TCMS Trends 2025

Smarter trains. Better future.

As the rail industry evolves in response to the demands of a rapidly changing world, the focus on Train Control and Management Systems (TCMS) becomes increasingly vital. The trends shaping 2025 promise to enhance operational efficiency, bolster safety, and pave the way for more sustainable practices.

In this document, we will explore four pivotal areas: the rising importance of Enhanced Cybersecurity to protect against growing digital threats, the development of ETCS Interoperability to ensure seamless integration across diverse systems, the continuing trend of developing safety functionalities to enhance risk mitigation, and the commitment to Sustainability as rail operators strive to minimise their environmental impact.

01

ENHANCED CYBERSECURITY

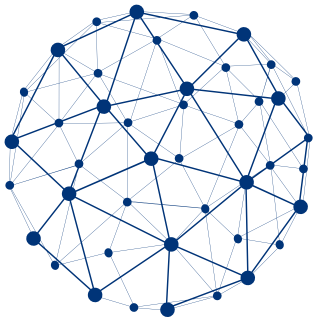
AS RAIL NETWORKS BECOME INCREASINGLY DIGITAL AND INTERCONNECTED, CYBERSECURITY WILL CONTINUE TO BE A DEFINING CHALLENGE FOR THE INDUSTRY MOVING FORWARD. WITH THE INTEGRATION OF IOT DEVICES, CLOUD-BASED SYSTEMS, AND REAL-TIME COMMUNICATION NETWORKS, TRAIN CONTROL AND MANAGEMENT SYSTEMS (TCMS) ARE MORE EXPOSED TO CYBER THREATS THAN EVER BEFORE.

As train systems become more digital and connected, cybersecurity within Train Control and Management Systems (TCMS) will become a critical focus. The increased use of IoT devices, cloud-based systems, and real-time communication networks will expose rail systems to a broader range of cyber threats, from data breaches and system disruptions to sophisticated attacks like ransomware and industrial espionage. These vulnerabilities could potentially compromise critical operations and passenger safety.

In response, cybersecurity measures in TCMS will evolve, incorporating multiple layers of defence. Advanced encryption will secure data exchanges between trains, trackside equipment, and control centres, while network segmentation will isolate critical components, minimising the spread of potential breaches. AI-driven real-time threat detection will empower operators to respond quickly to cyber threats, reducing response times and preventing potential disasters.

Beyond these technical advancements, the rail industry will push for standardised cybersecurity frameworks and certification requirements, ensuring a unified approach to securing rail systems across regions and manufacturers. Cybersecurity will also encompass secure remote access for maintenance and software updates, crucial as rail systems adopt predictive maintenance and remote diagnostics, where sensitive data flows through interconnected networks.

02



ETCS INTEROPERABILITY

AS THE RAIL INDUSTRY CONTINUES TO EVOLVE, INTEROPERABILITY IS EMERGING AS A CENTRAL FOCUS, WITH THE EUROPEAN TRAIN CONTROL SYSTEM (ETCS) DRIVING THIS TRANSFORMATION. RAIL OPERATORS FACE THE GROWING COMPLEXITY OF MANAGING MIXED FLEETS, LEGACY SYSTEMS, AND TECHNOLOGIES FROM MULTIPLE SUPPLIERS, MAKING THE NEED FOR SEAMLESS INTEGRATION ACROSS PLATFORMS MORE CRUCIAL THAN EVER.

Interoperability is rapidly becoming a key focus in the rail industry, with the ETCS at the forefront of this transformation. As rail operators face the challenges of retrofitting a large number of mixed fleets and legacy systems with ETCS functionalities it will not be possible for ETCS providers to serve the market within the desired time. Under these circumstances, there is a role for independent TCMS suppliers to act as integrators between ETCS OBU and existing TCMS.

A central element of this trend is the evolution of ETCS-TCMS gateways, which act as vital interfaces between disparate systems. These gateways will enable the seamless exchange of data between otherwise incompatible technologies, ensuring that new advancements can integrate with legacy infrastructure. This will allow for greater flexibility, reducing the need for extensive system overhauls and ensuring different manufacturers' subsystems can work together harmoniously.

As the rail sector embraces this shift toward enhanced interoperability, driven by ETCS, operators will benefit from reduced operational complexity, increased efficiency, and improved safety. Real-time communication between trains and trackside systems will become more reliable, supporting advanced functionalities like start/stop of catenary sections and precise location of station platforms.

03

SAFETY

DEVELOPING NEW SAFETY FUNCTIONALITIES WILL REMAIN A KEY TREND IN 2025 AS THE RAIL INDUSTRY ADAPTS TO EVOLVING REGULATORY REQUIREMENTS AND SEEKS TO ENHANCE RISK MITIGATION. AS RAIL INCIDENTS HIGHLIGHT AREAS FOR IMPROVEMENT, THE INDUSTRY WILL REMAIN COMMITTED TO ADVANCING SAFETY MEASURES THAT CAN PREVENT ACCIDENTS, PROTECT PASSENGERS AND STAFF, AND BUILD PUBLIC TRUST.

In 2025, governments and international organisations will likely set more stringent requirements for safety and compliance, pushing operators and manufacturers to implement more advanced safety solutions. Meeting these evolving standards will be essential not only for regulatory compliance but also for securing operators' licenses to operate in specific regions, where safety will remain a defining benchmark.

Rail incidents will continue to drive safety innovations in 2025. Lessons from these incidents — whether related to equipment malfunctions, infrastructure issues, or human error — will inform the development of new technologies and functionalities designed to prevent similar events. As the industry builds on these incident-led improvements, passenger trust in rail systems is likely to grow, aligning with the public's increasing expectations for safety.

New functionalities to address specific risks identified in recent years will continue to be developed. With a better understanding of common causes of rail incidents, companies will focus on creating targeted solutions that prevent or minimise these risks. By designing functionalities that directly address these known risks, the rail industry will work toward reducing incident rates, increasing operational resilience, and reinforcing a proactive safety-first culture.

04

SUSTAINABILITY

AS THE TRANSPORTATION INDUSTRY INCREASINGLY EMPHASISES SUSTAINABILITY, TRAIN CONTROL AND MANAGEMENT SYSTEMS WILL BE POSITIONED AT THE FOREFRONT OF REDUCING THE CARBON FOOTPRINT OF RAIL OPERATIONS AND, PAVING THE WAY FOR MORE EFFICIENT AND ECO-FRIENDLY OPERATIONS.

The transportation industry is increasingly focusing on sustainability, and as the rail industry embraces greener propulsion technologies, such as hydrogen fuel cell and battery trains, TCMS will ensure that these trains meet performance and environmental targets. In an increasing number of rail networks, TCMS will enable real-time monitoring and optimisation of energy consumption, allowing immediate adjustments to improve energy efficiency. This process will involve strategically regulating energy usage throughout a journey by adjusting train speeds, managing battery usage, and recharging in hybrid and fully battery-driven trains.

High-speed rail networks will benefit from the advanced systems by delivering reliable, energy-efficient, and environmentally sustainable operations, positioning them as a key element in the evolution of sustainable transportation compared to traditional car and air traffic. TCMS will play an essential role in enabling smoother, more efficient journeys, ensuring that both established and newer rail technologies align with sustainability goals.

Automated power changeover, which enables trains to seamlessly switch from catenary to battery power, is set to become more widespread. Manual pantograph operation can be vulnerable to human error, but SIL 2 safety functionality ensures safe and automatic operation of the catenary at any speed or in varied environmental conditions, enhancing energy efficiency and supporting operators' sustainability goals. This technology also opens the door for more hybrid vehicles to operate in partially electrified network areas. For hybrid vehicles, automated power change-over can further optimise fuel efficiency by seamlessly switching between fuel sources, maximising the performance of multi-source hybrids.

CONCLUSION

As we look toward 2025, the evolution of Train Control and Management Systems stands at the forefront of a transformative era for the rail industry. The integration of enhanced cybersecurity measures will safeguard vital systems against emerging threats, while the push for ETCS interoperability will facilitate seamless communication across diverse technologies, ensuring operational coherence in a complex landscape. The continued development of safety functionalities will advance safety measures to prevent accidents, protect passengers and staff, and build public trust. Coupled with a strong commitment to sustainability, these trends highlight the rail sector's dedication to minimising its environmental impact while delivering reliable, efficient and safe services.

Together, these advancements will not only modernise rail transport but also contribute to a more connected, secure, and environmentally friendly future. The journey ahead promises to be dynamic and exciting, as the industry harnesses the power of technology to meet the challenges of tomorrow. As stakeholders across the rail sector embrace these trends, they will play a crucial role in shaping a resilient and innovative transportation landscape for years to come.

ABOUT EKE-ELECTRONICS

For almost four decades, EKE-Electronics has been a proud supplier of Train Control and Management System solutions to train manufacturers, operators, and integrators around the world. We provide tailored solutions for system integration, train automation, train communications, train diagnostics, and improved safety.

If you would like to learn how EKE is addressing the trends outlined in this document, follow us on LinkedIn for regular updates and insights.

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