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Ultimate Rail

MAGAZINE FOR RAILWAY TRACKING

12 INTERFACES

How a broad interface portfolio can increase the added value of data-based information.

20 DATA MASHUP

Overlaying data from inductive sensors and Distributed Acoustic Sensing opens up new possibilities.

NETWORKING
CREATES
ADDED VALUE OF INFORMATION

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Dear reader,

Digitalisation took hold in the railway industry long ago – and is progressing at an ever-increasing pace. We are coming across associated keywords such as big data, artificial intelligence and cloud computing on a daily basis now. These conceal numerous challenges and changes – but at the same time, just as many opportunities and possibilities, if not more.

Exploiting this potential and being able to successfully shape the associated change process requires profound know-how and creativity. A decisive factor here is the openness to share knowledge, make findings available and exchange ideas with all stakeholders. In addition to this, it is crucial to be open to new ideas and approaches which at first glance may seem completely new to the industry.

We believe that networking creates information – and that communication is the key to this; whether it be exchanging information with research partners, integrators and users during the design phase of a project – or at system level. The better individual units and subsystems are linked to one another, the more valuable and efficient the output. Only then can innovations emerge that offer what is needed.

In this issue of our customer magazine, we would like to give you an insight into how we interpret this philosophy in more detail. The associated and highly topical issues will also be discussed, using exciting examples, at the Wheel Detection Forum 2017 in Vienna, which I would like to take this opportunity to cordially invite you to.

Until then, I hope you enjoy reading this edition of our customer magazine Ultimate Rail.



Michael Thiel

CEO, Frauscher Sensor Technology



MIXED NEWS

Developing cutting-edge solutions together requires a great deal of flexibility and openness. This philosophy is an essential factor of Frauscher's success – and also supports the continued growth of the company.

30

YEARS OF FRAUSCHER

is being celebrated this year. Since the company was founded by Josef Frauscher in 1987, it has successfully established and further developed its position as market leader in the field of axle counting and wheel detection.

40+

ON-SITE ASSIGNMENTS

on the customer's premises – totalling more than 2000 hours – have already been successfully completed worldwide this year by the Frauscher service team.

10

FTS INSTALLATIONS

have already been installed by Frauscher since this revolutionary technology was launched. Based on the knowledge gained so far, these applications are now being further optimised in cooperation with the relevant operators, system integrators and research partners.

80 000

METRES

of a track can be monitored by a single FTS unit. Several units can be joined together to monitor additional track sections. This provides a comprehensive solution for train tracking, condition monitoring of train and infrastructure components, and for different safety applications.

11

PERCENT OF TURNOVER

is invested into research and development every year at Frauscher. This makes it possible to further develop new approaches such as Frauscher Tracking Solutions FTS.

15

NATIONALITIES

are represented among Frauscher staff, who often work in their respective home country.

11

SITES

are operated worldwide by Frauscher, including the opening of a new office in France. Following initial projects in France and in the Maghreb states, Frauscher will now further strengthen its presence in these sectors.

600

PARTICIPANTS

on average every year take part in roughly 80 Frauscher training courses. These are either offered at one of the global Frauscher sites or directly on the customer's premises.

18 000

WHEEL SENSORS

were installed worldwide in 2016. Altogether, more than 140,000 wheel sensors from Frauscher are currently being used around the globe, all working under different climatic conditions.



→ Vast quantities of data are recorded in the railway sector, but only purposeful networking can produce information.

RAILWAY: DIGITAL WITHIN ANALOGUE

Digitalisation is the dominant topic in the railway industry too.

All available data must be used intelligently for this purpose. This is emphasised by Stefan Marschnig, Associate Professor at TU Graz.

Has the railway industry missed the digital revolution? This is the impression it gives sometimes with the constant talk of the “rise in digitalisation” in the field of science and the railway industry. However, the rail sector is anything but an analogue specialist field that has been left behind. Instead, digitalisation arrived decades ago – much earlier than in other sectors. For a long time now, railways have been controlling operations digitally, collecting large volumes of data and making data-based decisions. The challenge today therefore does not lie in digitalisation itself, but in making use of its technical possibilities to convert raw data into valuable information.

Do not confuse data with information

Data is commonly used once only to answer questions like “what?”, “where?” and “how often?”. The following examples, however, show how additional information can be generated by analysing existing data. This means that data can also provide answers to the question “why?”, thereby contributing to system optimisation through a more essential, targeted use.

The recording of incidents using measurement ↘

? HOW DIGITAL IS THE RAILWAY?

The railway is already digital in many sectors and aspects, as is clearly illustrated by various examples of data collection systems. What these approaches have in common is that the acquisition of data is often of a local and selective nature.

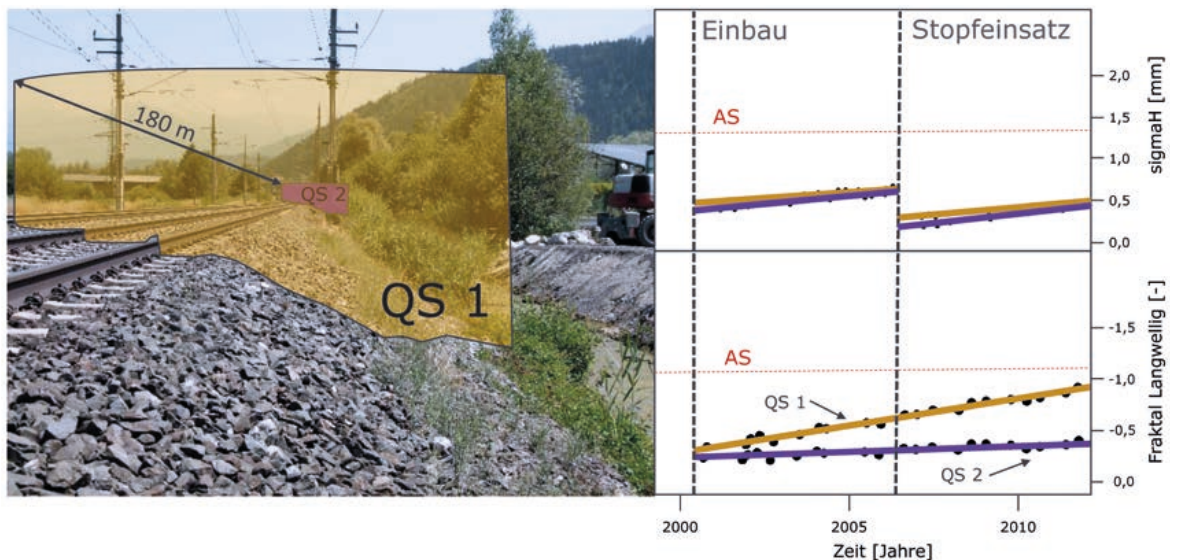
- ➔ Track test carriages which show exceeded thresholds and thus support reactive maintenance.
- ➔ Self-monitoring infrastructure systems which report faults, which in turn are then rectified reactively.
- ➔ Fixed measurement points where trains are tested in regard to a wide range of aspects, which in turn leads to train stoppages where conditions are safety-critical and – even without this operationally undesirable measure – again lead to reactive action.
- ➔ The train operation itself, in terms of safety and signalling systems, train paths, routes and other numerous operational processes.

technology is without a doubt crucial to everything safety-related and to the railway. For example, unauthorised access to the tracks, external manipulation of systems and system components, or unsafe operating states. Combined real-time data is also an undisputed added value to the operational aspect, for instance when passing on accurate information to passengers. The technical progress of the rail system cannot however be achieved by merely

collecting data or through data networking; what is needed instead is data analysis. Only then can we understand signs of wear and tear inherent to the system and optimise hardware and any associated processes.

NETWORKING DIFFERENT DATASETS

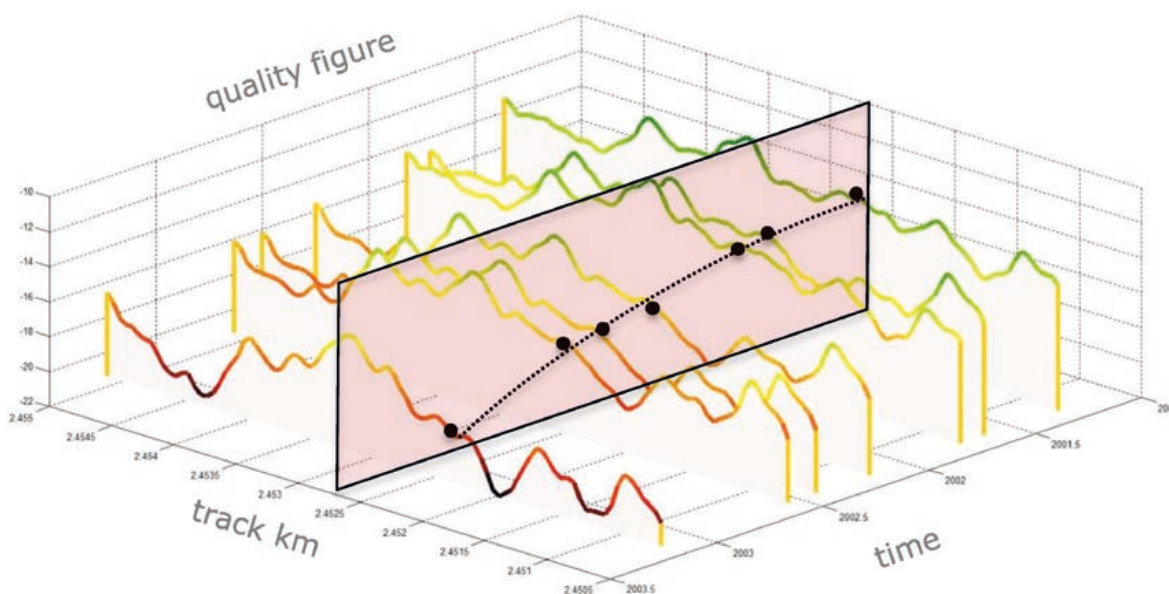
Data with different levels of detail can complement each other. With alternative evaluations – in this case, by means of fractal analysis – new information can be obtained from existing data.



MEASUREMENT DATA ANALYSIS IN TIME SERIES

Considering the change in signal within a temporal context provides a description of condition trends.

Based on corresponding databases, it is then possible to generate a variety of information.



Data analysis based on a substructure assessment

The Institute of Railway Engineering and Transport Economy of the Graz University of Technology has spent more than 15 years focusing on the description of the track superstructure behaviour. Since the quality of the track superstructure cannot be described based on data from a single measurement run – but its current condition can – work began on analysing the track position data of consecutive measurement runs and describing it using quality trends.

The data analysis does not take into consideration the linear expansion of a measurement signal with regard to a current condition, but instead its chronological sequence. In order to investigate the reasons for different changes in condition, the boundary conditions of the track being examined must be taken into account during the next step. Data from the test carriage of ÖBB-Infrastruktur AG is therefore combined with other datasets in this example. The condition trends can thereby be analysed dependent on the curvature, track superstructure, track load in total gross tonnes per day and the age of the system. Maintenance work that has been carried out, such as track tamping, rail grinding or cleaning of the ballast

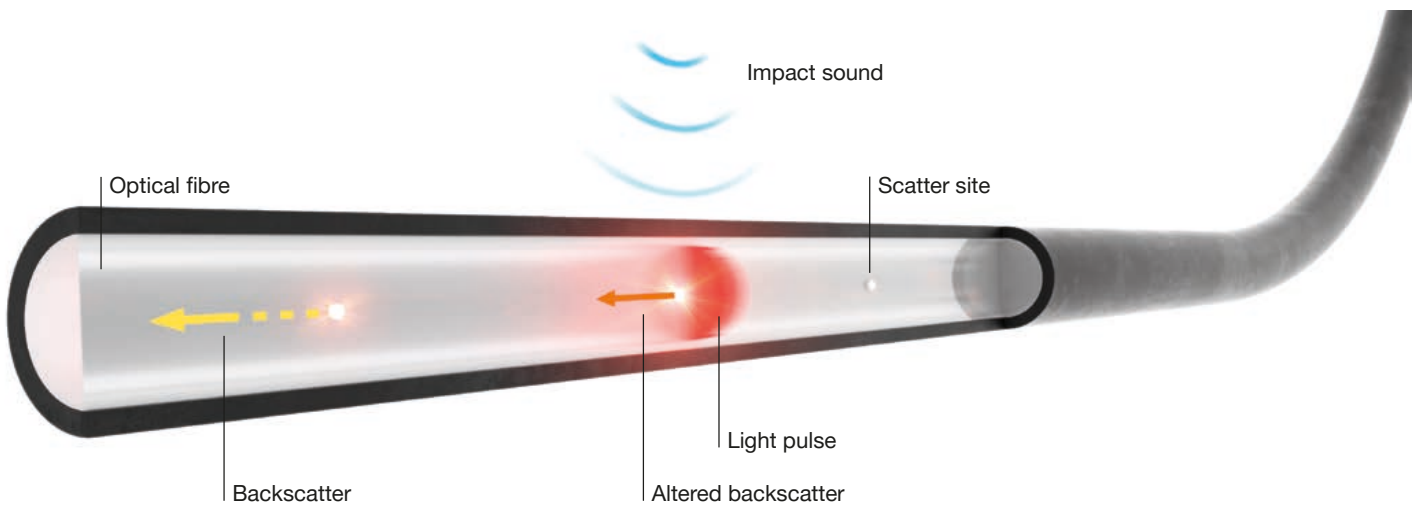
bed can also be taken into consideration together with the relevant date and processing time. This database (TUG-DB) allows detailed searches for the detailed analysis of the course of the track position to be carried out.

This approach, which can be read in detail in Dr Matthias Landgraf's dissertation, shows that data with different levels of detail can complement each other and that, depending on the objective of the statement, different data should be collected and evaluated.

Data analysis – the outlook

In the next few years, additional research and application fields will emerge against the backdrop of ever-increasing and more cost-effective technical possibilities for data collection and storage. The networking of different datasets shown in the previous example can be enhanced by (at least) two additional essential aspects: the prompt recording of local errors and further specification of the load collective. The Institute of Railway Engineering and Transport Economy has already requested and started some research projects, which are dedicated to both of these aspects. As far as measurement technology is concerned, the focus is on four technical options: ↘

↓ Fibre optic measurement systems are ideal for a wide range of tasks.



→ Onboard Measuring (OBM)

Simple and inexpensive measurement equipment can in the future be fitted onto standard trains (this is already happening in part today). Very consolidated data series, for example of accelerations, can promptly detect a sudden system failure. The detection of breakages of rail and frog parts or of rail joint failures is significantly improved by this trend.

→ Fixed measurement points (Wayside Train Monitoring Systems, WTMS)

As already mentioned, the load collective is crucial to the damage mechanisms along the route. The carriage-specific presentation of this load collective already provides a much more detailed picture of the cumulative load. This data model is nevertheless based on major simplifications, since the vehicle forces are derived from the as-new condition of the vehicles. Recording interaction forces that actually arise at fixed measurement points involves an additional stage of detail since wear conditions on the vehicle (for example flat wheels) are received, which in turn significantly affect the forces.

→ Fibre optic measurement systems (Distributed Acoustic Sensing, DAS)

The acoustic evaluation of light waves, which are transported in the tracks fibre optic cables, is a promising technology. Intelligent

evaluations of these light waves could give infrastructure operators tremendous added value. On the one hand, this allows for safety-related aspects (unauthorised track access, protection of work crews) to be presented metrologically. On the other hand, the technical monitoring of the wheel-rail contact is at least theoretically feasible. This would mean that both trackside and on-board points of failure (for example broken rails and flat wheels) could be identified. If, however, evaluations like these are combined with already existing databases, this could provide answers to outstanding questions regarding the system reaction and ultimately the system configuration and coordination.

→ Local metrological arrangement of track/point components (smart assets)

To fully understand which forces actually affect the infrastructure and to what extent, it may be useful to take local measurements, for instance on point components or individual sleepers. A continuous, network-wide arrangement of all assets will not be considered, not only for economic reasons, but also because having a large number of sensors installed would lead to an increased number of error messages.

Besides a basic understanding of the data generated, the correlations between the data are also of particular interest. If, for example, flat wheels are detected on WTMS, then these can be identified as DAS samples.

**“AS A RULE,
DATA BY ITSELF
IS NOT YET INFORMATION.”**

Equally, force peaks would have to occur on local track components, and by analogy, on the vehicle, and thus be identified in the OBM. The DAS and OBM technologies could then use information again from single-point observations in linear extension. Research will show how this additional information can be used over time in terms of the quality behaviour of the route.

Future measures

With all of these technical possibilities, one question remains to be answered first: How much should be measured? The more data to be compiled, the higher the probability that

- a. this data is not utilised further and
- b. that data and information derived from it contradict each other.

The validity of measured data and therewith its reliability is of paramount importance to the infrastructure operator. When taking measures and making decisions, digital stops here – the measures are and remain analogue. Being able to monitor infrastructure systems as best as possible and based on data is one thing, but making decisions about measures and implementing them is an entirely different matter.

The derivation and implementation of measures is influenced by numerous boundary conditions, and not the system itself. Valid state-of-the-art technical evaluations hereby form an essential basis for decision-making, but cannot however result directly in an analogue measure. Economic considerations, available budget resources, resource planning and – particularly when it comes to the railway – operational aspects must be included in the planning and implementation of measures in order to ultimately guarantee having the right measure, at the right time and in the right place. This analogue world is not likely to change much in the future, whilst on the other hand the digital possibilities will continue to make rapid progress when it comes to evaluating the condition of systems. With regard to the basis of decision-making, it is essential to draw on the best available know-how. ●



↑ Fixed measurement point ARGOS of ÖBB-Infrastruktur AG



AUTHOR

Assoc. Prof. Dipl.-Ing.
Dr. techn. Stefan Marschnig,
Associate Professor, TU Graz

→ Interfaces have a determining influence on the depth of information of data.

A woman with short dark hair and glasses, wearing a blue denim shirt, is looking intently at a computer monitor. The background is a server room with blue lighting and blurred server racks. The text 'HOW SYSTEMS COMMUNICATE' is overlaid on the bottom right of the image in white letters on a dark teal background.

HOW SYSTEMS COMMUNICATE

No function without communication: interfaces make sure that components of the railway infrastructure are networked effectively.



Each network is only as strong as the nodes that hold it together. This also applies to the networked systems of the railway infrastructure, which has numerous levels and components. Interfaces are therefore crucial to the transmission and exchange of complex data or whole data packets. They form a basis for the functioning of interlockings, monitoring and diagnostic systems, level crossing solutions and signalling equipment. Component manufacturers must therefore ensure that their products can communicate with existing structures and other systems.

Different interface formats are used depending on the solution, requirement and possibilities. A distinction is usually made between parallel interfaces and serial interfaces. The specific features of the two groups include the type and scope of data that can be transmitted, and the possible safety standards and type of data transfer media that can be used (see table on page 14).

Simple and direct: parallel interfaces

If application data is output via switching contacts, then an exclusive data connection is needed for each transfer and each direction of transmission. This applies when connecting a sensor to an evaluation unit or when forwarding the evaluated data to a higher-level system. This means that more and more connections need to be installed as the number of components to be integrated rises. The safety of the transmission, which is usually provided via a copper cable, must be classified as outstanding since components are arranged repeatedly on the interface. The likelihood of a short-circuit between the conductors must also be ruled out.

Using these proven, voltage-free hardware interfaces, axle counters and wheel detection systems can, for example, be easily and quickly integrated into electromechanical, relay and electronic interlockings. If an axle counter is exclusively used for train detection, it generally transfers the “clear/occupied” information via a relay interface as an output variable. It receives

the “resetting information” via a voltage-free input, such as an optocoupler.

Multi-directional and flexible: serial interfaces

Serial interfaces offer a range of benefits compared to parallel solutions. These include being able to easily implement decentralised architectures and the bidirectional transmission of various information via a single connection. They are already being used as standard these days in the railway industry for more complex applications. And based on the current trend, it is clear that in future they will be used even more frequently.

Transmission of various application data

To output application data via serial interfaces, at component level it is possible to connect via Ethernet, glass-fibre or radio connections, for instance. In comparison with systems with parallel interfaces, the hardware outlay is significantly less since a common connection can be used for various data. This in itself enables a serial interface to exchange a series of additional information such as direction or speed, in addition to the output of “clear/occupied” or “reset”.

Diagnostic data too can be transmitted in the same way as safety-relevant data when protocol interfaces are used. An additional communication channel therefore does not need to be set up in addition to the actual system connection. When using parallel interfaces, the flexible extension of the data transfer is not possible. In order to do that, specific contacts would have to be set up from scratch for the transmission of each individual piece of information.

Safety protocols

A prerequisite for using serial interfaces is that the relevant safety protocols are available. The development outlay required may initially strike the user as being an extra cost factor. However, thanks to rising demand, different protocols specifically developed for railway applications are now already available and can be used for this purpose. The freely available Frauscher

Safe Ethernet FSE is an example of this kind of protocol. You can read more about this in the article “Strictly according to protocol” (pages 16-19).

Data transfer media

Software interfaces can provide data via various media and networks. Besides fibre optic cables, the media also include radio

connections and copper cables. It is crucial that the requirements in accordance with EN 50159 for safety-relevant communication in data transfer systems are taken into consideration in the railway sector. Since Category 3 networks essentially hide the risk of unauthorised access, it is advisable to use Category 2 networks in order to protect the railway infrastructure. These manage without the need for cryptographic protection of the data being transmitted – and with it, an update at short intervals.

→ Modern axle counters can be integrated via parallel or serial interfaces.



Exploiting the full potential

Existing systems based on hardware interfaces can usually be extended in the future. This is because new components can for instance be integrated via relay interfaces if they are equipped accordingly. But the full potential of data can only be exploited at a cost. While switching contacts demonstrate a very good real-time behaviour due to their extremely short response time, the specific inputs and outputs required due to the exclusivity of the lines, which was described at the start, are very expensive.

When implementing new systems, serial interfaces can provide significant savings since the infrastructure can be used in succession to the transmission of various data. This not only means independence from the respective transmission medium, but also the possibility of a flexible system extension. By using the defined protocol, other components can be integrated with relatively little hardware outlay.

Outlook: networks and clouds

The possibilities that digitalisation offers also lead to increased demands on data processing and storage in the railway sector. The set-up of corresponding network structures is progressing quickly. As is the case in many other sectors, the use of cloud applications is becoming increasingly significant. They are especially impressive when it comes to the preservation and constant availability of data.

The aforementioned demands on safety and availability, which play a vital role here in the railway industry, mean that these

	PARALLEL	SERIAL
APPLICATION DATA	Limited possibilities	Extensive possibilities
SAFETY LEVEL	Proliferation of components with failure detection	Complex safety protocols
TRANSMISSION PROTOCOL	-	Internet protocols, UDP, TCP, IP
TRANSMISSION MEDIUM	Copper cable, exclusive line per information and direction of transmission	Various media can be used (glass-fibre, WiFi, radio, etc.), transmission of different information via one line

developments still face huge challenges. In principle though, we must assume that suitable solutions with regard to diagnostic data will be available sooner rather than later unlike in safety-relevant areas.

Data transmission, data processing and data storage – here too, digitalisation is driving change in the railway industry. There is no shortage of examples of this. Cloud-based data management is already being used in various sectors and increases the potential even further through big data storage, machine learning and cognitive computing. In safety-relevant sectors in particular, these approaches must also go through a series of specific developments. ●



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 Manager,
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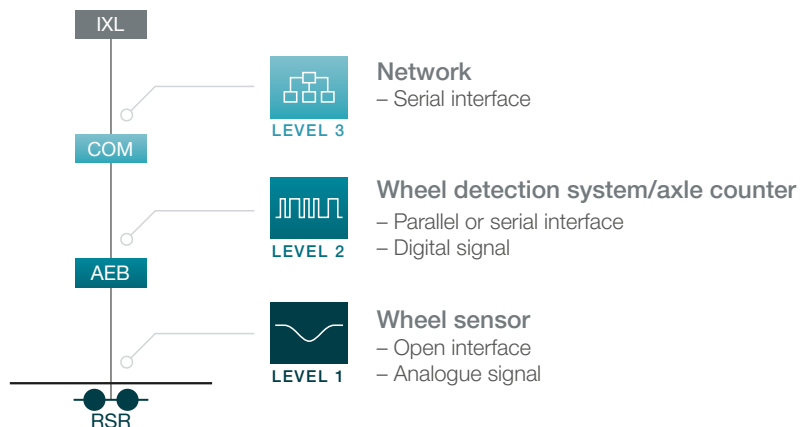
FOCUSING ON CUSTOMER BENEFITS

Parallel and serial interfaces offer specific benefits according to requirements. That is why it goes without saying that we should offer all interface variants in the product portfolio in order to cater for all types of integration.

We want to maximise the benefits to our customers and therefore make our data available via analogue or digital interfaces. Full integration of our systems into higher-level networks is also possible. At integration level 1, the RSR110 wheel sensor emits a separate evaluable sensor signal via an open analogue interface. Our wheel detection systems and axle counters provide data evaluated at Level 2 as information via digital interfaces. In turn, this can then be fully integrated into higher-level architectures at Level 3, via the Frauscher Safe Ethernet FSE protocol or by implementing customer-specific protocols. The disclosure of company know-how will of course give rise to controversy. However, we have made a conscious decision in favour of doing so as we consider the customer benefits to be overriding and want to make sure that our customers can use the systems independently.

Rudolf Thalbauer

Research & Development Director, Frauscher Austria



→ Software protocols open up a wide range of possibilities in the railway sector.



**“STRICTLY
ACCORDING TO
PROTOCOL”**

Railway applications are becoming more and more complex. Melanie Kleinpötzl, Frauscher Product Management, explains in an interview how high-performance software protocols guarantee the essential problem-free communication between systems.

It is impossible these days to imagine the railway industry without digitalisation and networking. What role do software protocols play in all this?

The use of digital data has opened up a wide range of new and improved applications to the railway industry. This has facilitated the mutual exchange of a wide variety of information between systems. But this transfer of data needs more than just suitable interfaces. Digital communication only becomes possible by implementing the relevant protocols – thereby giving them a key role.

Selecting the optimum software protocol must therefore be taken into consideration at the project planning stage. Either a protocol that is already being used in the existing system is adapted, or a protocol that is alien to the system or a completely new protocol is fed in or developed. In any case, there are different factors that should or must influence this decision.

Many system integrators are already using specific protocols. What should they consider when making adaptations if new components are to be integrated?

We have already implemented three projects where this very approach was chosen. This has allowed us to gather valuable experience in the interplay and compatibility of protocols and interfaces and we know that having precise knowledge of the respective protocol specifications, for instance with regard to the initialisation process, is indispensable. Basic prerequisites must also be fulfilled at hardware level. The adaptation of existing protocols can therefore incur considerable costs, depending on the requirement.

But, if a system integrator has implemented a secure protocol of its own in order to bring about communication between interlockings or in order to communicate with the elements located in the field, then the connection of, for example, an axle counter or tracking solution via that very same protocol will be the simplest and most effective solution for the system

integrator concerned. This is because this guarantees that additional data can be easily integrated into the existing system environment and then processed further.

And what are the options if there is no protocol?

This is when you usually revert to existing protocols, which however have not yet been used with the existing system and must therefore also be adapted accordingly. For applications within the railway sector, this also means taking into consideration the relevant standards and requirements. As the data transfer system is generally exposed to a diverse range of threats, it must be possible to identify the message errors listed in EN50159. In the past, countless standardised and proprietary protocols were developed that incorporated the corresponding security features. The standardised protocols, such as UNISIG, Subset-098 or RaSTA, are mostly very complex, with the result that implementation would give rise to considerable expense.

Proprietary protocols are available both in simple and complex forms. They have often gone through developments, which generate partly unnecessary overheads that are carried forward. Specifications may well be available, but these often lack additional matters that must be considered at the implementation stage. The main problem, however, relates to the entitlement to implement this protocol in the first place and then to use it.

So, the Frauscher Safe Ethernet FSE protocol was developed against the backdrop of these different options?

Yes indeed. The objective of the work on the FSE in the first instance was to develop a railway-specific software protocol. Based on UDP/IP, this facilitates communication between two points, thus satisfying the requirements in accordance with CENELEC SIL 4 and EN 50159 Category 2.

This significantly speeds up the integration of new components in various projects. Up to 201 bytes of application

data can be sent in two directions via a safe transmission in cycles. Besides information of up to 40 counting heads or 80 track sections via just one communication board, this includes resetting information and I/O information from the interlocking to the communication board. Redundant board or network structures are also supported.

Why has Frauscher opted for the Ethernet format when developing this software protocol?

What clinched it for us was how widespread the format is: Ethernet is state-of-the-art and can be used as standard in most existing networks, with no additional hardware costs. With regard to use in the railway sector in particular, various benefits speak in favour of the Ethernet format. These include the extremely safe connection, which assures very high-speed data transmission – up to real-time transmission.

And the very stable connection ensures that virtually no data is lost. The vast address space allows for a large number of participants to have simultaneous access. Furthermore, it is also possible to transmit various data via a network ↘

+ TRACK MORE WITH LESS

The Frauscher Safe Ethernet FSE protocol has already proven itself many times over.

- ➔ Freely available, railway-specific software protocol
- ➔ Rapid integration and system extension
- ➔ Bidirectional transmission
- ➔ Freely definable datasets can be transmitted



➔ The Ethernet format offers a range of benefits.

where different data transfer media, such as cables, optical fibres and radio can be combined.

How does Frauscher make this protocol available to its customers and partners?

We have discussed this at great length, as we do not simply want to give away our newly acquired know-how without any thought. The unanimous decision in the end, however, was to make the FSE freely available for various applications. This is also in keeping with Frauscher's philosophy:

Both parties should benefit from the open partnerships and collaborations with users – namely by exchanging information and practical use.

So far, the FSE protocol has been successfully implemented on four different PLC platforms. This made it possible for us to implement twelve customer projects for various applications. These solutions are now being used around the world. In 20 other companies, work has already started on implementing these solutions using additional hardware platforms. All in all, information relating to the protocol has

201

bytes of application data

Safety-relevant, non safety-relevant and freely definable data can be transmitted with FSE.

1

universal protocol

Software protocols can be used to transfer a diverse range of data.

4

hardware platforms

The FSE protocol has been successfully implemented on PLC platforms from Siemens, Pilz, HIMA and Schneider.

20

ongoing collaborations

Working together with system integrators and operators, Frauscher is implementing FSE in customised solutions.

so far been discussed with 80 interested parties to explore the potential in various applications.

And even though the protocol was specifically developed for transmitting axle counting data, its beneficial features have also enabled it to be used to transfer non-axle counting data. We too are learning something with every new implementation.

To receive the freely available information about the FSE protocol, simply get in touch with us. Once details such as the intended purpose and any possible adaptations have been clarified, we can get started with the

implementation work – together and with a completely flexible approach, but always strictly according to protocol. ●

80 potential interested parties

Positive experiences from markets around the world are increasing the demand.

12 implementations completed

The possibilities of simple and rapid integration have had a positive effect on the project's progress.

INFORMATION

FSE enables a range of information to be transmitted

- Information on status of track section (FMA)
- Current number of axles in a track section
- Train length indication
- Direction
- Speed
- Wheel diameter
- I/O information from the AEB/IO-EXB
- Test byte
- Other freely definable datasets

CONTACT

To find out more about the Frauscher Safe Ethernet FSE, contact:

➔ melanie.kleinpoetzl@frauscher.com



MIXED TECHNOLOGY FOR MORE INFORMATION

↑ The networking of data from various systems increases the level of efficiency and safety in the rail sector.

Mixing wisely for real added value: When Distributed Acoustic Sensing (DAS) is linked to axle counters and inductive wheel sensors, valuable information can be generated for railway applications.



In the field of signalling technology, axle counters and wheel detection systems based on inductive wheel sensors are often used for data collection purposes. These provide single-point, yet highly accurate data on train detection, the number of axles, speed or the direction of travel. For solutions based on Distributed Acoustic Sensing (DAS), data is continuously collected and evaluated as real-time information. In 2016, as the market leader in wheel detection and axle counting, Frauscher combined its tried-and-tested products with DAS to form the Frauscher Tracking Solutions FTS. This marked a crucial step forward.

Potential draws global interest

The revolutionary potential of the basic physical principle was already apparent during the evaluation of the use of DAS in the railway sector. Since then, together with interested operators, system integrators and research institutes, Frauscher has already developed fundamental concepts and ideas and set up various installations.

From the experience gleaned, new approaches were and continue to be realised for other applications. At the same time, it became apparent that further optimisation would require close cooperation and the open exchange of information, along with a joint analysis and assessment of the results.

A single fibre is sufficient

Installing the FTS is a very efficient way for operators to upgrade their infrastructure. The fibre optic cables needed are already in place along many routes, since they are often used for communication purposes. The fibre bundle only needs a single fibre to integrate the FTS. Vast sections of the route can therefore be expanded economically and efficiently.

Tests have shown that a single DAS unit can optimally cover up to 40 kilometres of glass-fibre. Various signatures of people on the track or travelling trains can be classified within this range. Persons and comparable acoustic sources can be detected within a radius of 5 metres from the fibre optic

cable, whilst trains with a considerably higher acoustic energy level can even be detected at a distance of approximately 50 metres. These values are influenced by various factors, including the condition and quality of the cable, the type and site of routing and various surrounding sounds.

Cable quality and condition

Various versions of the fibre optic cables are available, which can effect the sensitivity. Whilst the quality and purity of the glass-fibres co-determine the range, the material, strength and condition of the sheath can increase or restrict the sensitivity of the system.

Type and site of routing

Until now, ideal results were obtained with cables laid in a concrete cable tray or directly into the ground, running approximately three to five metres away from the track. Other methods, such as attaching the cable directly to the foot of the rail or to attachments near the track, might make it easier to detect certain acoustic sources. However, they prevent the parallel detection of other influences.

Surrounding sounds

Since the FTS detects and classifies different incidents through its acoustic signatures, all acoustic sources in the vicinity of the track must be taken into consideration. All of these influences combined can lead to overlaying, which in turn must be taken into account in the evaluation. Corresponding filters can, for example, mask firmly located and routinely detected acoustic sources. Depending on the intensity of the acoustic emission, the distance of the acoustic source to the glass-fibre also plays a role. This interaction can also cause weaker signatures, for example from steps, to be overlaid by stronger distinct signals, like a train.

A combination equals more output

By combining the inductive sensor and DAS technology, the FTS is able to offer the railway industry numerous new possibilities for data generation. Implementing data from the operator's

other systems can improve the quality of the information even further, but also places special demands on interfaces and data formats. In test installations realised up to now, various applications have already been implemented in the fields of train detection, infrastructure monitoring and safety applications.

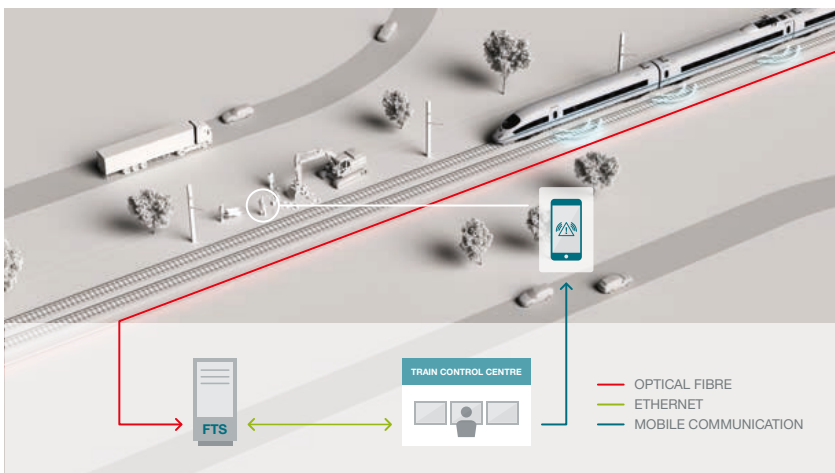
More information means better safety

The oil and gas industry successfully uses DAS for a range of safety applications. Adapting the corresponding algorithms for the railway sector was therefore one of the first steps to be taken when developing the FTS. This enables people and animals on or in the vicinity of the track to now be detected. It also allows various safety applications to be implemented, such as the detection of activities associated with vandalism or cable theft.

Passing on data and linking it with additional information further increases the potential of the applications. This means that interfaces to safety equipment can be used to provide alarm messages by email or SMS. Work crews can be accurately located and provided with information, for instance about approaching trains, via a direct connection on mobile devices. Even drones can be supplied with data which is then used to directly fly to a section to be controlled.

SAFETY ALONG THE WHOLE LINE

Information about various activities can be forwarded directly to maintenance personnel via mobile devices, for example.

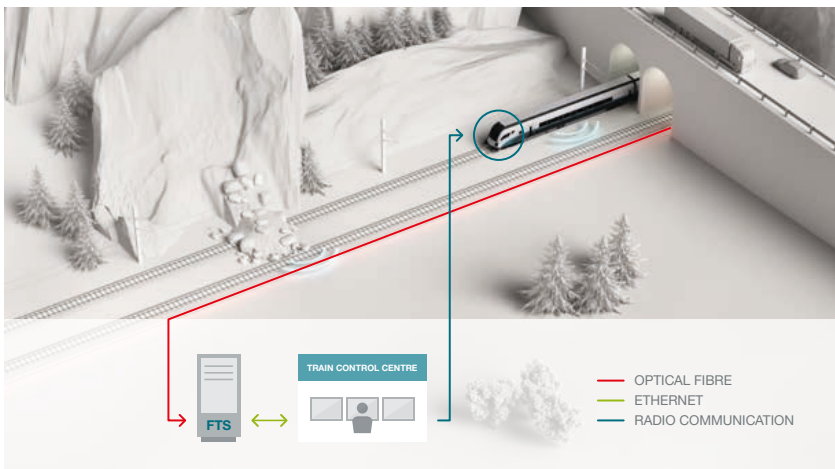


Condition monitoring: listen to your infrastructure!

When monitoring the condition of infrastructure and train components, the FTS can supplement or even reduce equipment installed trackside. For example, this allows flat spots on wheels or broken rails to be identified based on acoustic signatures. Rock falls can also be located and the corresponding information can be forwarded directly via radio to approaching trains. In accordance with the current state of the art, DAS-based systems do not allow you to assign identified signatures directly to a certain track. A decisive interface is therefore an interface to a wheel detection system which is used in parallel. If data from both systems is overlaid, certain incidents can be localised with even greater accuracy along the route. Integrating information from the operator's different databases can enrich this data pool even further: if train numbers are implemented, flat wheel alarms can be assigned to a specific train, and to a specific axle via the wheel detection system.

ALL COMPONENTS AT A GLANCE

Early detection of damage, caused either by rock fall or broken rails, increases operational safety and supports urgent repair work as well as predictive maintenance.



Real-time train tracking

The FTS make it possible for all trains within a monitored track section to be located in real-time. In non safety-relevant areas, they can also be used as a stand-alone solution, i.e. without integrating an axle counter or wheel detection system. Since no specific equipment has to be fitted to the vehicles, their design and origin are insignificant. The information obtained provides considerable benefits for traffic management. In remote areas, this technology can provide a cost-effective and efficient solution to controlling systems.

Integrating an axle counter, for instance the Frauscher Advanced Counter FAdC, makes it possible for the DAS-based real-time tracking of trains to be combined with safety-relevant applications. Associated interfaces enable level crossings to be controlled with even greater precision. Inputs from both systems can be combined in the Traffic Management System (TMS) in order to calculate accurate times of arrival, supply platform displays or to precisely coordinate and compose platform announcements.

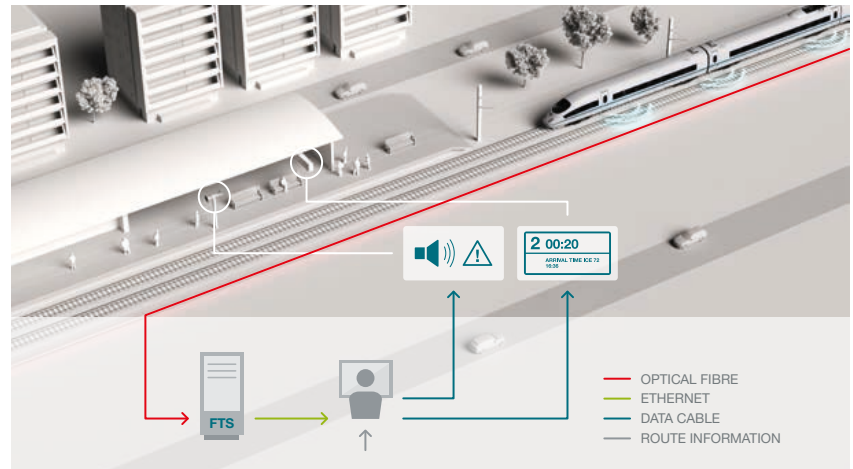
Outlook

The knowledge gained so far shows that the chosen path to develop two parallel strategies will continue to hold true. On the one hand, existing components must be optimally linked to the new technology in order to generate additional information for different applications, quickly and at no extra cost.

On the other hand, new architectures need to be developed at the same time. Results from previous installations have contributed to associated concepts being intensified even further. It has become apparent here that, in particular, the networking of data from different sources offers great potential for optimising existing and developing new applications. The possibilities of a pre-evaluation of this data must now be driven forward in order to be able to efficiently extrapolate information and use it in a targeted manner. The

REAL-TIME TRAIN TRACKING

Data from the real-time train tracking can be used to optimise traffic management, for example for platform announcements and platform displays.



requirements for data transmission and storage – as is the case in many other sectors – are therefore once again the topic of discussion in the railway sector. ●



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→ Wheel sensors with an open interface are used for individual evaluations.

THE QUESTION REMAINS: ANALOGUE OR DIGITAL

Signals from wheel sensors can be analogue or digital. Manfred Sommergruber uses the example of the Frauscher RSR110 wheel sensor to explain the respective features.

+ TRACK MORE WITH LESS

The open interface of the RSR110 opens up a whole range of possibilities.

- **Accurate and reliable** completion of measurement tasks
- **Real-time transmission** of data
- **Flexible** evaluation options
- **Simple integration** via analogue or digital interface

Openness is the way forward: when developing solutions for the railway sector, this means that information on and about the interface is passed on in a comprehensible and structured manner. This is the only way to make know-how available, which can then be used to optimally identify and meet the requirements of individual projects.

If inductive wheel sensors are developed following this philosophy, then this offers a whole range of specific benefits. Thus, the sensor signal is made available unchanged and directly via an open interface, whereby implementation and evaluation can be completely customised. Direct integration also ensures the maximum level of detail during the evaluation. Since no specific evaluation unit is needed, the need for hardware components, space and energy consumption and the associated costs are reduced to a minimum.

“The conviction that a wheel sensor with an open analogue interface can offer

significant benefits to system integrators and operators, was the driving force behind the development of the RSR110. This wheel sensor combines robustness and reliability and is the first one from our portfolio that is available without an evaluation unit. Our customers can use the sensor signal as required by the respective application,” says Manfred Sommergruber, Technical Sales Manager at Frauscher, explaining the history behind the product.

Soon after its launch, this wheel sensor was installed in a wide range of applications – and new ones continue to be added. For example, Prosoft now uses the RSR110 as a standard component in its RFID systems. “Based on the open interface of this sensor, we can fully evaluate the signal according to our requirements,” says Martin Novak, CEO Prosoft Süd Consulting GmbH. “The high level of accuracy demonstrated by this device and the flexible integration options were key reasons in our decision to use the

RSR110 today as a standard component in our systems.”

Analogue or digital?

True too of open interfaces is that, in comparison to an analogue interface, the digital version offers benefits in particular with regard to the speedy completion of the integration. Different Frauscher wheel detection systems use special evaluation units here. The resulting digitalised signals go through a pre-evaluation stage, which makes it possible for the data to be further processed quickly.

“After having implemented the RSR110 into several projects, we received positive feedback from various markets. At the same time, however, we discovered as we talked to customers that some do not actually need such accurate information as the analogue signal provides. Instead, a pre-evaluated digital signal including digital interface would have been sufficient in some instances,” says Manfred Sommergruber. “So, we decided to develop a Wheel Sensor Signal Converter WSC, which converts the analogue signal into a digital signal and creates the corresponding interface. This not only reduces the outlay for the customer, who now no longer has to deal with the conversion themselves. It has also led to an even quicker and simpler integration into higher-level systems.”

Flexibility is key

In principle, the same information can be provided via analogue and digital interfaces. They differ in that the pre-evaluation for the signal conversion to some degree limits the possible level of detail of further evaluations, unlike when directly inputting the analogue signal into higher-level systems.

“With the RSR110 and WSC, however, we can always offer our customers exactly those components that meet the requirements of the individual project,” summarises Manfred Sommergruber, giving an example of a project where both approaches were applied: “The feedback from one customer was that he is already using the RSR110 together with the WSC

board to feed the sensor information into his system via the digital interface.

This in turn activates various monitoring systems. However, one specific installation required the exact wheel positions to be evaluated. This requirement was met by directly feeding in the analogue signal, which simply resulted in other RSR110 sensors with no WSC board having to be implemented. It was therefore possible to successfully fulfil two requirements using just the one product.” ●

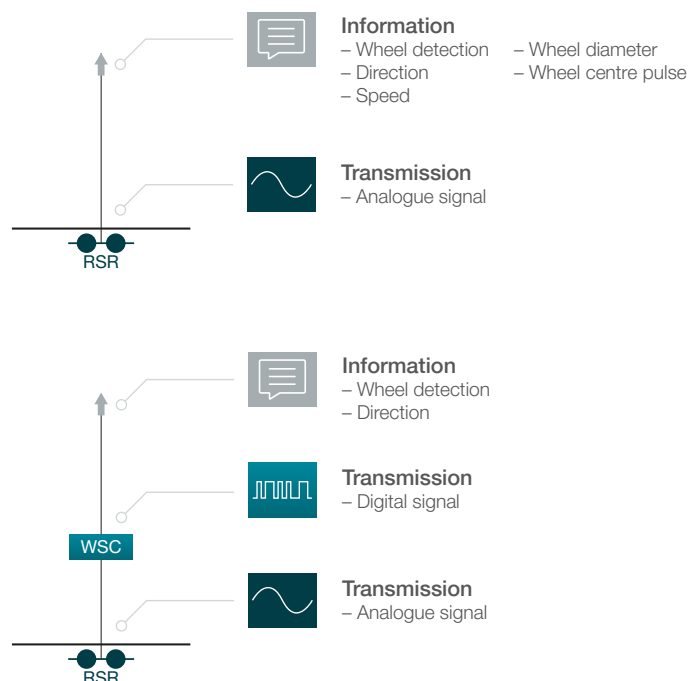


AUTHOR

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VARIABLE SIGNALS

The signal can be used directly from the sensor or can be digitalised first via the WSC for simpler integration.



→ Level crossings must also operate reliably in remote areas.



CROSSING RAILROADS SAFELY

When a new level crossing solution was being developed for John Holland, RCS used the Frauscher Advanced Counter FAdC and FSE protocol.

+ TRACK MORE WITH LESS

The FSE protocol supports the RCS level crossing solution.

- **Less complex** system
- **Financial savings** due to smaller hardware outlay
- **Specific programming steps** in the control unit

Track circuits have been, and still are, used for many railway applications – and the same applies in Australia. Here solutions were created for level crossings using solar-powered DC track circuits, for example. Later on, these were then further enhanced by overlaying with audio-frequency track circuits, before the first axle counter solutions were combined with these approaches. A range of innovative level crossing solutions was therefore developed based on the track circuits. Certain challenges could however still not be met in a satisfactory manner, such as handling weak contacts between the wheel and rail electronics.

Experience is the way forward

Various concepts were developed in order to meet these requirements, but these proved to be less cost-effective. John Holland therefore defined criteria for developing further approaches: high efficiency and reduced costs were some

of the key elements. Flexibility also had to be guaranteed to enable both centralised and decentralised architectures to be implemented. It also had to be possible to integrate additional trigger points, not only via cable but also via radio connections, without having to change the set-up of the actual level crossing control system.

When components become solutions

The system integrator Rail Control Systems Australia (RCS) addressed these requirements when developing a corresponding level crossing solution. After testing various options, RCS decided to integrate the Frauscher Advanced Counter FAdC into the system, as the features of this axle counter fully met John Holland's criteria. After all, its software interface was to be the key to implementing a cost-effective and efficient solution. The simple integration and possibilities to implement innovative system architectures provided

the project with further benefits.

The level crossing solution developed by RCS meets the criteria of GENELEC SIL 4. John Holland decided to test the system further. In October 2016, RCS and Frauscher were therefore given the opportunity to install a test system at Bathurst within the New South Wales Country Regional Network (CRN). John Holland looks after this network on behalf of the New South Wales government department Transport for New South Wales (TfNSW).

Software interfaces save money

With the level crossing solution installed in the test system, a GENELEC SIL 4 approved HIMA F35 programmable logic controller (PLC) is deployed. Communication between the axle counter and the PLC is achieved via the Frauscher Safe Ethernet FSE software protocol.

“Using this protocol not only reduces the complexity of the system, but also provides many financial savings, as less wiring and hardware is needed,” says Stewart Rendell from John Holland. The expert explains the benefits in more detail: “Besides the safety-relevant clear/occupied status, this also allows the transfer of directional and speed information or diagnostic data to the PLC. In order to carry out minor diagnostic work, this data can be accessed via an on-site PC. If a more detailed analysis is needed, the Frauscher Diagnostic System FDS can also be accessed remotely. Furthermore, the FSE protocol also allows specific programming to be implemented in the HIMA control system in order to be able to take so-called hi-rail vehicles into consideration. These are placed onto the track or removed from the track in the vicinity of level crossings. This special programming ensures that this process does not produce an error message in the axle counter.”

Setting standards

The series of tests carried out at the trial installation proved to be successful. The solution created on the basis of the FAdC with FSE interface has the potential

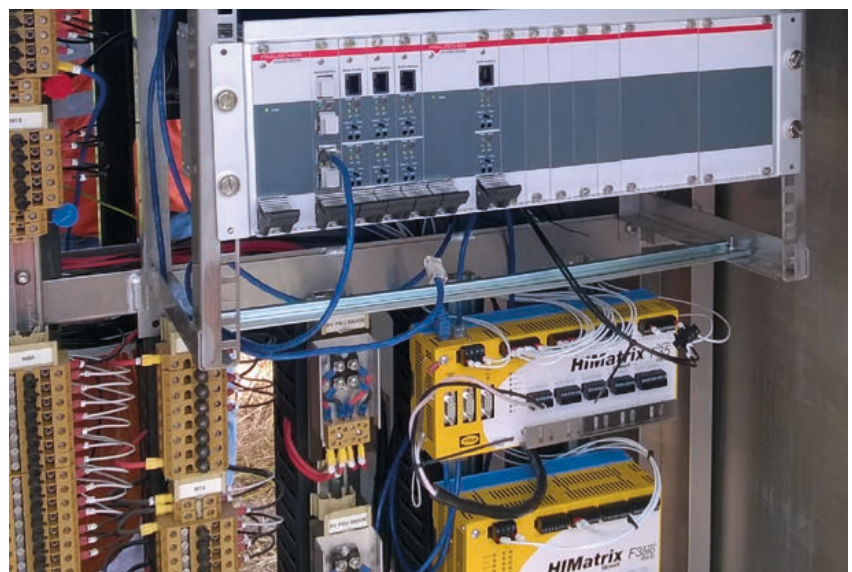
to set new standards for level crossing applications in Australia. Combining the rail-specific software protocol and axle counting software interface makes it possible to easily establish communication with the HIMA control system and easily integrate other trigger points via WiFi. The same protocol can be used here without the need for any additional wiring or changes to the architecture.

In addition to this, the FAdC offers two intelligent functions to handle faults and unexpected impacts. These functions are freely available, at no additional cost. Supervisor Track Sections STS guarantee that a level crossing can continue to be operated safely in the event of a permanent fault with the track section. The Counting Head Control CHC allows damping caused by non-train related metal objects to be suppressed. These functions thereby support the system's availability and at the same time minimise the need for resets, which is especially beneficial in remote areas. ●



AUTHOR

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↑ The Frauscher Advanced Counter FAdC offers smart functions that maximise the availability of the level crossing solution.

→ The infrastructure and environment of the Houston METRO are particular challenges for the signalling components.



TRACKING TRAINS IN HOUSTON

+ TRACK MORE WITH LESS

The FAdC guarantees easy access to information.

- **Easy integration** into existing structure
- **Rapid installation** using special rail claw
- **Increased availability** thanks to smart functions
- **Preventive maintenance** based on diagnostic data

The 51st Super Bowl, which welcomes 700 000 visitors, was the incentive to upgrade the Houston METRO. A new axle counter has further improved the efficiency, reliability and safety of the network.

The network of MetroRail Houston, or METRO for short, which was opened in 2004 and has since been extended across three lines, carries low-floor trains powered by an overhead line. The tracks run interchangeably as grooved rails, on concrete or in gravel beds. This variable track structure and the severe environmental conditions are a huge challenge for the outdoor equipment components. The same applies to the wheel sensors, which are used with axle counters for train detection purposes. As the system that had been used to date had been unable to handle these conditions satisfactorily, the operator decided to explore alternative options. The aim was to further improve

operational safety for the 51st Super Bowl 2017, which welcomes several hundred thousand visitors to the city.

Rain, heat and metal

Extreme heat, humidity, storms with heavy rain and local flooding characterise the weather in Houston. In particular, sensors in housings that are fitted to grooved rails must have adequate protection to prevent the ingress of moisture and must still be able to operate when immersed in water. Rainwater can also carry along metal debris, which is then mistakenly detected by the sensors.

Clear announcements

Houston METRO defined a series of clear criteria for the implementation of a new train detection system. To ensure easy integration into the existing signalling system, it was essential to utilise the existing I/O inputs and cable systems so as to keep service interruptions to a minimum during the changeover. Quick delivery and commissioning was required in time for the Super Bowl, as the large sporting event was certainly going to challenge the public transport system in certain ways.

With this in mind, it stood to reason to evaluate alternative options that could make use of the existing system. The sensors needed to work effectively in busy areas where there are significant electromagnetic influences.

On-site testing

Frauscher reviewed the requirements and installed twelve RSR180 wheel sensors at six non safety-relevant locations for testing purposes. The evaluation was completed using the Frauscher Advanced Counter FAdC. Existing track holes were to be used when fitting the sensors. Frauscher therefore designed a special bracket for the RSR180, which could be mounted to existing holes. Due to the tight schedule, as the project progressed, the decision was made to use Frauscher's proven SK140-010 rail claw, which had been developed specifically for use in situations where there is very little space between the rail and ground. Waiting for further development and approval of the prototype would have taken too long.

Following the initial successful results, another test installation was set up in the interlocking of the Northline Transit Center. The Frauscher Magnetic Noise Receiver MNR was used to analyse all METRO fleet vehicles. Based on the knowledge gained, Frauscher was able to choose a sensor with a special operating frequency to eliminate interference from the outset and guarantee optimum operation.

Minimum effort, maximum output

The tests carried out showed that the FAdC met all of the requirements with regard

to environmental influences, interfaces, reliability and simple integration into the existing infrastructure. The axle counter's flexible design enables efficient data transfer via a relay interface to the traffic control system and interlocking. The cable system only had to be slightly modified and the installation work only had minimal impact on operations.

In addition, two intelligent functions of Frauscher's axle counter were used to tackle unexpected impacts: the Supervisor Track Section STS allows operation to continue when faults from external sources occur, by combining two track sections in a virtual section. It is then activated when a fault occurs on a section. This increases the system's availability considerably without affecting safety or having to install additional equipment and incurring additional costs.

The SIL 4 compliant and patented Counting Head Control CHC function is used to avoid errors caused by unavoidable influences. If adjacent sections are clear, the wheel sensor switches to stand-by mode in which a freely configurable number of unwanted damping, from either metal waste or steel-toe capped boots, can be suppressed. As a result, no fault or occupied indication is generated and a reset is not necessary either. Approaching vehicles deactivate the stand-by mode and are safely detected. The Frauscher Diagnostic System FDS also provides diagnostic data, which can be used to constantly monitor the status and functionality of the axle counter. Selective and regular maintenance work

can thereby be coordinated and planned very efficiently.

The robustness of the RSR180 wheel sensors and the improved availability of the FAdC contributed significantly towards better punctuality during operation. This is how the Houston METRO successfully transported more than 700 000 passengers through the city during the sporting event – a successful kick-off for the public transport system for the 51st Super Bowl. ●



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→ Wheel sensors fitted inside housings must operate reliably under a variety of conditions.

CONTACTS & DATES

Frauscher employees all around the globe are always present at the most important events in the railway industry. Arrange an appointment with us or visit our exhibition stand: marketing@frauscher.com

EVENTS REVIEW

➔ EURASIA RAIL

2–4 March 2017 | Istanbul, TR

Frauscher's good standing in the region was confirmed at Eurasia Rail.



➔ SIFER

21–23 March 2017 | Lille, FR

Participation at SIFER and a new office in Hagenau: Frauscher strengthens its presence in France and Maghreb.



➔ ASLRRA

22–25 April 2017 | Grapevine, US

The ASLRRA was one of five trade fairs where the Frauscher US team is exhibiting this year.



➔ RAILTEX

9–11 May 2017 | Birmingham, UK

Exhibition stand and a newly opened office in the UK: the modernised Frauscher design is reflected in its global presence.



COME AND VISIT OUR EXHIBITION STAND

- ➔ **IHHA**
2-6 September 2017 | Cape Town, SA
- ➔ **Railway Interchange**
17-20 September 2017 | Indianapolis, US
- ➔ **TRAKO**
26-29 September 2017 | Danzig, PL
- ➔ **Nordic Rail**
10-12 October 2017 | Jönköping, SE
- ➔ **NT Expo**
7-9 November 2017 | São Paulo, BR
- ➔ **AusRail Plus**
21-23 November 2017 | Brisbane, AU

OPPORTUNITIES TO MAKE AN APPOINTMENT

- ➔ **FRA Grade Crossing**
15-17 August 2017 | St. Louis, US
- ➔ **APTA Expo**
9-11 October 2017 | Atlanta, US
- ➔ **S+D Kongress**
9-11 November 2017 | Fulda, DE

4TH WHEEL DETECTION FORUM THE FUTURE OF TRAIN TRACKING

➔ 4-6 October 2017 | Vienna, Austria

Detecting and tracking trains and events in order to provide railway operators with valuable information: **this is the future of train detection.** The focus of this conference is on current solutions, which are based on wheel detection, axle counting and Distributed Acoustic Sensing (DAS) or alternative tracking technologies.

Attendance fee: € 370 (incl. VAT)

Incl. documents, catering and networking events

Conference language: English

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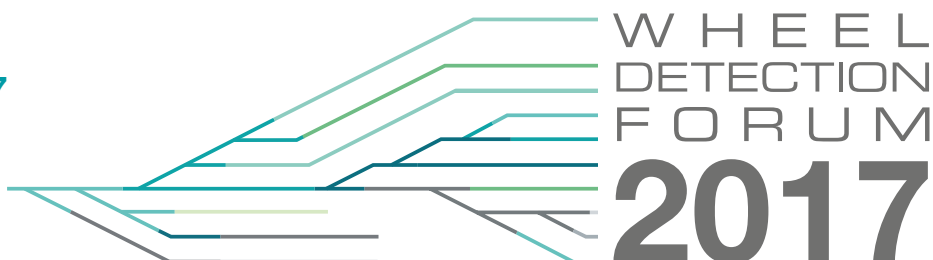
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4TH WHEEL DETECTION FORUM

THE FUTURE OF TRAIN TRACKING

4–6 October 2017
Vienna, Austria



KEYNOTE SPEAKERS:
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