Frauscher Tracking Solutions provide new possibilities for railway applications.

Preventive maintenance and quick configuration: New tools for the FAdC.
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<td>We are where our customers are: We are represented by subsidiaries around the globe and on the floor at all the major railway exhibitions</td>
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Dear readers

“Track more with less”: Generate more information with less effort; this way of thinking is becoming increasingly more important for modern railway signaling systems. True to this philosophy we also want to make it simple for system integrators and operators to get all the relevant information they need to operate and monitor their networks and to protect their infrastructure.

Therefore, we are focusing on improving the performance and reliability of existing products, such as wheel detection systems and axle counters. At the same time we are aiming to simplify integration, diagnostics, and handling as much as possible. We are optimizing systems, reducing the number of components, and making additional information available.

For this purpose we are going to invest even more in research and development in the future. We are also looking for partnerships within new technological areas, such as Distributed Acoustic Sensing (DAS). Over recent years we have tested appropriate technologies that have become available on the market. Encouraging outcomes and the increasing level of interest expressed by several customers have convinced us of the need to develop a new business area based on DAS: Frauscher Tracking Solutions (FTS) fits perfectly within our existing portfolio. Furthermore, it can be combined with our core systems for axle counting and wheel detection. Thus, we can provide our customers with massively expanded options.

This exciting and proven technology opens up a wide range of applications with the ability to track trains, monitor asset condition, secure infrastructure, and protect personnel in real-time using one single solution.

Systems based on Distributed Acoustic Sensing, such as FTS, will significantly improve the way trains are tracked in the near future in a way that is unlike any other existing technology. We are looking forward to being one of the first companies within the industry to provide appropriate solutions and to participate in further developments.

I hope you enjoy reading our latest edition of Ultimate Rail, Frauscher’s magazine and newsletter for our friends across the globe.

Yours,

Michael Thiel
CEO
Frauscher Sensor Technology
We’re making railways safer with innovative technology. Our investments in research and development contribute to this. At the same time, the consistent expansion of production options is creating opportunities to satisfy increasing demands.

8,500,000 EUR was invested in the new Frauscher Innovation Center and in the expansion of our sensor production site at our headquarters in St. Marienkirchen. The Innovation Center will become the international platform for all our research and development activities. And with the production facilities we have been able to significantly increase our manufacturing capacity in order to fulfill customer demands worldwide.

4TH

WHEEL DETECTION FORUM IN VIENNA:
Since 2011 this forum has evolved into a real industry event for leading sensor manufacturers, system integrators, operators and consultants, as well as for representatives from academies and professional associations. Its fourth edition will take place in 2017. Speakers can submit their papers by sending them to: marketing@frauscher.com

2500

LASER PULSES per second are sent into a fiber optic cable by Frauscher Acoustic Sensing’s newly developed optical unit. In this issue of Ultimate Rail, discover how this system, which is based on Distributed Acoustic Sensing, will revolutionize the railway industry.

30,000

WHEEL SENSORS can be manufactured per year at our expanded sensor production facility in St. Marienkirchen. The 500 m² area provides more than enough space and optimum conditions. All inductive sensors and almost all evaluation equipment are manufactured here at Frauscher HQ.
3

SUCCESSFUL YEARS
Founded in 2013, our subsidiary Frauscher Sensor Technology India Private Ltd., located in Bangalore India, is celebrating its birthday.

400

TRACK SECTIONS
will be supplied to METRO in Houston, United States. This project will be carried out by our North American subsidiary, Frauscher Sensor Technology USA Inc.

6500

SENSORS
will be installed in the Dedicated Freight Corridor West in India.

Frauscher India has partnered with Hitachi in order to master this project, the most extensive in our company’s history. This enables us to provide our customers with the best service when carrying out their wide-ranging projects.

10,000,000

FAIL-SAFE DETECTED AXLES –
this is what the Frauscher Advanced Counter (FAdC) can achieve on average. The robust design of the hardware and software components provides the basis for detecting so many axles to such a high degree of reliability.
Future network: Thanks to DAS, the glass fibers can function both as sensors and communication media to meet tomorrow’s train tracking needs.
THE NEW GENERATION OF LIVE TRACKING

Technology of the future: Distributed Acoustic Sensing (DAS) transforms fiber optic cables into virtual microphones. This system provides the potential for monitoring train operations as well as railway infrastructure at the same time.

Over the last five years it has become clear that fiber optic acoustic sensing, which is based on such technologies as Fiber Bragg Grating (FBG) or Distributed Acoustic Sensing (DAS), is attracting increasing interest among railway operators and signaling experts. Frauscher has carried out a number of real-life tests in various fields and operational areas in partnership with various suppliers and operators.
After completing these comprehensive evaluation exercises, our experts stated that DAS would have the greatest potential to become a base technology for numerous railway-specific applications. Our experts were able to reach this conclusion based on their collective knowledge of signaling technologies.

DAS for railway operation: Possibilities and potential

This technology can be used to detect the factors that are relevant to this industry, including trains, maintenance vehicles, personnel, trespassers, environmental events, and more. DAS has applications for railway operations, including the monitoring of components on tracks and trains as well as the securing of infrastructure.

From a technical point of view, it is already possible to track events and components on and near the track over a distance of 40 kilometers using just one DAS-based monitoring unit. Whole networks can be monitored by multiple connected units.

Innovative algorithms allow for individual categorization of tracked events. Specific alarms and reports can be generated using this data.

Limitations of DAS for railway operations

However, the railway industry has its very own requirements and standards, so it is essential to comprehensively develop existing approaches. The needs of continuous train tracking, in particular, present new challenges to existing DAS-based solutions. Looking at the most important factors, the main limitations of using DAS on railways can be described as follows:

- **Track ID:** Current DAS systems cannot identify whether detected indications are actually on the track or close to it. It is also difficult to define on which track a train is moving within multi-track areas, and it is nearly impossible in more complex track layouts.

- **Accuracy:** With the current status of technology, DAS does not yet have the proven capability to detect individual axles in a robust or fail-safe manner, which is required for such safety-relevant applications as ensuring train integrity along long stretches of network.

- **CENELEC compliance:** Until now, the necessary basic developments and processes have yet to be established in order to create a solid foundation for SIL applications based on DAS. In addition, the existing limitations regarding the accuracy and location of detection will need to be resolved, to a certain degree, in order to achieve CENELEC compliance.

DAS as a base technology for railway applications

However, these limitations can be overcome. Innovative solutions combined with an intelligent combination of approaches make it possible to use DAS as a base technology for railway applications. You can learn more about how Frauscher is managing these hurdles in this issue of Ultimate Rail.

Let us tell you about how DAS will revolutionize the nature of railway operations and how you can benefit from possibilities previously unheard of, without having to install additional components on your tracks.
Laser impulses transform fiber optic cables into virtual microphones that can detect ambient noises.

HOW DOES DISTRIBUTED ACOUSTIC SENSING (DAS) WORK?

The principle of Distributed Acoustic Sensing is based on changes in the intensity of light reflections caused by sound waves radiating against a single-mode fiber optic cable. These changes can be detected. Thanks to specially developed algorithms, it is possible to transform measurable signatures into valuable information about train movements, people on and near the tracks, and other critical activities like manual or machine digging. DAS is already being used in the areas of oil, gas, and border protection. Any single-mode fiber can quickly be turned into a kind of listening device that takes advantage of DAS while requiring minimal processing of the fiber at either end of the monitored fiber section. By taking advantage of spare capacity on existing fiber cables next to a track, a system can be installed that takes account of railway-specific requirements.
The best of both worlds:
The combination of the Frauscher Acoustic Sensing (FAS) and axle counters or wheel detection systems creates new possibilities for railways.
A range of tests with DAS has revealed that the limitations of existing approaches in terms of their applicability to railways can be overcome through intensive research. Frauscher has formed its own expert team to research the full potential of this technology. All members of this working group have a fundamental knowledge of both DAS as well as the needs and standards of the railway industry.

FTS-FAS: Frauscher Acoustic Sensing – a railway specific DAS

A railway specific DAS-based solution has now been developed in close cooperation with interested railway operators, who have provided valuable input data regarding some important criteria. This data helped determine the particular system solution needed to carry various applications, as well as to transmit and store data, for example. In a subsequent step, the research group developed some prototypical algorithms that make it possible to detect and classify specific events.

Frauscher Acoustic Sensing (FAS), is now available for use in some basic applications. These include train tracking in areas where safety is not relevant and monitoring of infrastructure components, for instance, by detecting wheel flats, rail breaks or the presence of people and activities, such as digging on and near the track.
Even the initial trial installations have revealed a range of additional application areas. Now we plan to make further revisions to hardware and software in order to evaluate further potential applications within these specific fields.

**Integration with detection systems: FTS-FAS**

One initial idea for how to deploy FAS is to use the technology together with proven wheel detection systems and wheel sensors. By overlaying data from both approaches, we can increase the possibilities of applying such information to decision-making. Trains can be assigned to tracks, and their length can be determined more exactly. Furthermore, detected events and the particular conditions of assets, such as wheel flats, can be accurately localized. Thus an integrated solution with wheel detection systems enables the use of FAS on multi-track lines, where several rails are connected by numerous switching points.

**FAS provides additional information for modern axle counters: FTS-FAdC**

The most sophisticated proposal consists of combining FAS with a modern axle counter, such as the Frauscher Advanced Counter (FAdC). In this configuration, the FAS provides valuable data to support complex and safety-relevant applications, given that the axle counter operates on the basis of CENELEC SIL 4.

Using FTS-FAdC+, the axle counter can be used as a fail-safe system to detect vacant tracks, while data input from FAS, such as dynamic determination of train location or estimated time of arrival (ETA), can be supplemented.

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**FAS Display Unit**

The HMI provides clear information and alerts.

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**DATA**

- **Information from FAS**
  - Train position
  - Direction
  - Speed
  - ETA
  - Headway
  - Rail break
  - Wheel flats
  - Rockfall
  - Catenary flashover
  - Trespassing
  - Cable theft
  - Vandalism etc.

- **Information from axle counter**
  - Clear/occupied indication, including track identification (SIL 4)
  - Number of axles
  - Speed
  - Direction
  - Diagnostic data

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**TRAIN 1677**

---

**Position:** 35 102 m

**48° 21'58.78" N 13° 34'51.15" E**

**Speed:** 107 km/h

**ETA:** 09:15 am

**LXL Riedau**

**Status:** O.K.
**Human Machine Interface HMI**

True to our motto “track more with less,” we have also developed a specific Human Machine Interface (HMI) that makes accessing and handling all generated data as simple as possible: the FAS Display Unit. This ensures the clear delivery of all information as well as the accurate classification of tracked events as a basis for planning and implementing appropriate activities.

Furthermore, information can also be transmitted to mobile devices through text messages or even to drones, which can be sent to appropriate locations according to precise GPS data. In addition, we have made it possible to interface with IT networks.

Whichever option is chosen, FTS allows for immediate response. It can function either as a stand-alone or as a combined solution.

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**CLEAR GOALS FOR FTS**

The concept of our task force seeks to achieve two goals at once: First, we are developing a railway-specific DAS system that can be used in basic applications where safety is not a factor. Second, we are already focusing on creating a basis for combining this new system with proven axle counters and wheel detection systems in order to develop applications where safety is relevant.

Martin Rosenberger,
Product Management Director, Frauscher Sensortechnik GmbH
Frauscher Tracking Solutions (FTS) will be a full train tracking system that enables applications that exceed all expectations and generates new ideas for train control and traffic management.

With the development of FAS, we have successfully adopted the DAS principle. The system can already be used as a stand-alone solution for train tracking in non-vital applications as well as on one-way tracks. Nevertheless, as experts in track vacancy detection with many years of signaling experience, Frauscher has its focus set on vital applications that comply with CENELEC.

**Information²**
When used as a stand-alone train tracking solution, FAS provides information on the train’s position, speed, acceleration, direction, length, and more. The data generated can serve as a basis for optimizing schedule management, train announcements, exact train positioning, and improving the speed profile.

For train tracking to Safety Integrity Level 4 (SIL 4), FAS can be combined with proven technologies. This is possible due to the smart system architecture of all Frauscher products: The axle counter can handle track vacancy detection, while the FAS is able to generate additional information. In most cases, this type of design requires only minimal investments in infrastructure because the required fiber cable is usually already installed along the tracks.

**Combined knowledge for efficient train tracking in new markets**
The coherent integration of both systems in FAdC⁺ enables new possibilities for train tracking and track monitoring. For instance, this system can be deployed to detect track vacancy on long and remote block sections in areas with challenging environmental conditions: In such
DISTRIBUTED ACOUSTIC SENSING CAN BECOME A FUNDAMENTAL TECHNOLOGY FOR TRAIN DETECTION.

In contrast to other approaches, such as ETCS, GNSS or 5G solutions, FTS requires no on-board components. This makes it possible to detect all rail vehicles with a minimum of components, thereby significantly improving efficiency and interoperability. At the same time, this solution is able to reduce the system’s operational costs and decrease its complexity.

Efficient localization of train infrastructure
In contrast to other approaches, such as ETCS, GNSS or 5G solutions, FTS requires no on-board components. This makes it possible to detect all rail vehicles with a minimum of components, thereby significantly improving efficiency and interoperability. At the same time, this solution is able to reduce the system’s operational costs and decrease its complexity.

The future of train tracking
FTS will become a complete system for train tracking that meets all quality, availability, and security requirements. It will open up new applications and ideas in train control and traffic management that exceed all expectations.

"We have done a large number of tests with DAS on our railway networks, and we have gained fascinating results that give us an idea of the potential of this technology. However, we recognize that railway-specific hardware with high resolution and range has to be developed in order to meet specific requirements and railway standards. In anticipation of these future developments, we are certain that DAS can become a fundamental technology for train detection."}

Max Schubert,
Project Leader Distributed Acoustic Sensing, DB Netz AG
One single solution for tracks and trains: Frauscher Tracking Solutions (FTS) combines DAS technology and wheel detection systems, thereby forming a powerful complete system. This facilitates new possibilities for monitoring even complex railway networks.

Smooth railway operations depend on ensuring maximum availability across the entire infrastructure. Therefore, consistent monitoring of every component on both trains and tracks is needed.

Today, a wide range of monitoring systems is available that provides various solutions to this requirement. These highly specific systems, e.g., for wheel flat or hot box detection, allow for punctual monitoring of train components. Precise wheel sensors with high availability from Frauscher are frequently used to trigger appropriate track side equipment for measuring and monitoring. Due to this, our company has been able to acquire comprehensive knowledge on how to implement such applications during recent decades.

Detecting events all along the track

In light of these experiences, the newly developed Frauscher Acoustic Sensing FAS provides an ideal solution, as it enables monitoring of both trains and infrastructure components.

By using FAS, it is possible to monitor whole railway networks, including their surrounding environment. Even events which are unforeseeable and hard to detect...
can be tracked in a reliable way. These include rail breaks, which are known to be a major risk along the track. The system also detects catenary flashovers, floods, rockfalls and downed trees, as well as landslides. This makes it possible to significantly reduce the number of operational interruptions, which can prove to be very expensive.

Minimizing costs while maximizing the output

The DAS-based FAS from Frauscher Tracking Solutions offers a solution for monitoring an operator’s complete infrastructure in real-time. So far, we have developed a range of prototype-algorithms to detect and classify specific events, including rail breaks and loose track joints as well as vibrations from catenary flashovers, rockfalls, and landslides.

The ability to combine this new approach with proven wheel detection systems also makes it possible to monitor components mounted on trains as well as to precisely localize detected events. For this purpose signals from FAS are extended by data from wheel sensors and evaluation boards. These include the ability to precisely position the first and last axles of the train. The system allows you to exactly pinpoint a train on a track and to determine its length more exactly.

By merging and overlaying signals from both systems, it will be possible to precisely localize status information from train components, such as wheel flats that can then be assigned to a specific axle. This makes it possible to use FAS within complex railway networks that include numerous lines running in parallel and that are connected by several switching points.
Efficient railway operations depend on ensuring a high level of safety in various areas. To that end, FAS provides a comprehensive solution that ensures various factors, ranging from work safety to protection against vandalism.

The need to ensure safety presents a multifaceted major challenge of railway operations: Infrastructural components, such as cable systems, cabinets, and the trains themselves, must be protected against theft and vandalism. The safety of all persons who come in contact with the railway system is another factor that must be considered. This ranges from employees to passengers and trespassers.

Huge costs, short ranges
As a result, security solutions for railway stations and other facilities along the tracks have to deal with complex requirements in order to be able to contribute to boosting the efficiency of railway operations. These include reliable detection of activities, transmission of appropriate information to the user in real-time, and ensuring constant availability.

The solutions that are currently used mostly provide a single point of surveillance. In order to meet the requirements mentioned above, a range of complex security systems has been developed. Their architecture often complicates their integration with higher processes. Moreover, the numerous components that are needed to run those installations entail high maintenance costs. Furthermore, security patrols are often employed to conduct random checks at all points along the network, although these systems should actually make such manual checks superfluous.

Safety that comes from one source
The use of DAS is quite common in the areas of oil, gas, and border protection, where it has proven itself for monitoring infrastructure and carrying out various security applications. In following the experiences of these industries, Frauscher has extended the application areas of its products beyond train tracking.

Frauscher Acoustic Sensing (FAS) offers main lines and mass transit systems the opportunity to install an all-in-one security system that can expand the reach of rail network surveillance.
FAS transforms measurable signatures that are produced by such events as vehicle movements or the footsteps of persons into valuable information that can be used to generate alarms and reports about the presence of trespassers, objects, and more. Furthermore, such concrete determinations make it possible to recognize activities such as digging with greater certainty.

**Providing information in the right areas**

Information generated by the FAS is combined with accurate GPS data. It is then transmitted to the Display Unit, where it can be handled according to individual requirements. For example, it is possible to send personnel to the site and to switch off power in the right areas or to determine the most effective escape route when a train needs to be evacuated. The data generated can also be provided to mobile devices or even drones that can be sent to the operation site.

**SECURITY APPLICATIONS**

- **Trespassing**
  FAS can track trespassers in dangerous or restricted areas in real-time. Furthermore, animal flocks can be detected and approaching trains advised to reduce their speed.

- **Working groups**
  With the monitoring range functionality of FAS, maintenance work performed by way and work-crews can be more closely coordinated and better protected, which increases productivity and can improve operational efficiency.

- **Cable theft**
  The level of sensitivity of FAS makes it possible to identify different types of activities, and it can act as a powerful tool to protect against vandalism and theft. This naturally shortens response times by front-line security when reacting to suspicious activities.

- **Vandalism**
  By directing security patrols to the locations that the FAS detects, the effectiveness of these patrols can be significantly increased. A paradigm shift in vandalism prevention will save tremendous amounts of time and resources that are spent on reducing damage remediation.
Rapid installation, high availability, and easy handling: The requirements for signaling systems continue to increase. Frauscher already established a convincing platform with its Frauscher Advanced Counter (FAdC) some years ago. This axle counter has continued to be refined since the time of its original release. In close cooperation with operators and system integrators, a complete tool environment has been developed which meets a broad variety of different requirements. The two latest tool developments are the Frauscher Alarm and Maintenance Systems (FAMS) and the Frauscher Configuration Tool (FCT).

**Frauscher Alarm and Maintenance System (FAMS)**

The new Frauscher Alarm and Maintenance System (FAMS) offers operators a compact solution for monitoring all their Frauscher axle counter components at a glance. Diagnostic information generated by one or more Frauscher Diagnostic Systems (FDS) can be managed via this interface, enabling detailed planning of preventive as well as regular maintenance tasks.

As a result FAMS increases the efficiency of the existing tool environment: Different information can be gathered and forwarded to higher ranking systems at various levels. FAMS can significantly boost the cost efficiency of train operations thanks to this feature, among others.

Clear, flexible, and efficient: Frauscher provides new tools to users of its Frauscher Advanced Counter (FAdC), further increasing the axle counter’s versatile areas of application.
Frauscher Configuration Tool (FCT)
System integrators can speed up configuration of components in their projects by using the Frauscher Configuration Tool (FCT). This new software supports user groups with differing levels of experience. Beginners find it intuitive to use, and experienced users are able to quickly configure it to their needs. It provides immediate real-time updates during configuration processes in case of errors. For double-checking the configuration, an overview table can be displayed instead of individual text files. Additionally, the software allows project templates for common system layouts to be saved and reused. As a result, the FCT makes it possible to achieve significant savings throughout the configuration phase of a project by keeping the amount of human intervention during system commissioning to a minimum.

Frauscher Diagnostic System (FDS)
Furthermore, the use of FDS can minimize maintenance costs: Important information about wheel sensor current, for example, can be read from a central service area. Interruptions can be prevented, since they can be identified before they even occur. However, if a service interruption does happen, it is possible to minimize its actual duration by simplified error analysis and targeted error correction. FDS thus ensures the higher availability of axle counters and wheel detection systems.
We are at your service: Our representatives are available at our subsidiaries all around the globe, within our dedicated FTS-team, at all of the major railway trade shows, and of course at our Wheel Detection Forum in Vienna.

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DATES

GLOBAL RAIL INFRASTRUCTURE
March 9–10, 2017 | Frankfurt, Germany

RAILTEX
May 9–11, 2017 | Birmingham, UK

RAILWAY INTERCHANGE
September 17–20, 2017 | Indianapolis, USA

TRAKO
September 26–29, 2017 | Gdansk, Poland

WHEEL DETECTION FORUM
October 4–6, 2017 | Vienna, Austria

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- Wheel detection
- Axle counting
- Distributed Acoustic Sensing (DAS)
- Further tracking technologies (FBG, GNSS, etc.)
- Interfaces and communication

Presentations should outline future challenges, latest research results, improvement of RAMS or best practice cases. A structured and factual abstract in English – 200-350 words – is required.

Abstract submission closed 20 DECEMBER 2016
Notice of abstract acceptance 10 FEBRUARY 2017
Short paper due for review 10 APRIL 2017

Please hand in the abstract online at www.wheeldetectionforum.com

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