

Networked maintenance for greater rail capacity

The European railway network in 2026 is a highly complex, continent-wide transport system and a cornerstone of sustainable mobility. As demand continues to grow, so do the requirements for infrastructure availability. Over recent decades, mechanisation, digitalisation and automation have significantly improved productivity in track construction and maintenance. Modern machinery can now accomplish in hours what once required extended line closures.

DESPITE THESE advances, the sector faces major challenges. Rising demand is placing increasing strain on infrastructure capacity, exposing a fundamental conflict: the network must remain highly available while also requiring regular maintenance. However, maintenance consumes valuable track time, which is becoming increasingly scarce.

Track availability vs. maintenance output: an ongoing conflict

The tension between infrastructure availability and maintenance output appears unavoidable. As utilisation increases, so does the need for maintenance work and associated track possessions. At the same time, pressure to maximise network usage reduces available maintenance windows, often limiting work to nights or weekends. This results in short construction sections, which can increase unit costs and lead to inconsistent quality.

Conversely, longer track possessions would improve efficiency and reduce costs but would significantly disrupt operations. Even with partial traffic rerouting, such disruptions are increasingly difficult to justify in heavily used networks.

This raises the question of whether better planning and optimised use of track possessions could provide a balanced

solution. Experience shows that simply improving machine performance is insufficient. Output depends on multiple factors, including possession duration, logistics, machine availability, and safety requirements. Sustainable efficiency gains require a holistic optimisation of the entire track construction and maintenance process – from installation to renewal.

An integrated end-to-end process

A systematic approach requires viewing track construction and maintenance as a fully integrated process. Data collection, planning, execution and documentation must interact seamlessly to accelerate workflows, reduce possession times, and improve quality. The focus lies on coordinating all phases – from condition assessment and preparation to execution and transparent documentation.

Each stage of the process contains modules with optimisation potential. While full implementation does not immediately maximise availability, every improvement contributes to more efficient work sites and better use of existing infrastructure.

Condition recording as the basis for planning

Reliable asset management depends on continuous monitoring of track conditions. Given the long planning horizons in railway systems, accurate and up-to-date data

is essential for determining maintenance needs and allocating resources effectively.

Continuous condition recording improves planning reliability and enables early communication of maintenance activities, which is crucial for stakeholder acceptance. It also allows maintenance to be scheduled by balancing remaining component life with operational impact. Furthermore, comprehensive data analysis makes it possible to bundle multiple work sites into shared possessions, improving overall efficiency.

Key diagnostic areas include the substructure, ballast, rails, sleepers, turnouts and overhead contact lines. Modern systems now allow data collection at operational speeds, eliminating the need for additional track closures and manual measurements.

One example is high-precision, non-contact track geometry measurement. Systems such as Referenced Track Geometry (RTG) combine inertial measurement with camera-based referencing to deliver highly accurate, absolute track position data at speeds of up to 80 km/h. This replaces manual surveying and provides reliable input for maintenance planning and execution.

Automated turnout inspection represents another advancement. Previously labour-intensive and disruptive, it is now performed using 3D laser measurement and high-speed video technology during train passage. This

enables rapid, detailed condition assessment while improving safety by eliminating the need for personnel to enter hazardous areas.

Digital twins and AI in work preparation

Digital technologies are transforming planning processes. LiDAR scans and camera systems generate detailed digital twins of infrastructure, allowing virtual site inspections from the office. This reduces the need for additional track possessions and travel time and ensures that high-quality data is always available.

Digital inventories are particularly valuable for both maintenance and new construction. Artificial intelligence can automatically detect, classify and store infrastructure objects in asset databases. This comprehensive documentation supports lifecycle monitoring and forms the basis for condition-based maintenance strategies.

A key efficiency factor is the digital integration of workflows. Traditionally, data processed in the office had to be manually transferred to machines. Today, systems such as tmOS enable continuous digital data flow – from measurement and analysis directly to machine control systems. By eliminating interfaces and data losses, these solutions enhance process reliability and create a consistent data foundation for decision making.

Efficient project implementation

Execution is the core of any maintenance activity, determining both efficiency and quality. Given limited track possessions and increasing precision requirements, assistance systems, automation, and integrated machinery are becoming essential.

AI-supported assistance systems, such as the Plasser TampingAssistant, are paving the way towards autonomous machines. Using high-resolution sensor data, these systems analyse the working environment in real time, identify infrastructure components and obstacles, and automatically position work units. This reduces operator workload, minimises errors and stabilises process quality while addressing skilled labour shortages.

Another key development is the integration of multiple maintenance tasks into a single process. Modern tamping

Autonomous tamping of a turnout without machine operators in the work cab during a demonstration at the iaf 2025.



machines combine functions such as measuring, correcting and post-measuring track geometry, as well as stabilising and profiling ballast. Tasks that previously required entire machine trains can now be performed by a single unit. This reduces staffing requirements, simplifies logistics, and shortens track possession times.

For more complex projects, continuous machine systems – similar to assembly-line processes – integrate all steps of track renewal or ballast excavation. These systems streamline logistics and coordination, further improving efficiency.

Transparent documentation and quality assurance


Post-measuring and documentation conclude the maintenance process and are essential for quality assurance. Modern machines record track conditions immediately after work is completed, generating detailed documentation.

Tools such as the Plasser TampingReport consolidate data from multiple systems into structured reports. These provide detailed analyses at the sleeper level and clearly show changes in track geometry and ballast condition. Additional data – such as positioning information, machine parameters, and images – can also be integrated, offering a comprehensive view.

Through systems like Plasser Datamatic, processed data is automatically transferred to the back office, where it is available for documentation, analysis and long-term monitoring. This supports infrastructure managers in planning future activities, comparing maintenance measures, and improving overall process reliability.

Summary

The ongoing development of digital and automated solutions demonstrates that the apparent conflict between track availability and maintenance output can be mitigated. A holistic, end-to-end approach – combining condition-based planning, digital work preparation, and automated execution – enables more efficient use of limited track possessions.

By integrating all process phases and leveraging modern technologies, railways can increase both infrastructure quality and network capacity. This not only ensures the long-term performance of the system but also supports the growing demand for sustainable rail transport. 



Fabian Hansmann

Head of Marketing,
Plasser & Theurer (Austria)

Fabian Hansmann graduated from Graz University of Technology in Austria with a degree in civil engineering, specialising in environmental and transportation engineering. From 2011 to 2015, he worked as a research associate at the Institute of Railway Engineering and Transport Economy. After completing his PhD on railway track asset management, he joined Plasser & Theurer as Senior Expert Track Technology. In August 2019, he relocated to the United States to serve as a scientific advisor for Railroad Engineering and Applied Technology at Plasser American. After two years, he returned to Europe, where he currently holds the position of Head of Marketing at Plasser & Theurer.