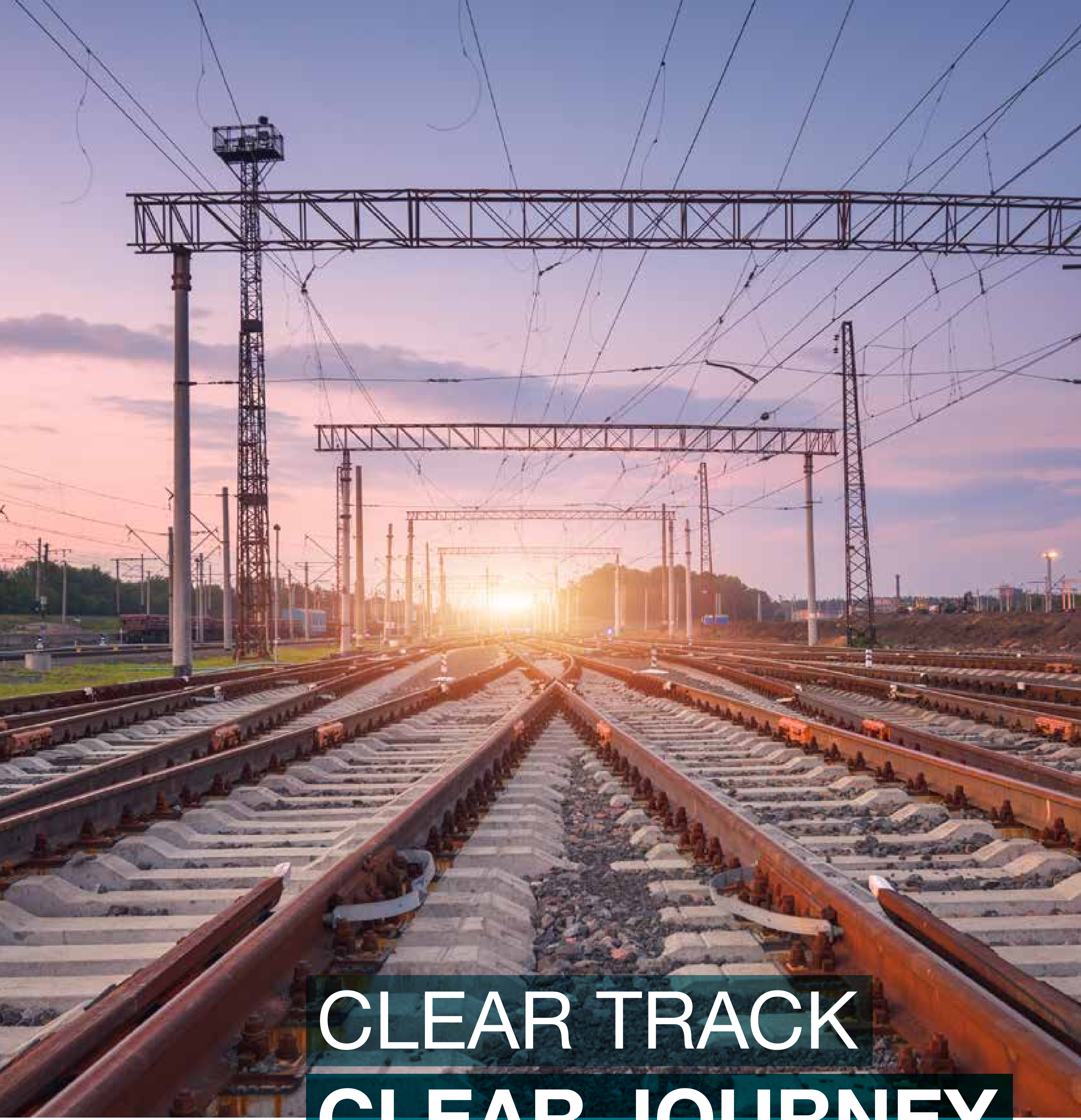
TRACK MORE WITH LESS

Frauscher SENSiS offers various advantages:

- **A variety of information from a single sensor**
- **Analysis** directly at trackside
- **Simplified mounting** and commissioning
- **More lightweight** sensor and claws

SMART TRACKSIDE DEVICE

Optimised components, integrated analysis, supplementary functions: the new wheel sensor from Frauscher combines new digital possibilities with existing, time-proven features.



CLEAR TRACK **CLEAR JOURNEY**

Data hub for modern track vacancy detection: train detection systems must work absolutely reliably and effectively, particularly in the light of increasing route utilisation. Even minor malfunctions can have far-reaching consequences. The new SENSiS system provides an appropriate solution.

Reliable track vacancy detection has been and still is the key task for inductive wheel sensors. For this reason, the electronic analysis device used must as a rule be developed and approved to CENELEC standards. The corresponding criteria were therefore also the basic conditions for the work on the electronic system in the indoor equipment in Frauscher's new SENSiS system. In line with the adapted sensor functions (see p. 12 in this issue of Ultimate Rail), a separate processing unit (PU) was developed It will be exclusively available in combination with the new sensor.

Tried-and-tested systems by Frauscher already mentioned here also served as a basis – in particular the Frauscher Advanced Counter FAdC. In contrast to this axle counter, the sensor in the new architecture already gives a local axle counter reading. The PU then generates the clear/occupied notification for the associated track sections. In addition to the new features, the sensor and indoor equipment also contain the functionalities of the FAdC. This includes Supervisor Track Section STS and Counting Head Control CHC. The new system is compatible with the existing Frauscher Advanced Counter.

Data hub in the indoor equipment

In order to establish a link between the sensors on the track and higher-level systems such as the interlocking system or maintenance tools, the PU becomes the data hub. It performs various key tasks:

- Creates clear track sections based on the sensor information
- Generates additional information based on the sensor information
- Distributes signalling data safely and with high-availability
- Offers user-friendly service interfaces
- Allows configuration parameters to be adapted
- Issues operational parameters for efficient error rectification
- Features integral overvoltage protection

Reduced space requirement and energy consumption

Since all tasks are undertaken by the PU, there is no longer the need for extensive cabling. No dedicated evaluation units are needed in the trackside connection box or indoor equipment since the signal is already digitised in the sensor. Optional lightning protectors can be integrated if desired, but they are not a mandatory requirement. The PU is mounted on a DIN rail, which means that there is no longer a need for the 19-inch board rack or installation frame. The more compact design allows new installation options which had previously not been possible. Reducing the number of components required also has a positive effect on spare parts management.

Data transfer: two-way

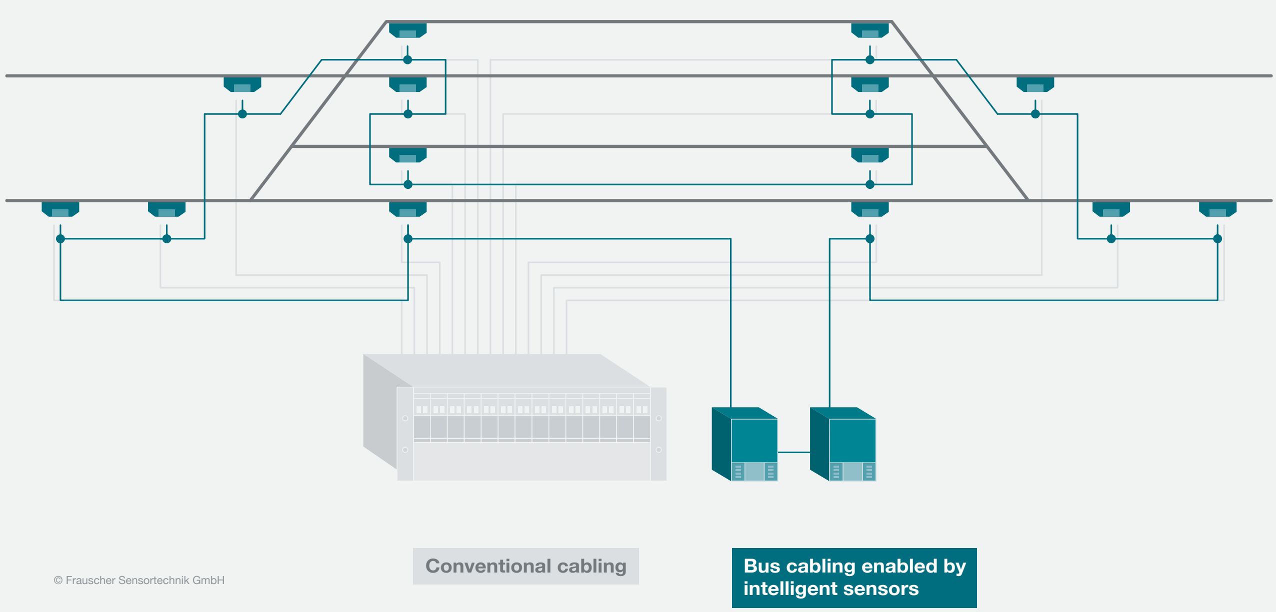
To enable a variety of data to be transferred flexibly, the PU has been equipped with a network interface which is used to connect it to the interlocking system. Customer-specific protocols or the Frauscher Safe Ethernet FSE protocol can be used for communication. The requirements of EULYNX have also been taken into account. Information from the bus interface of the sensor is prepared and transferred accordingly. And vice versa, the PU can also transmit data from the interlocking system to the sensor. This makes it even easier to implement new applications.

Bus system provides ring architecture

To connect the sensors to the indoor equipment, a separate bus system was established. Just one additional connection is needed per PU to allow up to 16 sensors to be linked with the unit. In contrast to the star-shaped cabling of sensors, the new system provides a ring-shaped architecture. The cable material needed is thus considerably reduced since there is no longer the need to individually connect each sensor to the indoor equipment. This results in significant cost savings in terms of material and installation time. ↘

SAVINGS DUE TO RING ARCHITECTURE

Star architectures require a separate cable for each sensor. Bus systems enable cabling to be configured in a ring. This significantly reduces the length of cable required.



© Frauscher Sensortechnik GmbH

In its role of data hub, the Processing Unit PU is responsible for various tasks.

But what happens in the event of a cable fault? Where a ring is installed, a second PU comes into play in the SENSiS system. Cable faults such as short-circuits or interruptions do not then affect the availability of the system due to the special configuration of the bus and ring architecture. These are output at diagnostic level and can then be rectified.

Keep emergency route free: dedicated diagnostic channel

Safe signalling data and the diagnostic network can be separated in the SENSiS system: Whilst the axle counter and interlocking system communicate via one network, diagnostic data is transmitted in a completely separate network. The direct digital connection allows the status information of each individual sensor to be requested.

The extensive availability of hand-held devices also makes diagnostics and maintenance easier. Suitable smartphones or tablets are already part of the standard repertoire of maintenance teams for some railway operators. It should also be possible to connect these devices directly to a sensor in the field. A Bluetooth module has also been implemented for this purpose, and it can be either deactivated or activated.

Let's get on with it!

Depots and shunting yards will benefit immediately from the advantages of SENSiS. In these segments in particular, large savings can be achieved as a result of reduced cabling and minimum space requirement. They are also ideal for collecting information for the further development of new systems and for adapting the associated architectures. In the medium term this ongoing development will enable the system to be used in all rail segments. ●

AUTHOR

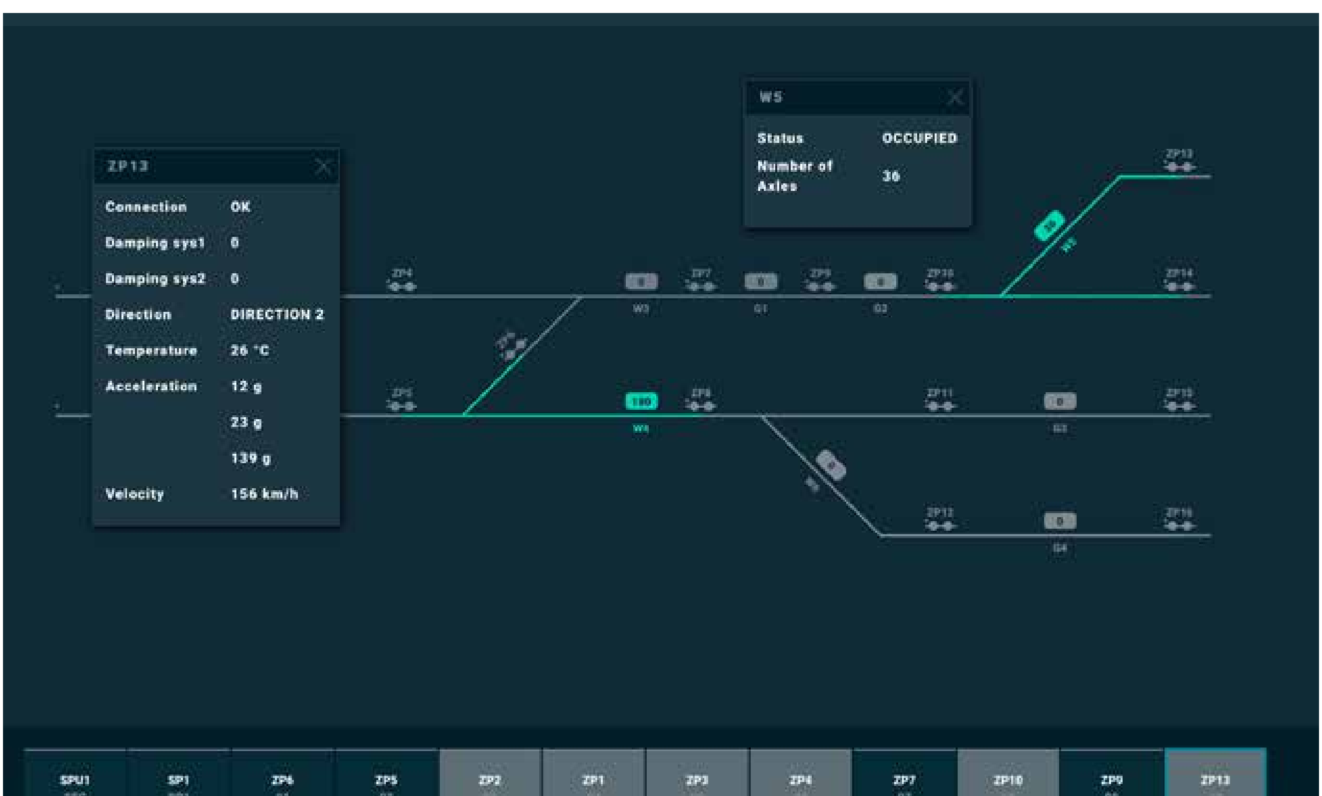
Hannes Kalteis,
Product Management,
Frauscher Austria

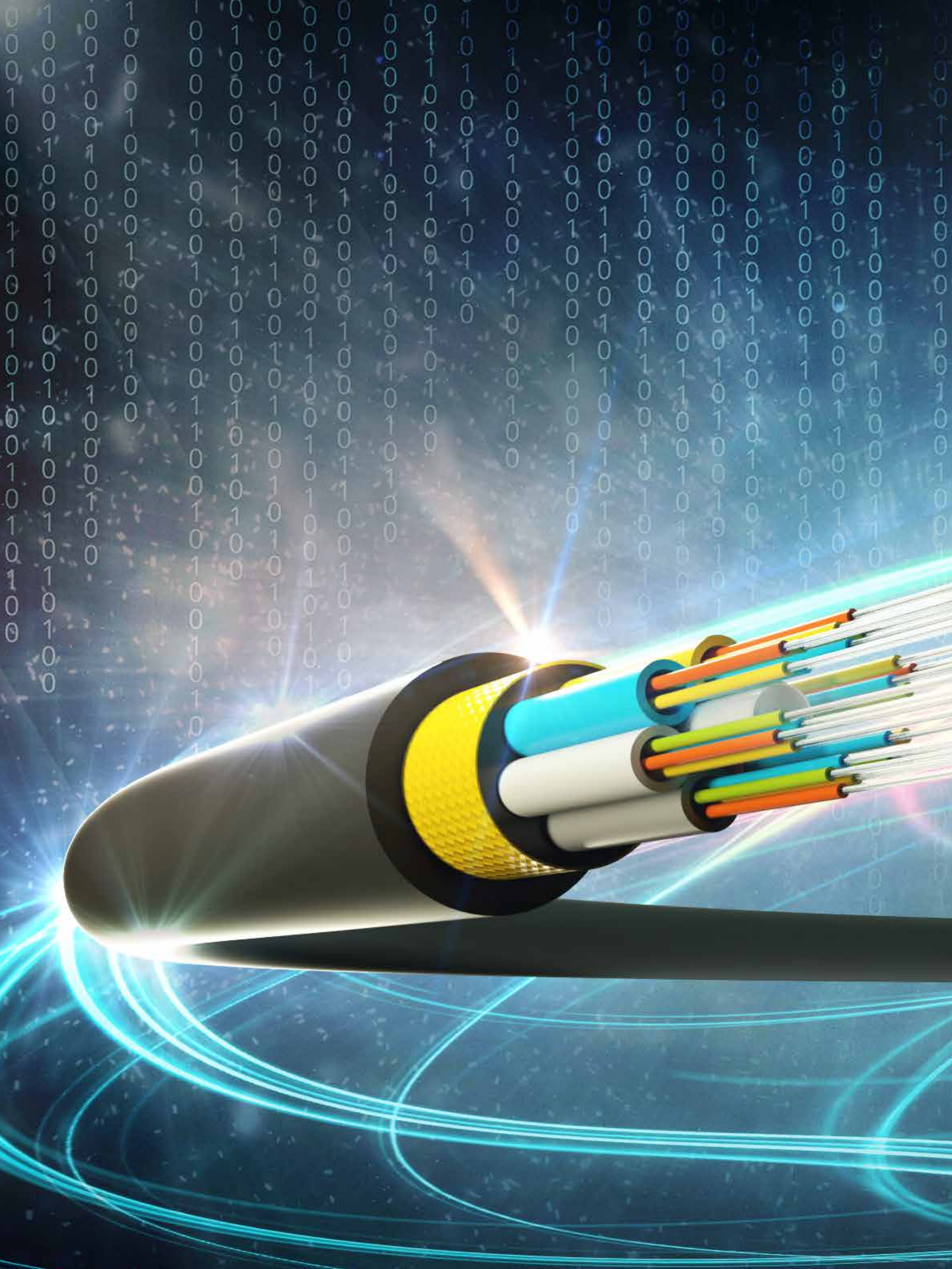
CONTACT

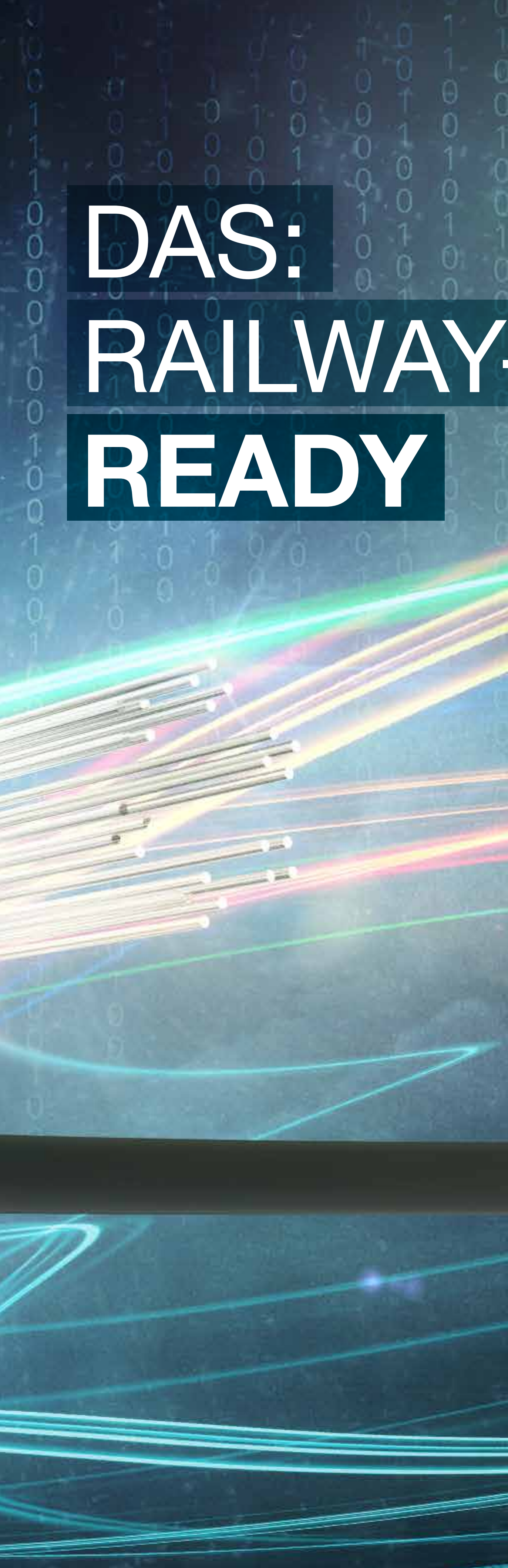
Further information on SENSiS:
productmanagement@frauscher.com

REAL-TIME INFORMATION AT FIRST HAND

In the SENSiS system, diagnostic data can be retrieved on a variety of devices in a clearly understandable form.







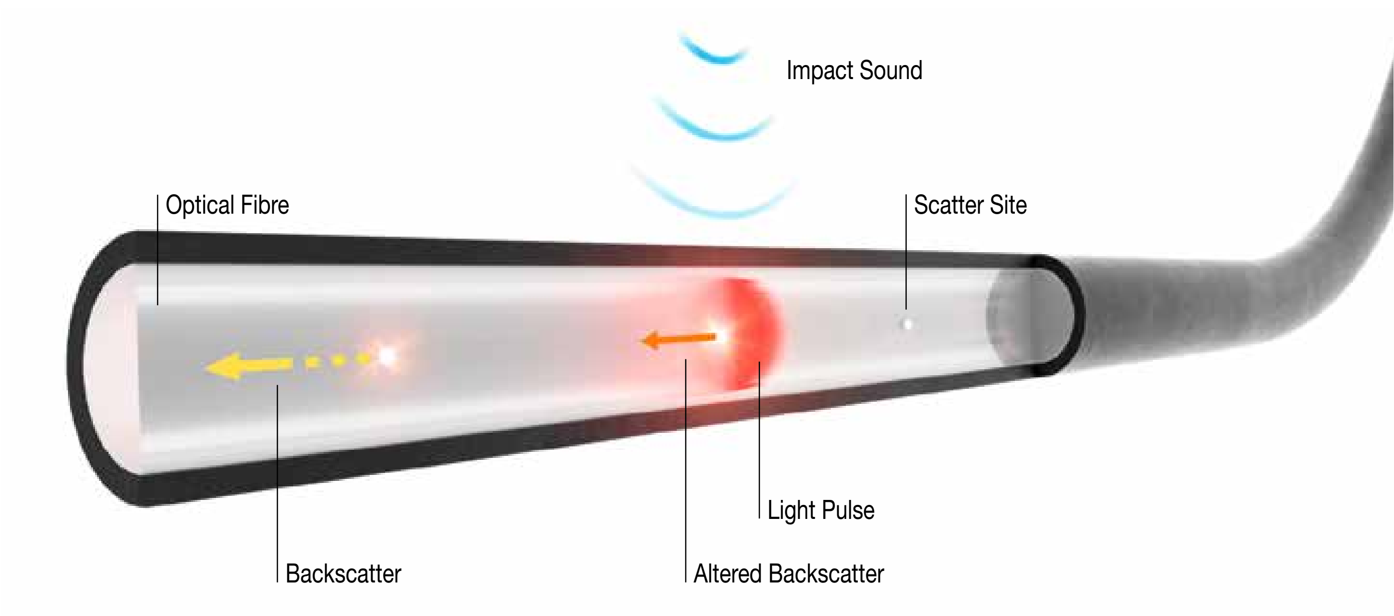
DAS: RAILWAY-READY

From tracking trains to monitoring infrastructure, railway operators are faced with plenty of tasks. To accomplish these tasks they increasingly rely on digital systems. The data they require, though, is first-hand. Distributed Acoustic Sensing (DAS) delivers the requisite bits and bytes.

These days, real-time data represents the basis for many applications in the railway sector. In particular this is the case when digital approaches are introduced. However, specific criteria often apply to railway applications. They require a very high degree of precision and reliability. In accordance with these requirements Frauscher has carried out a great deal of research and development in order to further develop Distributed Acoustic Sensing (DAS) as the base technology for its Frauscher Tracking Solutions FTS. The expertise we have accumulated over the decades has been combined with our openness to new approaches and our experience from test installations around the world – which already number over 30. ↘

HOW DOES DAS WORK?

The functional principle behind DAS-based systems: DAS is used to detect changes in the intensity of light reflections in a fibre-optic cable that is pulsed by a laser. These differences can be caused by sound waves when they encounter the cable. Classification algorithms can translate changed signatures into specific messages.



Further development of the measurement method

During further development of the measurement method the focus was on the accuracy of various items of information: for instance, the length and speed of a train and the status of individual components of the train and the infrastructure. To achieve this, the optoelectronics have been optimised with regard to the type and evaluation of the optical pulse, As a result, more detailed information can be obtained during the detection of moving objects. The beginning and end of a train could thus be identified much more clearly in the evaluations, which ultimately means that the completeness of the train can be checked, at least in non-fail-safe application areas. Furthermore, Frauscher is working on the development of filters that allow for a reduction in noise signals and in turn an increase in the range covered by individual DAS units.

Comparison of the cable routing and track layout

Fibre optic cables that are already in-situ and that have previously been used for communication purposes are frequently used in the installation of FTS. This leads to significant cost savings during installation, as new cables do not need to be laid. However, it also involves certain challenges. Coils of fibre can often be found along existing fibre optic cables, which usually function as reserves. These ensure that, for example, repairs can be carried out on the cable quickly and easily. However, when detecting trains using FTS, these coils led to discrepancies between the optical distance measured in the cable and the true distance that a train has travelled. The starting point in both cases is the transmitting unit, via which laser pulses are sent into the glass fibre.

INFORMATION

More detailed information on how DAS works is provided in the technical article **“Distributed Acoustic Sensing as a base technology for railway applications“**, which can be found under Media Centre at www.frauscher.com

As a solution to these irregularities, the relevant points have been manually identified and filtered in initial installations. The aim is to develop a logic in order to automate this step. To do so, an algorithm is being developed using artificial intelligence, which independently identifies, classifies and filters the pattern occurring at the relevant points. This results in the accuracy of the measurement being further increased and the calibration phase during the installation being shortened significantly. A comparable function has been developed for situations in which the routing of the cable is completely different from that of the track.

New potential for flexible architecture

To increase flexibility and performance, the connection between the detection unit and the processing unit of the FTS should in future be enabled via high-performance networks, for example a fibre optic backbone. Implementing suitable interfaces allows for the setup of different architectures. In doing so, data can either be transferred to a centralised processing and classification unit based on specific hardware or Cloud technology, or a unit installed decentrally.

Interfaces and data implementation

The implementation of logic and artificial intelligence takes into account and enables the import of data from other systems, such as information from inductive wheel sensors or axle counters. However, additional inputs, such as train numbers from the Traffic Management System, can also be incorporated into the information generated by the FTS. Platform announcements can thus be supplied and controlled automatically, based on continuous train detection, reliable track clear indication and the accurate identification of individual trains, for example.

The future of train detection

Since the introduction of FTS, more than 30 installations have been carried out in various countries. These test different applications in the field of train detection as well as the monitoring of infrastructure components. What's more, various pieces of information for increasing safety in the vicinity of rail networks – for example through the detection of unauthorised access to sensitive areas – have been evaluated and are already being put to use. The findings obtained based on these systems are incorporated directly into the further development of hardware and software, whereby new possibilities and insights are being identified on an ongoing basis.

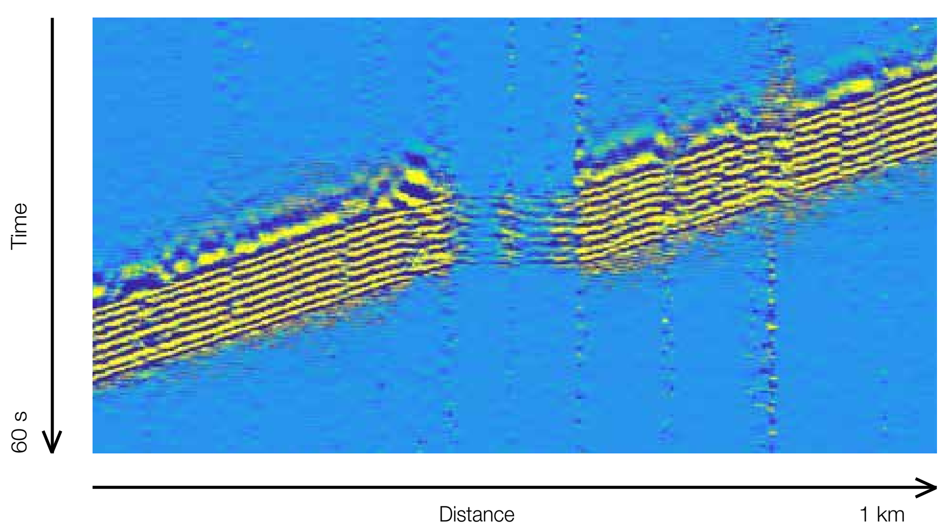
Frauscher also involves customers, partners, component manufacturers, universities and other institutions in this comprehensive research and development programme. In light of the complexity and sheer scale of the possibilities identified up until now, the roadmap for processing corresponding tasks now covers several years, during which time the FTS has been constantly updated. ●

INFORMATION

The progress Frauscher has made so far in developing DAS is discussed in greater detail in the technical article **"Distributed Acoustic Sensing (DAS) in the railway sector: the realisation of a vision"**. This can be found in the media centre at www.frauscher.com.

AUTHOR
Gavin Lancaster,
R&D | Acoustic Sensing Manager, Frauscher Austria

↓ Fibre-optic spools are filtered in the FTS using a dedicated logic.



LISTEN AND LEARN

More and more frequently, traditional maintenance philosophies are being called into question: rather than sticking to fixed intervals or mileages, operators nowadays often depend on condition-based maintenance. The Frauscher Tracking Solutions FTS support this trend.

Maintenance tasks are only carried out when the condition of the equipment, systems or components (assets) so dictate: this approach can save many railway operators both time and expense. This is why the concept of condition-based maintenance (CBM) is becoming increasingly popular. Systems based on Distributed Acoustic Sensing (DAS) are constantly supplying accurate real-time information on the condition of, and changes in, the infrastructure for this purpose. A team of experts from Frauscher further developed the DAS-based Frauscher Tracking Solutions FTS in respect of the corresponding applications.

Continuous monitoring of wheel-rail contact

The ongoing analysis of infrastructure using FTS is based on continuous monitoring of wheel-rail contact. The quality of this monitoring is the key factor in the service life of system and train components. This quality is derived from various parameters such as the roundness of the wheel, the surface of the rail and the track design. Even minimal irregularities can lead to increased manifestations of wear and abrasion. In some cases this can even result in critical operating states. This is why continuous detection and thus early recognition of changes in condition along the entire route is extremely useful. Firstly, this enables the detection of irregularities that arise slowly over the course of time. To do so, the system compares the relevant signatures that are captured each time a railway vehicle passes a point. Secondly, events that occur suddenly can also be reliably detected.

FTS can also be used to determine whether a specific anomaly in wheel-rail contact comes from the train or from the infrastructure. If a notification is triggered by an out-of-round wheel, for instance, then this pattern will be part of the train signature and be detected in association with the train. By contrast, if there are changes in the infrastructure, several axles will have a noticeable signature in one specific position.

The infrastructure is kept under permanent scrutiny

The system identifies indicators from the detected signatures. Based on this, trend analyses are formed for individual, ten-metre long infrastructure segments. Warning or alarm notifications can now be created and transmitted using defined, user-configured threshold values. These indicate the type of change as well as the location.

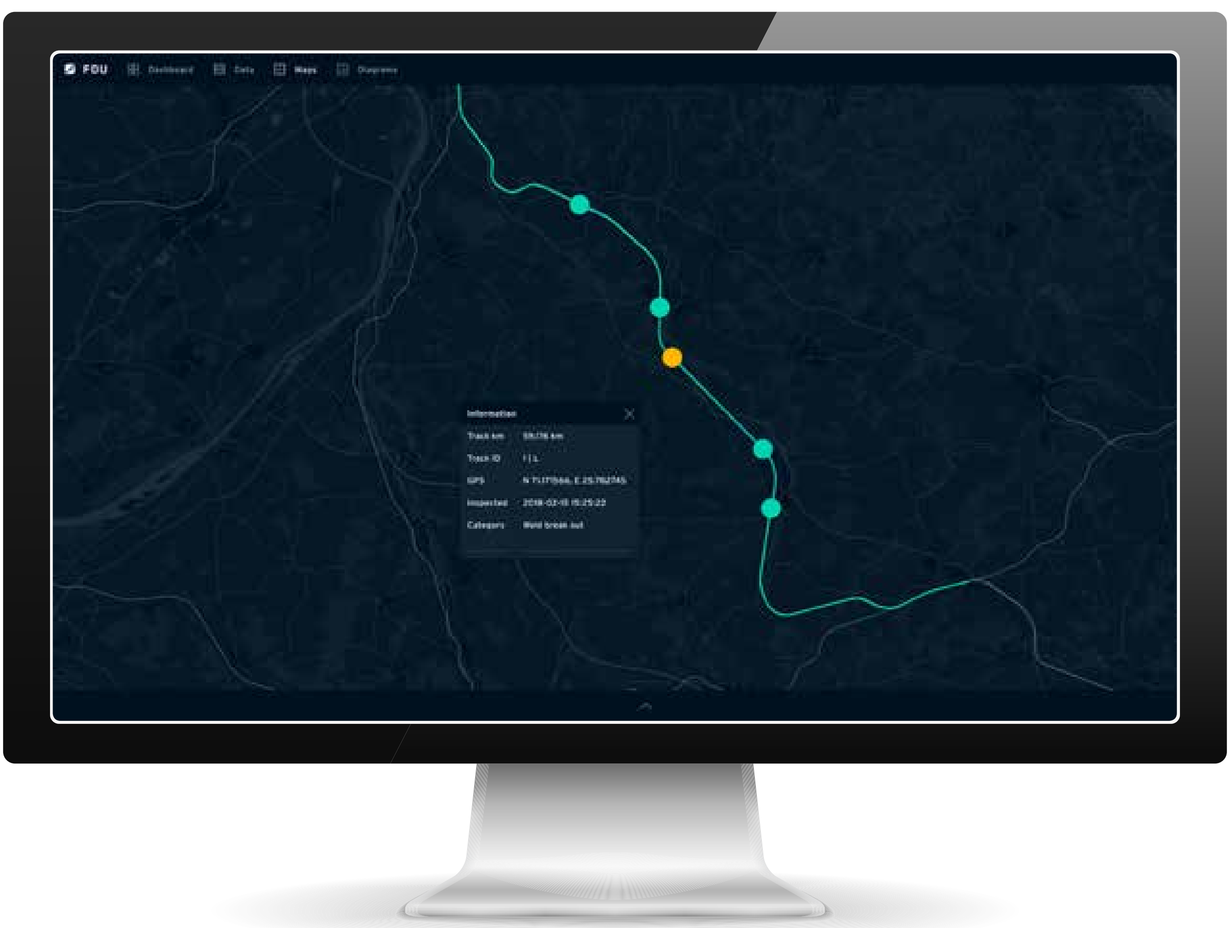
To present the information in visual form, Frauscher provides a graphical user interface with a map view and heatmaps. The condition of the infrastructure can also be represented in definable categories. A zoom function is provided to allow either the entire route or one position with corresponding localisation in route kilometres or GPS data to be shown. The current condition as well as any change in condition over a specific period of time can also be retrieved. Filters can be set for even more detailed analyses and evaluation.

Classifying damage: a learning process

However, detecting changes alone is not enough. One and the same technical anomaly can in fact produce indicators that vary in frequency and intensity depending on whether the train passing over the section of track in question is a long, heavy freight train or a short, light passenger train. The DAS systems that are currently available are not yet able to classify the changes detected with sufficient accuracy. Items that stand out are therefore evaluated by maintenance personnel during the development and installation phase. A visual inspection is often enough to identify the cause of the warning, classify the change and take the necessary action within a defined period. Frauscher is developing tools to automate these processes. ↘

USER-FRIENDLY INTERFACE

Frauscher developed a dedicated interface that displays accumulated notifications for particular locations. This may involve colour coding on traditional maps.



Until now, essentially three classifications have been defined from a number of different installations.

No detectable or only minimal defects: No action required. An external influence or a defect that is not yet visible to the eye has been detected. A filter can be set or an appropriate comment recorded.

Non-critical defects: The system has identified a relevant fault, but it does not need to be corrected right away. The requisite actions can be scheduled in good time.

Critical defects: An action must be initiated immediately in order to resolve the safety-critical operating condition and minimise any expensive subsequent damage during repair.

↑ Even minor defects like this rail head crack have already been detected using FTS.

Empirical results

The company is working very closely with the operators of certain selected installations. They are jointly considering the evaluation, interpretation and derivation of measures. Specific issues and ideas for further development of the evaluation software and logic are directly incorporated into Frauscher's development processes using agile methods. Discussion has focused primarily on three scenarios:

Rail monitoring: All types of rail defects that cause vibrations or a marked noise spectrum are detected. These include surface defects such as rail corrugation, squats, rail head cracks, wheel burns, corrosion, indentations, cracks and gaps. Rail breakage occurring whilst a train is in transit can also be detected by the system with a high degree of probability. However, due to the many different forms and physical basic conditions, a warning system with a 100 percent detection rate and zero error rate cannot be achieved.

Rail connection and sleeper monitoring: Locations were detected in several installations where the rail connection was broken or absent. These are typically faults that do not necessarily require action to be taken right away. Such action can be planned for one of the upcoming maintenance rounds.

Substructure and track superstructure monitoring: The FTS system localises weaknesses in the substructure and track superstructure, such as hollow areas under sleepers, cavities or compacted areas. Under certain circumstances the condition of the track bed can result in critical situations within a relatively short space of time. This is especially the case in mountainous regions where the track can become unstable due to heavy rain or mudslides.

Summary

Continuous monitoring of wheel-rail contact using FTS opens up numerous possibilities for the user in terms of timely detection of weaknesses and changes in condition on the route. This enables maintenance measures to be defined, scheduled and managed in a focused and appropriate way. This is a paradigm shift in terms of maintenance strategy, similar to that which is emerging for vehicles. In addition to continuous changes, the FTS is also able to detect vehicle faults and short-term, sporadic influences on trackside infrastructure. This includes natural hazard management such as falling rocks and trees, catenary flashover or protecting infrastructure from vandalism, cable theft or unauthorised access to track systems.

When establishing FTS-assisted CBM concepts, the evaluation and classification of detected changes must be viewed as a fixed component of the maintenance process. One key step is the definition of threshold values for issuing a notification, and the sensitivity of the system. The high sensitivity level of the system means that a range of errors can be detected at a very early stage. At the same time, however, the risk of flagging up unimportant locations increases. This is where empirical values are really needed, so that the optimum setting can be calculated for the operator. Thus the experience of maintenance engineers will always be essential for developing the algorithms and evaluating the results: the maintenance engineers are called upon time and time again to categorise the actual relevance of a notification on the basis of their knowledge of the track section and the systems. Even in times of advancing digitalisation, employee experience will thus continue to form an indispensable basis for railway operations. This makes them helpful tools that improve efficiency while reducing ongoing costs. ●

AUTHOR

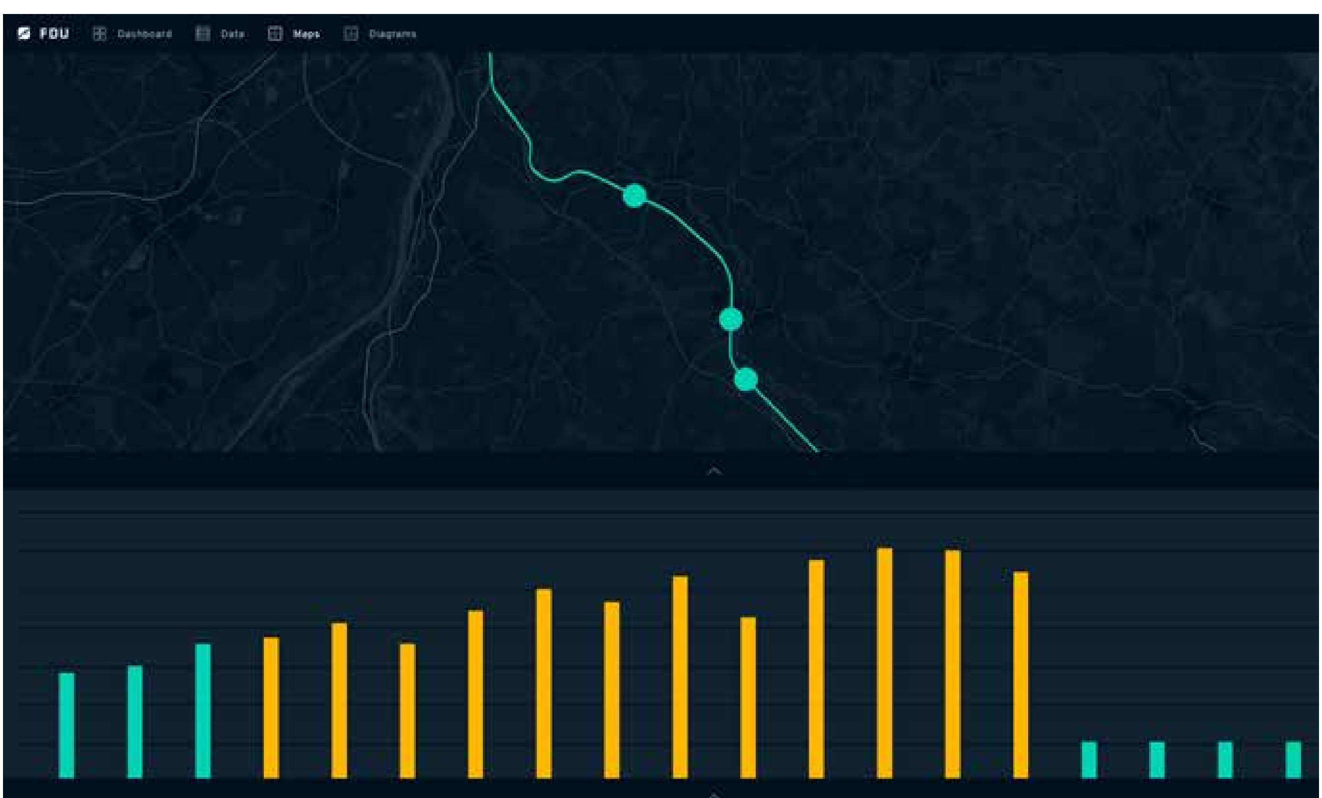
Stefan Huber,

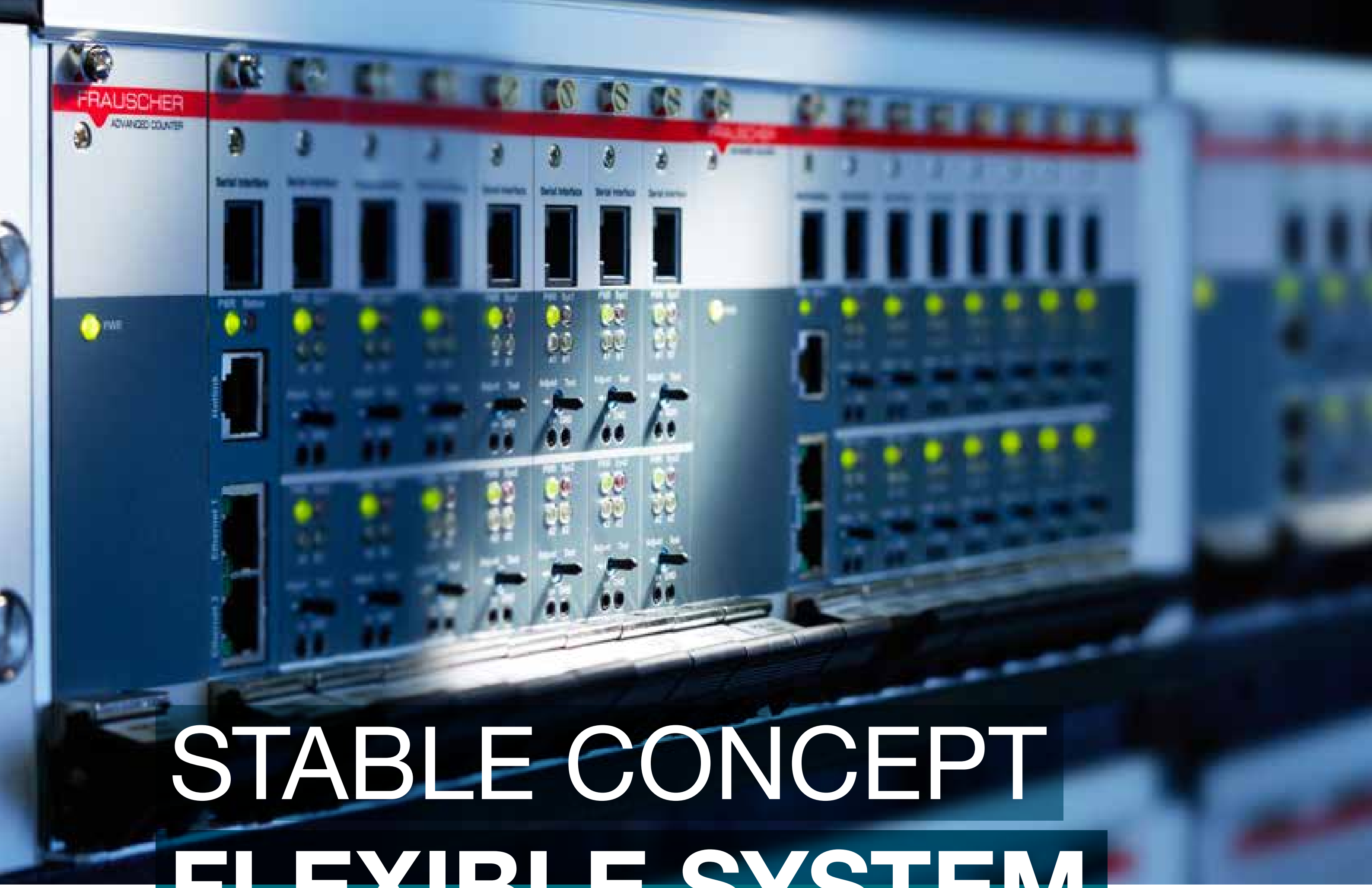
Product Management | ACM,

Frauscher Austria

INNOVATIVE TOOLS

The evaluation of the frequency and development of detected faults is an ongoing process. Growing databases for innovative tools can assist maintenance teams with their work.





STABLE CONCEPT **FLEXIBLE SYSTEM**

TRACK MORE WITH LESS

The FAdC delivers data reliably even in challenging circumstances

- **Choice of** parallel/serial interface
- **Serial protocol** FSE available
- **Custom protocols** can be implemented
- **Flexible architectures** are possible

Reliable and precise: An ever-increasing proportion of operators and system integrators are being won over to axle counters. Their primary use is for track vacancy detection, for which specific criteria apply depending on the market. The Frauscher Advanced Counter FAdC accordingly offers great flexibility here.

The work of the team at Frauscher that is entrusted with the ongoing development of Frauscher Advanced Counter FAdC is comparable with a train journey: tall mountains give way to wide-open steppes, then small villages, big cities and all the rest. In places the route is single-track, and in others the rail structures are complex. Specific requirements may arise depending on where the company's axle counter is deployed. The team responsible for the FAdC is therefore constantly gathering inputs and developing new functions based on the system being extremely flexible. The FAdC thus provides a broad platform for responding to customer- and market-specific requirements. This is impressively illustrated by a number of examples.

Ever ready: increased availability

Especially when the FAdC is used in the field of SIL 4 applications, availability is a key factor. For this reason, not only have a variety of redundancy concepts been developed over the years, but also some specific functions that further improve system availability.

Autocorrection on the track: the Supervisor Track Section function, abbreviated to STS, is an automated fault correction process. Every two track sections are overlaid by a supervisor section. Consequently, it is possible for a faulty track section to be reset automatically, without manual intervention, if the corresponding supervisor section is clear. Similarly, a faulty supervisor section is reset if the two corresponding track sections are clear.

Counting the items that really count: the Counting Head Control (CHC) principle avoids fault messages being generated by unavoidable factors. If the adjacent track sections are clear, the counting head is switched to a stand-by mode. In this idle state, a freely configurable number of undesirable instances of damping can be suppressed. Short-term influences do not generate a malfunction or occupied notification: there is no need for a reset. Approaching vehicles switch off the stand-by mode, meaning that they are detected and the occupied indication is output in a fail-safe manner.

Special solution: push trolley algorithm

The FAdC makes highly market-specific adaptations possible as well as higher-level solutions. Frauscher has had a presence and a base in India since 2013, and the Indian railway industry needed a market-specific adaptation. The team on the ground in India has meanwhile expanded to around a hundred people, and they are familiar with all the specific detail of that market. One element of this is dealing with what are known as push trolleys.

To this day the use of these manually-operated rail vehicles is widespread in India. They are mainly used for inspecting infrastructure, track condition or signalling systems. The challenge: push trolleys can be placed on the track at any point. If this is done on a section on which track clear indication is performed using axle counters, when the trolley crosses the next wheel sensor the result will be a count error. If push trolleys are only used on sections that are not being used by trains at the time, then this scenario can be rectified with the CHC function. However, especially on long sections – for instance between two stations – a trolley may be placed on the track in an occupied section. If it crosses a relevant wheel sensor it can be detected and cause a fault.

Working in collaboration with their Indian colleagues, the experts from Frauscher succeeded in developing a solution in the form of a special algorithm. It is based on the ability of the Frauscher wheel sensors to determine the wheel diameter. Since push trolleys are fitted with smaller wheels, they can be detected and suppressed. In this way the requirements of the Indian railways industry were fully satisfied even in this respect.

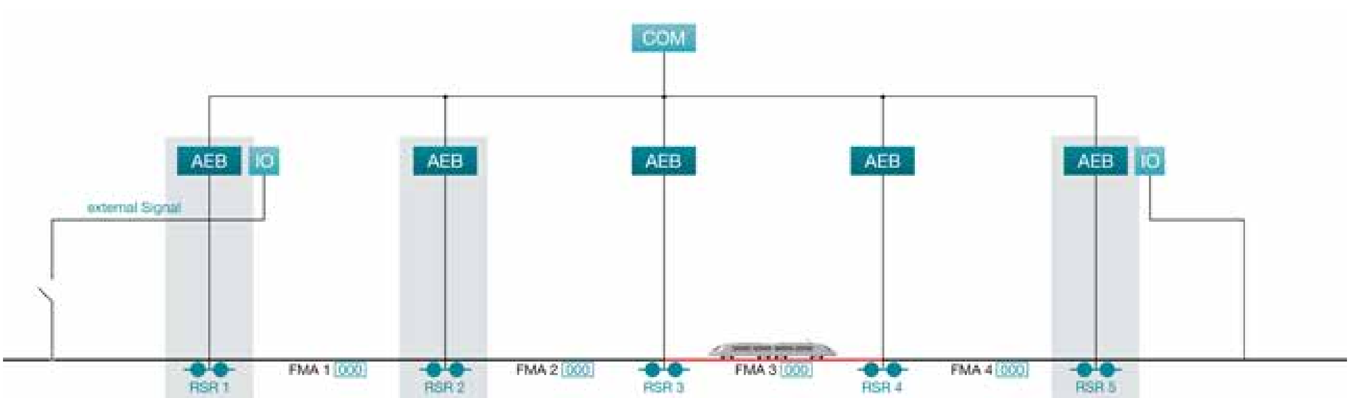
Local inputs – global solutions

This example illuminates the flexibility of the FAdC system. Alongside this development some additional features were also implemented in the corresponding adaptation. These are based on inputs from other railway sectors around the world – and can be deployed beyond the original national borders:

- STS and CHC can be deactivated for maintenance purposes
- Instances of damping that have been suppressed by CHC are highlighted in the diagnostics data
- Resets initiated by STS are highlighted in the diagnostics data
- For each track section, STS can now configure four rather than two virtual track sections

Furthermore, the FAdC system environment, which can be connected via a serial interface, is being continuously improved. Data is transferred using separately implemented, customer-specific protocols or the Frauscher Safe Ethernet FSE protocol (developed in-house). FAdC also has its own tool environment, which makes installation and maintenance even easier. The system is thus ready to tackle new challenges. ●

AUTHOR
Melanie Kleinpötzl,
Manager Product Management,
Frauscher Austria



↑ Counting Head Control CHC: active counting heads at traversed sections

AT HOME ON THE TRACK

Iron, wood, stone and concrete: the immediate environment alone can be more than a little challenging for wheel sensors. Frauscher has been constantly improving its wheel sensors through the years. Even the most basic model in the range can now withstand the most adverse of conditions.

Wheel sensors are produced for one purpose only – deployment on the track. The conditions that await them there may well strike fear into the hearts of similar products from other industries: heat, frost, flooding, industrial waste, extreme mechanical or electromagnetic influences, to name but a few. Despite all this, these devices need to perform their task dependably whatever the circumstances. From their inner workings and potting compound to their housing and fixing device, all these elements have to be up to the job.

RSR180: A rock in the range

The first wheel sensor Frauscher produced was the RSR180. When Josef Frauscher invented this sensor in 1987 he put in place the foundation stone for all the subsequent models which the company now supplies to operators and system integrators all round the world. Even today the durability of this grandfather to all the later sensors is plain to see: the RSR180 remains in Frauscher's product range to this day, more than 30 years on. Against a background of new technical possibilities and experience from around the world, it has been optimised time and time again through the years. The changes that have brought it to its latest version, the RSR180 GS05, highlight the positive features than now characterise this sensor:

1 **Mechanical enhancement:** The housing design and bolts have been improved in such a way that the sensor can be attached to its mounting with a torque of up to 40 Nm. This increases the stability of the entire system in the face of extreme mechanical influences.

2 **Potting compound:** Changing from epoxy to polyurethane further improved the sensor's durability. As a result, cracks that could allow moisture to penetrate inside the device are even less likely to develop. Furthermore, the potting compound and sensor housing

now boast fire resistance to ULV94 V-0, meaning that the sensor is approved for use in tunnels.

3 **Cable connection:** Its location in the middle of the sensor makes installation easier. The tensile forces affecting the cable are reduced. This change also makes it easier to lay a larger loop in order to minimise the bend radius of the cable. This has the effect of preventing cable faults and damage to the sensor resulting from stress on the cable connection.

However, the fundamental principle on which the RSR180 is based has remained unchanged throughout the years. To this day this makes it one of the most reliable and accurate wheel sensors ever. The philosophy of Frauscher has always been characterised by a spirit of innovation; a spirit that remains undiminished. This spirit is why Frauscher succeeded in producing such an impressive product that is equal to the differing requirements of railway markets around the world. The RSR180 is now used in over 70 different countries. And those who developed it are still learning new tricks.

A firm grip on the rail

Frauscher also patented a rail claw decades ago, and this too has undergone constant development through the intervening years. It enables sensors to be attached to the track without any drilling. The mounting height is freely adjustable on all models of the Frauscher claw. The SK150 rail claw also has clamps fitted on its sides that make it extremely easy to adjust for different sizes of rail foot. On the SK140, which has until now been supplied along with the RSR180, this was made possible by providing a choice between clamping bolts of differing lengths. Since the RSR180's update, it too is mounted with the SK150, which just adds to its versatility. For other rail profiles Frauscher can also offer, for instance, the SK420 for grooved rails or the SK140-010 for slab tracks with restricted mounting space.

The family of sensors is growing

Frauscher is carrying out further market- and user-specific development on even the later wheel sensors. The company's bold approach to implementing user-friendly innovations percolates down and results in a variety of features. One of these is the plug-in connection on the RSR123. The sensor itself combines different inductive processes. It is therefore extremely resistant to electromagnetic interference.

The RSR110 is designed for non-fail-safe applications and is now available in two system versions: the single wheel sensor RSR110s has an individual sensor system for direction-independent detection. The double wheel sensor RSR110d is equipped with two sensor systems and enables wheel detection along with directional information. Thanks to their open analogue interface, both wheel sensors can be easily integrated into the electronics of any system. This enables system integrators to adapt the evaluation of the information perfectly in line with individual requirements. ●

AUTHOR
Hannes Kalteis,
Product Management,
Frauscher Austria

PRODUCTS

RSR180: new unit version with the SK150 rail claw

RSR123: highly resistant to electromagnetic interference

RSR110: enables one-off analyses

CONTACTS & DATES

Frauscher is always present at key rail events around the world. 2018 shall again bring many opportunities for a personal discussion, and not just at InnoTrans. Appointments: marketing@frauscher.com

EVENTS REVIEW

RAILWAYTECH INDONESIA

22-24 March 2018 | Jakarta, ID

Frauscher presented its latest innovations for the first time at a trade fair in Indonesia.

RAILWAY SIGNALLING SYSTEM CONFERENCE

15 June 2018 | Taipei, TW

This customer event was organised by Frauscher; for the company it represented a successful gateway into the railway market in Taiwan.

THE RISE OF IOT AND BIG DATA IN RAIL

29 May 2018 | Munich, DE

Michael Thiel, CEO of Frauscher Sensor Technology, gave a presentation on Frauscher's new approaches to all aspects of IoT and big data in Munich.

RAILLIVE

20-21 June 2018 | Long Marston | UK

Large numbers of attendees at Europe's largest outdoor trade fair in the railways industry took this opportunity to meet the experts from Frauscher UK.

COME AND VISIT OUR EXHIBITION STAND

- **InnoTrans**
  18-21 September 2018 | Berlin, DE
- **SIFER**
  26-28 March 2019 | Lille, FR
- **Railtex**
  14-16 May 2019 | Birmingham, UK

ARRANGE A MEETING

- **Alpine Rail Optimisation**
  8 November 2018 | Vienna, AT
- **Digital Rail Revolution**
  21 November 2018 | Paris, FR
- **AusRail**
  27-28 November 2018 | Canberra, AU
- **Intelligent Rail Summit**
  7-29 November 2018 | Malmö, SE

WDF 2019

- **Save the date: 5-7 June 2019 | Vienna, AT**

We warmly invite any interested experts to submit a paper from September 2018 for the fifth WDF. The theme is "Intelligent sensing and tracking". The key issues to be explored shall be trends in train tracking and the condition monitoring of track systems. Further details and information as they are announced can be found on the event website:
www.wheeldetectionforum.com

Key dates:

Submission deadline for abstracts	**20 Dec. 2018**
Communication regarding acceptance	25 Jan. 2019
Submission deadline for full papers	18 Feb. 2019
Submission deadline for presentations	20 May 2019

IMPRINT

Issue
02.2018

Owner and publisher
Frauscher Sensortechnik GmbH, Gewerbestrasse 1, 4774 St. Marienkirchen, Austria

Editor-in-chief
Christian Pucher

Editors
Fabian Schwarz, Irene Schneebauer

Editorial Design
Anneliese Fraser

Photos
weda3D – The CGI company, Foto Resch, Frauscher Sensortechnik GmbH, iStockphoto, Q2 Werbeagentur GmbH, N+P industrial design

Printing
Wambacher Vees e. U.

Contact
+43 7711 2920-0
+43 7711 2920 25
marketing@frauscher.com
www.frauscher.com

5TH WDF

INTELLIGENT SENSING AND TRACKING

5-7 June 2019 | Vienna, Austria

Radisson Blu Park Royal
Palace Hotel Vienna

The 5th WDF provides an ideal platform for a wide range of railway experts from across the globe to share their latest insights and exchange their experiences.

WDF 2019

CALL FOR PAPERS

The streams of the conference focus on: Innovative sensing and tracking solutions for train localisation and asset condition monitoring.

Abstract 300 words in English

Submit at:
info@wheeldetectionforum.com

TIMELINE / IMPORTANT DATES

20 December 2018
Abstract Submission Deadline

25 January 2019
Acceptance notification

18 February 2019
Final Paper Submission Deadline

20 May 2019
Final Presentation Submission Deadline

5-7 June 2019
Conference

Excellent **networking** possibilities

More than **200** railway experts

20+ technical presentations

International discussion plattform

www.wheeldetectionforum.com