

THERE IS
ALWAYS A
**MISSION
EMBEDDED.**

SMART SAFETY MONITORING OF RAILWAY OPERATIONS

1. Introduction

Safety is the top priority of any sustainable transportation system. Ever-increasing traffic flows, greater mobility and, above all, environmental aspects make rail one of the most popular means of transport today.

However, ensuring safety in this sector is complex, as there is a wide range of risks and threats – like in any other transport system. This underlines the need for innovative surveillance solutions to better protect passengers, staff and property.

Innovative technologies like artificial intelligence (AI) and cloud computing open up completely new dimensions in the area of rail operation surveillance, so that more and more operators are considering switching from complex multi-legacy to fully integrated IoT-based surveillance systems that offer groundbreaking advantages.

2. Understanding the challenges of monitoring railroad operations

As an open and freely accessible system, the railroad carries a wide spectrum of safety risks – whether in stations, on trains or trackside.

The main challenges and threats operators face today include unauthorised intrusions, vandalism and theft on railway premises, as well as potential violence or even terror attacks in stations and onboard, which could ultimately also lead to loss of life.^{1) 2)} Such incidents incur enormous costs as a result of operational disruptions or damage to assets and infrastructure. In 2020, for example, illegal graffiti alone cost Deutsche Bahn 38 million Euros.³⁾

In the light of all this, it is clear that there is an urgent need for improved surveillance concepts to better protect areas of public transport. Only with the help of innovative new technologies like artificial intelligence and IoT-based solutions will it be possible to improve the detection and prevention of potential risks in the future, in order to take faster action and to make operations safer and more efficient.

¹ [Report on Railway Safety and Interoperability in the EU 2022 | European Union Agency for Railways \(europa.eu\)](#)

² [Final Report Summary – GRAFFOLUTION \(Awareness and Prevention Solutions against Graffiti Vandalism in Public Areas and Transport\) | FP7 | CORDIS | European Commission \(europa.eu\)](#)

³ [Bahn: Graffiti-Attacken kosten Verkehrsunternehmen viel Geld | ZEIT ONLINE](#)

Potential threats and challenges in rail operations



3. The benefits of intelligent surveillance systems

For decades, conventional surveillance systems have been indispensable for monitoring safety in rail operations. But not all technologies are keeping pace with today’s high demands on security surveillance. On top of that, many surveillance systems are cumbersome, with multi-legacy systems and software that serve specific needs without interacting – thereby making it unnecessarily complex and tedious sharing information.

New, intelligent technologies can make a significant contribution in this respect. They offer groundbreaking methods of surveillance that can play a decisive role in making rail operations smarter, safer and more efficient (Figure 1).

Harnessing the power of artificial intelligence

AI-powered video analytics provides security managers with real-time information, allowing them to step in more quickly, even before an incident happens. In addition to increasing safety, this also reduces the need for manual monitoring, allowing security managers to focus on what matters most.

Specifically, deep learning in computer vision facilitates a new generation of video analytics. It can automatically detect threats such as obstacles, weapons, vandalism and

unattended luggage. Moreover, the technology can help to manage challenges like crowd control to improve staffing efficiency, security management and traveller safety.

The advantages of cloud-based solutions

Integrated cloud-connected surveillance and management solutions take a big step beyond traditional systems. They offer huge advantages in terms of scalability and flexibility, for example by allowing multiple stakeholders to access video, audio and metadata simultaneously any-time and anywhere. In addition, a cloud-native architecture can be easily customised and expanded to include new features and functionalities that meet customer-specific surveillance needs. A cloud-based surveillance system can be deployed in less than a day.

Figure 2 shows the benefits of cloud-native system solutions. An additional advantage of a cloud architecture is that it reduces the need for in-house resources and capital expenses. Moving services to the cloud means less time and costs needed for hardware, system installation and maintenance. In addition, having hardware off site can free up workspace and reduce power costs.

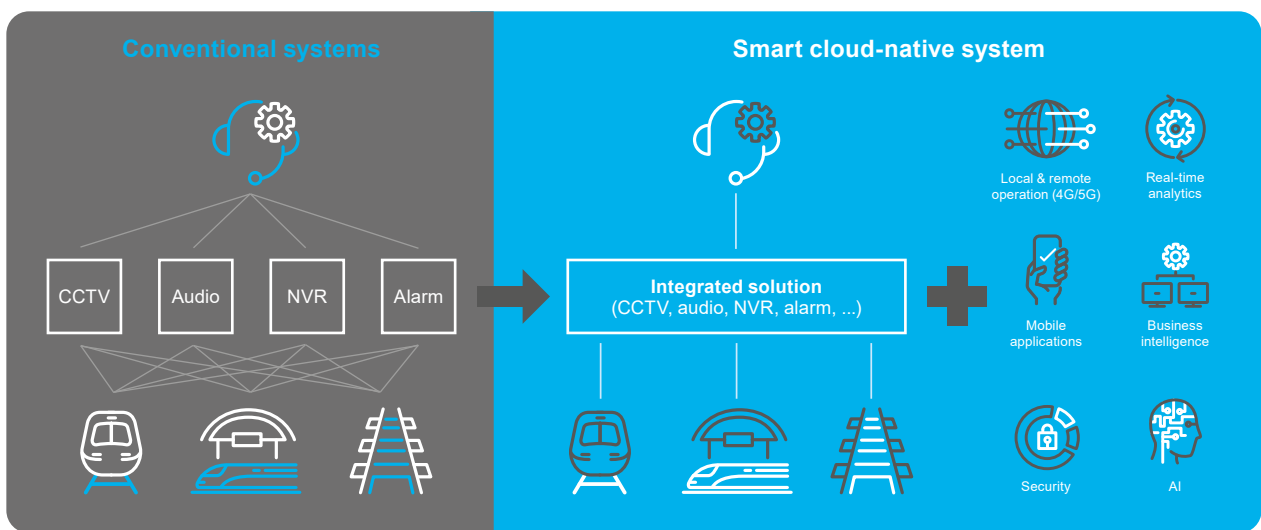


Figure 1: The complexity of multi-legacy systems compared to smart integrated cloud solutions.

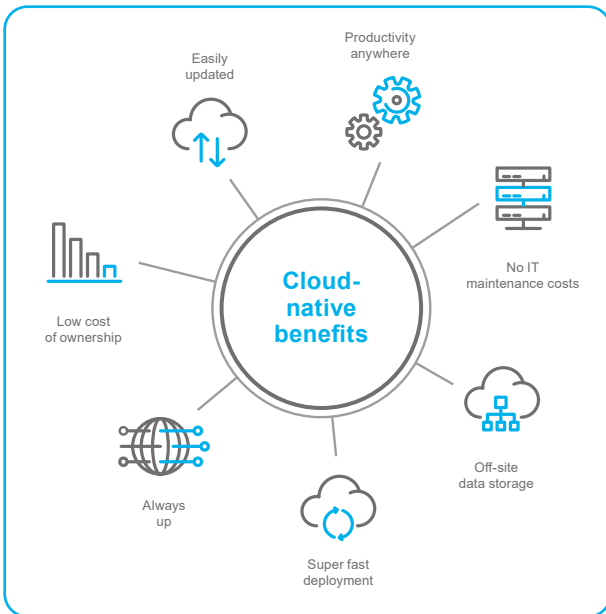


Figure 2: Benefits of public/private cloud-native systems

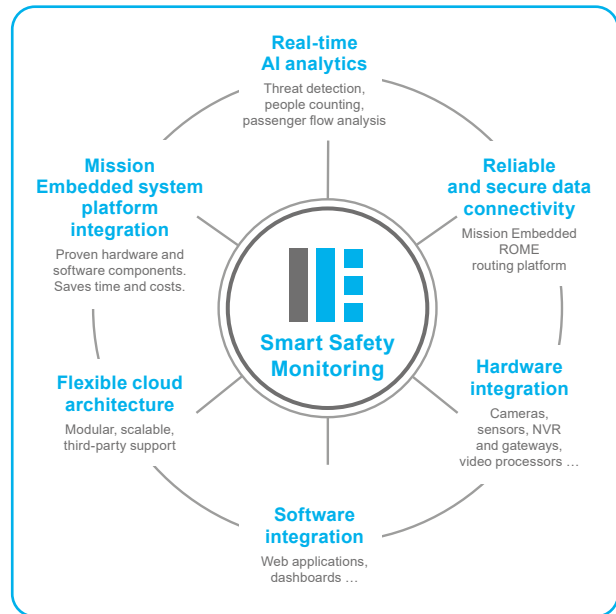


Figure 4: Modular, scalable and fully integrated system solution

4. Mission Embedded solution: Smart Safety Monitoring

Fully integrated surveillance solution with smart, comprehensive functionalities

Mission Embedded’s Smart Safety Monitoring is a comprehensive solution – consisting of hardware, software, and cloud infrastructure – that uses innovative technologies such as artificial intelligence and cloud computing to enhance the safety and operational efficiency of stationary, onboard and trackside railroad operations.

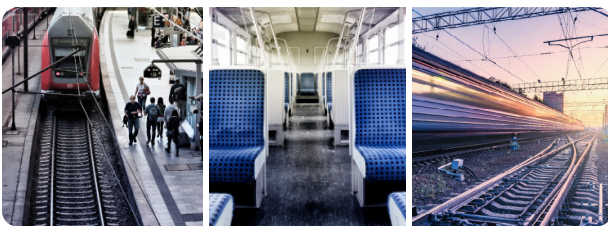


Figure 3: Stationary, onboard and trackside surveillance option

This scalable, modular solution can easily be integrated into existing stationary and onboard surveillance systems and also provides seamless, reliable and secure connectivity with existing third-party devices. It can be customised to fulfill all kinds of monitoring requirements, including spontaneous surveillance in areas without fixed installation, and offers great flexibility in terms of adding new features and functionalities.

On top of that, our solution serves as an integrated omni-channel communication platform that displays all surveillance technologies in one place for seamless command and control. It offers comprehensive control room functions such as video analysis and management, voice communication, incident management, systems control and much more.

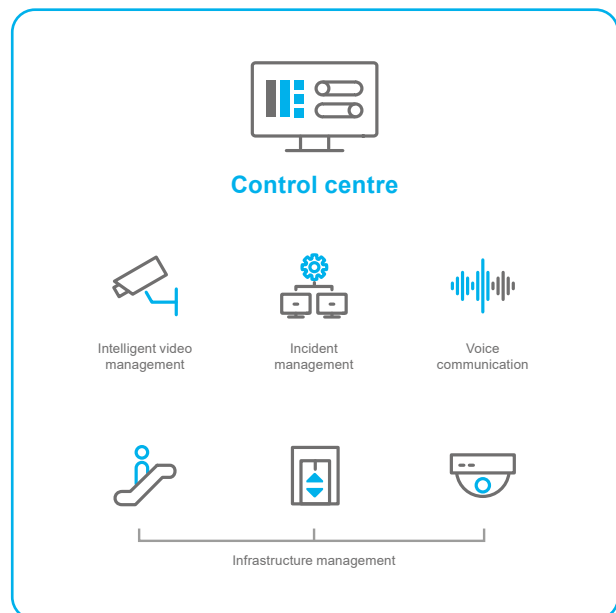
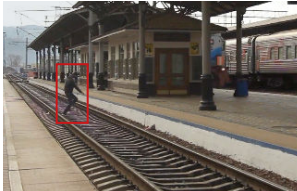


Figure 5: Advanced control room functionalities

AI-powered real-time analytics

Our solution facilitates the application of intelligent functionalities such as real-time AI-assisted video analytics and scene understanding. This gives surveillance managers the swift, objective and consistent information about incidents and potential safety risks that they need to investigate the situation or take further action. In this way, the system helps to detect threats more quickly and effectively and reduces the need for manual monitoring, thus enhancing the safety and operational efficiency in public transport. However, although required to ensure people's security and safety, these real-time analytics must not violate data protection provisions and other related regulations. For this reason, all video streams must be kept safe and may only be accessed by the appropriate bodies and authorities. Digital security and data protection must be handled accordingly throughout the surveillance solution and system.

Intelligent video surveillance applications



Intrusion detection (virtual fencing)

Detection of unauthorised intrusions in defined areas



Automatic people/passenger counting

Area-specific people counting in real time



Abandoned object detection

Automatic identification of suspicious objects left in public area



Vehicle detection

Detection of potential risks to secure safety for on-spot surveillance



Crowd density tracking & monitoring

Tracking and monitoring of highly frequented areas to streamline operations



Situational on-demand monitoring

Remote monitoring of critical onboard situations on demand

Cloud-native architecture

Mission Embedded Smart Safety Monitoring solution uses cloud and edge computing technology, which drastically improves usability, scalability and flexibility, while reducing costs and environmental impact. The system can be operated either via a private or public cloud. A private cloud provides enterprises with the option of having both physically and virtually protected services, allowing dedicated infrastructure and applications for use.

Selection of cloud services



Web-based application



Mobile application for remote users



24/7 remote access from any device



Real-time AI services



Analytics and reporting



Data recording, storage and management



Fast development and additional services



Data security with backup function



Network & system security

24/7 multi-site monitoring with advanced control room features

Video monitoring using web applications gives operators the flexibility to theoretically view thousands of video streams at the same time on any kind of device (stationary or mobile) – anywhere and anytime. This takes conventional video surveillance to the next level.

On top of that, supportive web applications offer a wide range of classic control room functions such as:

- Audio communication
- Video recording and playback
- Alert management
- Incident management
- Data reporting

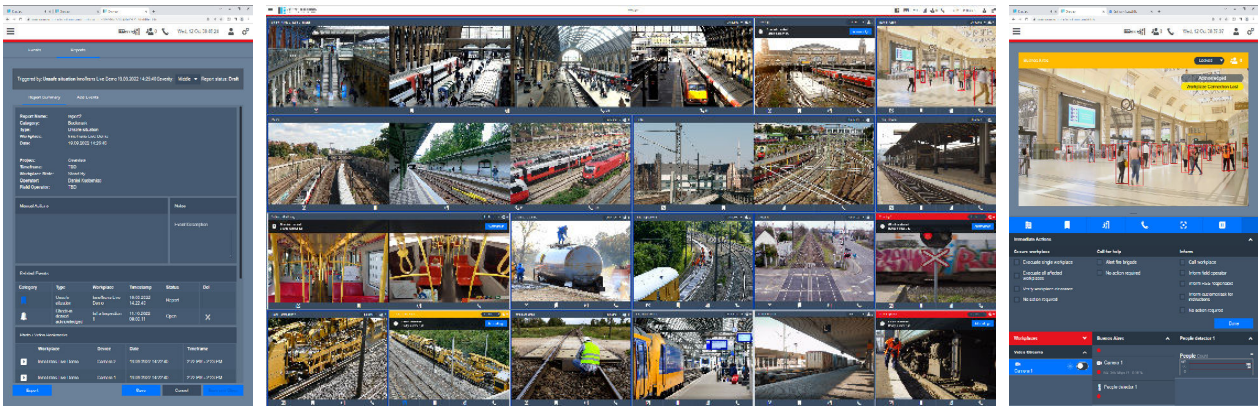


Figure 6: Smart Safety Monitoring application with browser-based control room display

Stable and secure train-to-ground communication

Onboard security surveillance entails large amounts of data that need to be transmitted via mobile communications. It is vital for train drivers, train attendants and the control room operator to be able to track onboard activities at the click of a button, even when network coverage is weak.

By using unique edge gateway technologies like dynamic bandwidth control and link aggregation, our smart solution provides a reliable platform for real-time information systems and modern surveillance applications that guarantee stable and secure network coverage in the event of connectivity limitations.

Easy system integration

Mission Embedded has extensive expertise in the field of complete system integration and connecting hardware, software and services. Our Smart Safety Monitoring offers both: an all-inclusive video surveillance solution as well as a partial solution that seamlessly connects with existing third-party systems.

In each case, operators can greatly benefit from using Mission Embedded’s existing, proven system platforms, like the versatile routing platform ROME (WiFi/4G/5G), which significantly reduces costs and speeds up time to market.

Comprehensive one-stop-shop solution

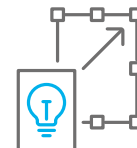
A complete system solution from Mission Embedded includes hardware components such as video processors, cameras, sensors or gateways, in combination with software applications like AI analytics, dashboards or web apps, and services, for instance data and video analytics, data storage and backup.

Open solution in combination with legacy systems

Moreover, our solution supports the integration of third-party legacy devices as part of the overall solution. This allows customers to integrate it into existing systems without having to purchase new equipment or services.



End to end
Ensure device compatibility and easy setup and commissioning



Open, flexible and scalable
Add as many devices to the platform as you need and save on future upgrades



Third-party support
High interoperability with existing devices

System architecture for stationary and onboard surveillance

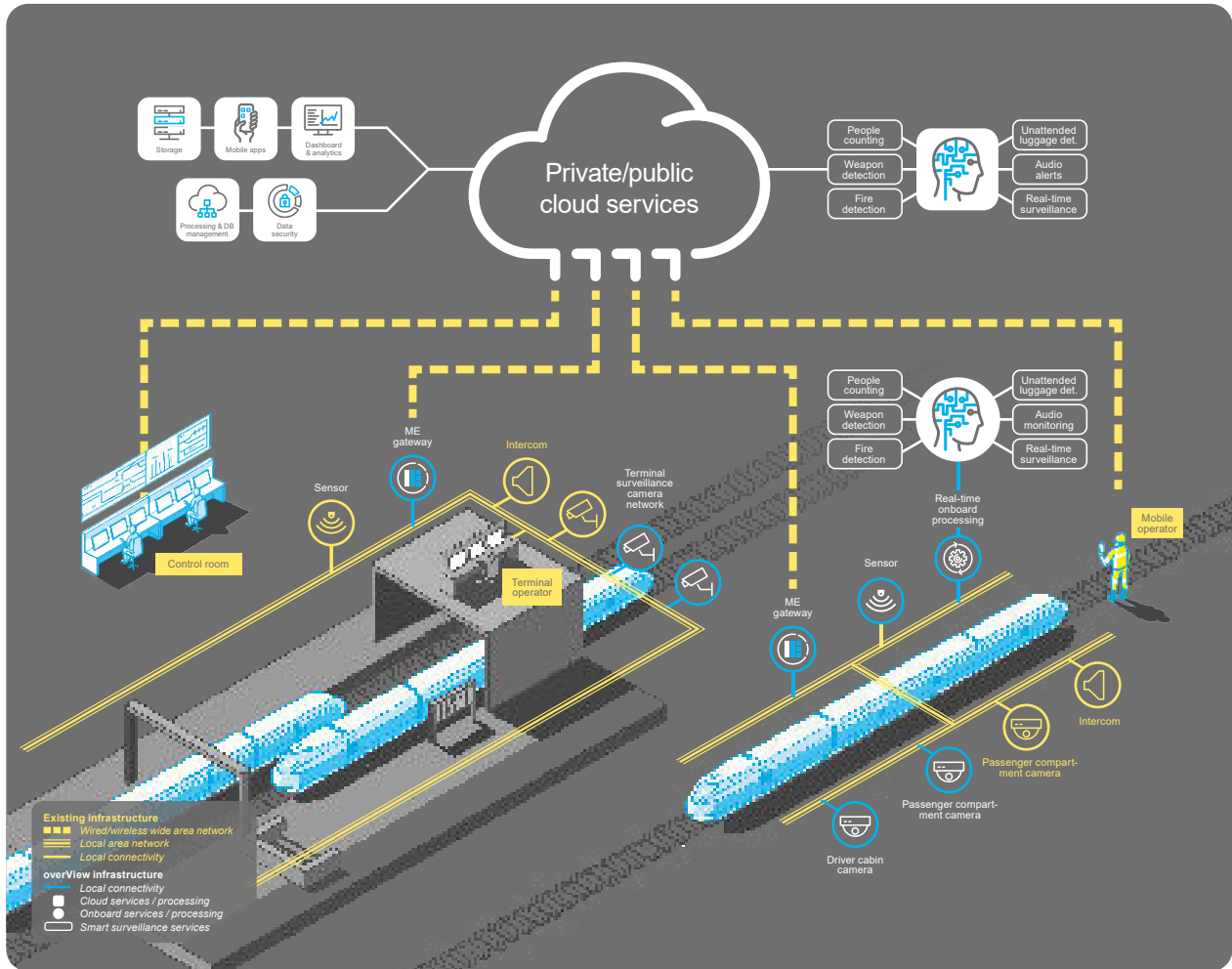


Figure 7: Mission Embedded Solution - system architecture for stationary and onboard surveillance

The architecture (Figure 7) illustrates the use of the Mission Embedded monitoring solution in a station and onboard. The devices used for monitoring the areas (cameras, sensors, intercoms, etc.) are either parts of the Mission Embedded system solution (outlined in blue) or third-party legacy systems (outlined in yellow) – highlighting the system’s ability to easily integrate and seamlessly

connect. Cloud and edge intelligence transforms the huge amounts of data into actionable insights for the control room, terminal and mobile operators. On top of that, the private or public cloud solution allows 24/7 real-time monitoring from any device.

System characteristics

The main features of Mission Embedded's Smart Safety Monitoring solution can be summarised as follows:

FEATURES	BENEFITS
Cloud-based services and edge computing functions	<ul style="list-style-type: none"> • Simplified remote management with web and/or mobile applications • Easy multi-site data and resource sharing • Multi-user access & permissions • Reduced hardware requirements • Improved scalability and flexibility • Enhanced functionalities (e.g. intelligent cameras) • Substantial cost savings
Artificial (AI) services	<ul style="list-style-type: none"> • Autonomous monitoring and threat detection • Real-time monitoring and video analytics • Increased efficiency • 24/7 surveillance
Scalable system architecture	<ul style="list-style-type: none"> • Customisable according to different application situations • End-to-end solution from a single supplier • High interoperability with existing devices • Fewer infrastructure requirements • Easy system integration
Comprehensive control room dashboard	<ul style="list-style-type: none"> • Scalable control centre architecture and web-based display • Mobile device support
Certifiable data security and connectivity	<ul style="list-style-type: none"> • Robust and safe multi-link LTE/5G connectivity • Secure network architecture with firewalls • Optional: Mission Embedded ROME wireless routing platform

5. Summary of the benefits

Mission Embedded Smart Safety Monitoring is an innovative and flexible video monitoring solution for railroad operators that significantly contributes to making rail operations (both moving and stationary) safer, more efficient and more economical.

Operators' many advantages can be summarised as follows:

- **Enhanced stationary and onboard safety**

Early detection of potential danger by means of 24/7 real-time alerting – allowing security personnel to respond to incidents more quickly, appropriately and proactively.

- **Smaller workload and enhanced decision-making for surveillance staff**

Fewer false alarms, meaning that surveillance operators can better detect crime or suspicious behaviour.

- **Reduced insurance expenditure**

When incidents occur, the ability to access accurate, high-definition digital footage through reliable and user-friendly video management systems allows operators to prevent and disprove fraudulent claims, avoid unnecessary claim payouts and reduce their insurance premiums by having accurate and reliable evidence to hand.

- **One-stop-shop solution**

Mission Embedded provides everything for your specific needs – saving you a lot of time and effort.

- **Improved operational efficiency**

Through enhanced monitoring functions, faster decision-making processes and streamlined workflows.

- **Enhanced situational awareness for railway staff**

Train drivers, for example, are better able to assess onboard situations.

- **Scalable, flexible and cost-effective overall solution**

The system architecture is easier to deploy and has fewer hardware, installation and maintenance requirements.

- **Better legal and regulatory compliance**

Because legislation is continually evolving, transport operators would do well to invest in future-proof technology that adapts to it – giving them peace of mind in knowing that their transport systems will always be compliant.

- **Enhanced asset and property protection**

With video analytics, businesses can monitor and protect their assets without the operators having to check them in person.

- **Less service disruption and downtime**

Thanks to quicker and better detection of incidents and speedier responses.

- **Increased passenger satisfaction**

IoT technologies offer operators myriad possibilities for creating new solutions and services to meet passenger expectations. Operators can personalise travel for individual passengers with near real-time data collection and analysis, as well as providing strong, reliable onboard WiFi so passengers can stay connected throughout their journey.

- **24/7 monitoring – from any device and anywhere**

Cloud video surveillance allows monitoring from any internet-connected device at any time.

- **Proven Mission Embedded system platforms: lower costs and faster time to market**

The use of Mission Embedded's existing and proven hardware and software system components saves costs and accelerates time to market.

5. About Mission Embedded

Mission Embedded has become a leader in intelligent sensor systems for railroad applications. Nearly 1,000 sold driver assistance systems for the railroad market bear testimony to its expertise and knowhow in this field. Its application of machine learning and artificial intelligence in various safety-critical use cases has led to several pending patents in the relevant field.

Mission Embedded is the partner for your product innovation:

- **100% cost security**

We guarantee development and series prices right from the start, keeping you in control of your product innovation costs and drastically minimising your risk. This allows you to focus on your market, while we take care of the technology and implementation.

- **25-year investment protection**

We offer up to 25 years of long-term support and lifecycle management. To ensure this, we rely on our vast life-cycle experience and intelligent, forward-looking strategies. Even long after market launch, we provide support for maintenance issues, production customisations, and issues in the field.

- **Knowhow advantage of 75+ experts**

Real added value is created through a combination of experience and knowledge. We ensure your lead in product innovation with the experience and specific knowhow of our highly specialised experts in the core areas of image and sensor processing, sensor and system integration, artificial intelligence, reliability, safety and security, radio and communication, embedded systems, low-power systems, and approvals.

- **End-to-end solution provider**

A system from us is more than just a smart combination of hardware, software and mechanics. We develop solutions that seamlessly integrate into your environment because they are based on an understanding of your needs that goes beyond mere specifications. In addition, we offer an all-round carefree package for your development and take care of, among other things, supply chain management, just-in-time production, and delivery. So that you get what you need, exactly when you need it – from the concept right down to hands-on support in the field.

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