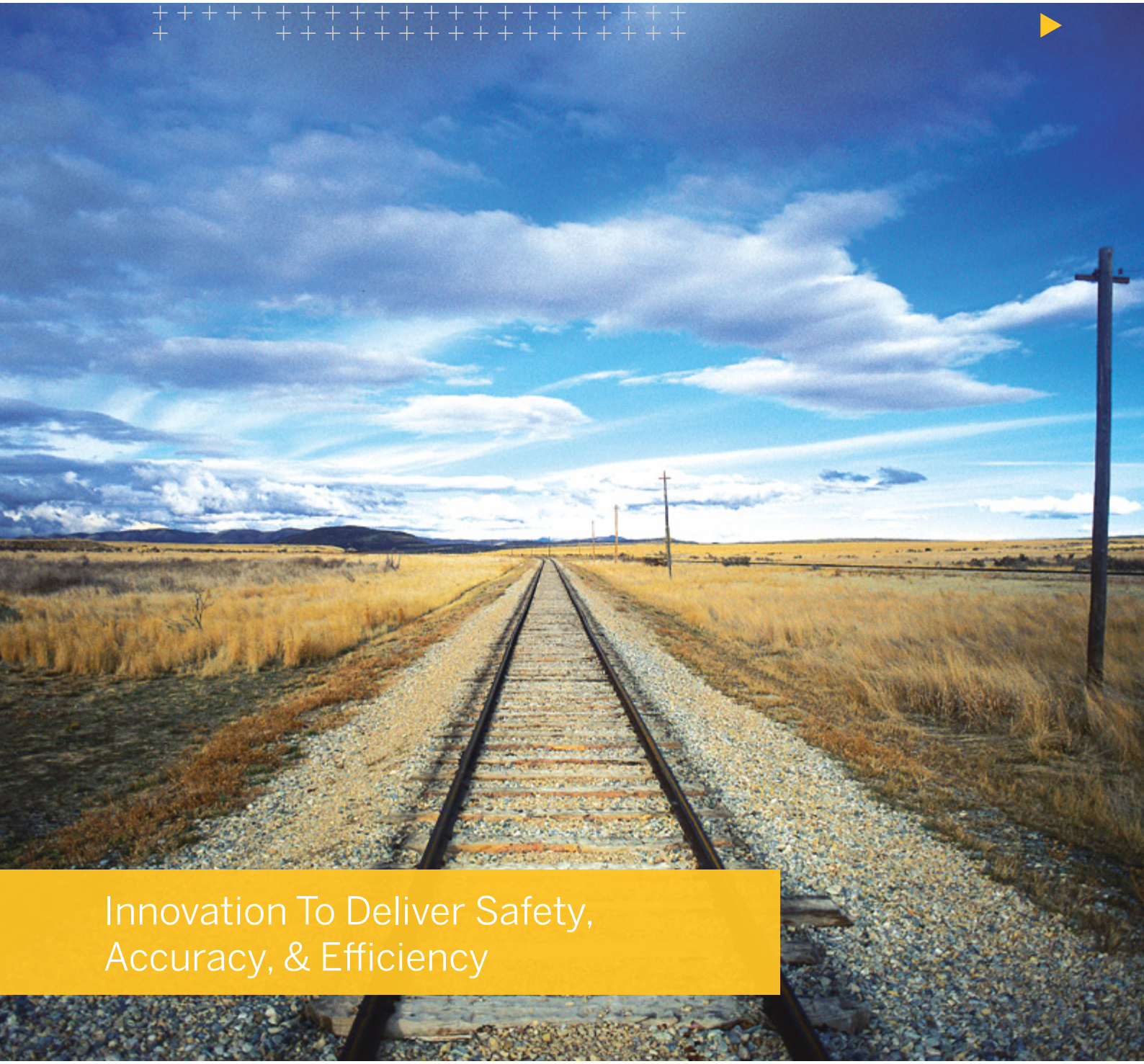


Innovation To Deliver Safety,
Accuracy, & Efficiency

Trimble Railway Solutions

An Industry Built On Motion

Trimble® railway solutions combine measurement with data management, communications and customized software to deliver accurate information with speed and reliability. Trimble solutions enable advanced process and workflow integration for a more streamlined operation. From feasibility studies through construction and operation, Trimble railway solutions provide important benefits to keep your operation running smoothly and safely.

SHORTEN LEAD TIMES FOR FEASIBILITY, PRE-PLANNING, AND PERMITTING

- Collect information on potential routes quickly, accurately, and economically
- Conduct rapid analysis and optimization of routes based on design, physical, and socio-economic parameters

REDUCE CONSTRUCTION TIME AND COST

- Increase productivity and reduce rework using automated construction systems
- Specialized track measurements for precise construction and quality control

MANAGE OPERATING COSTS

- Use alignment analysis to create track alignments that minimize operating costs
- Reduce downtime for maintenance with efficient monitoring and inspection systems
- Real-time remote diagnostics for effective condition based maintenance

LOWER COSTS FOR MAINTENANCE

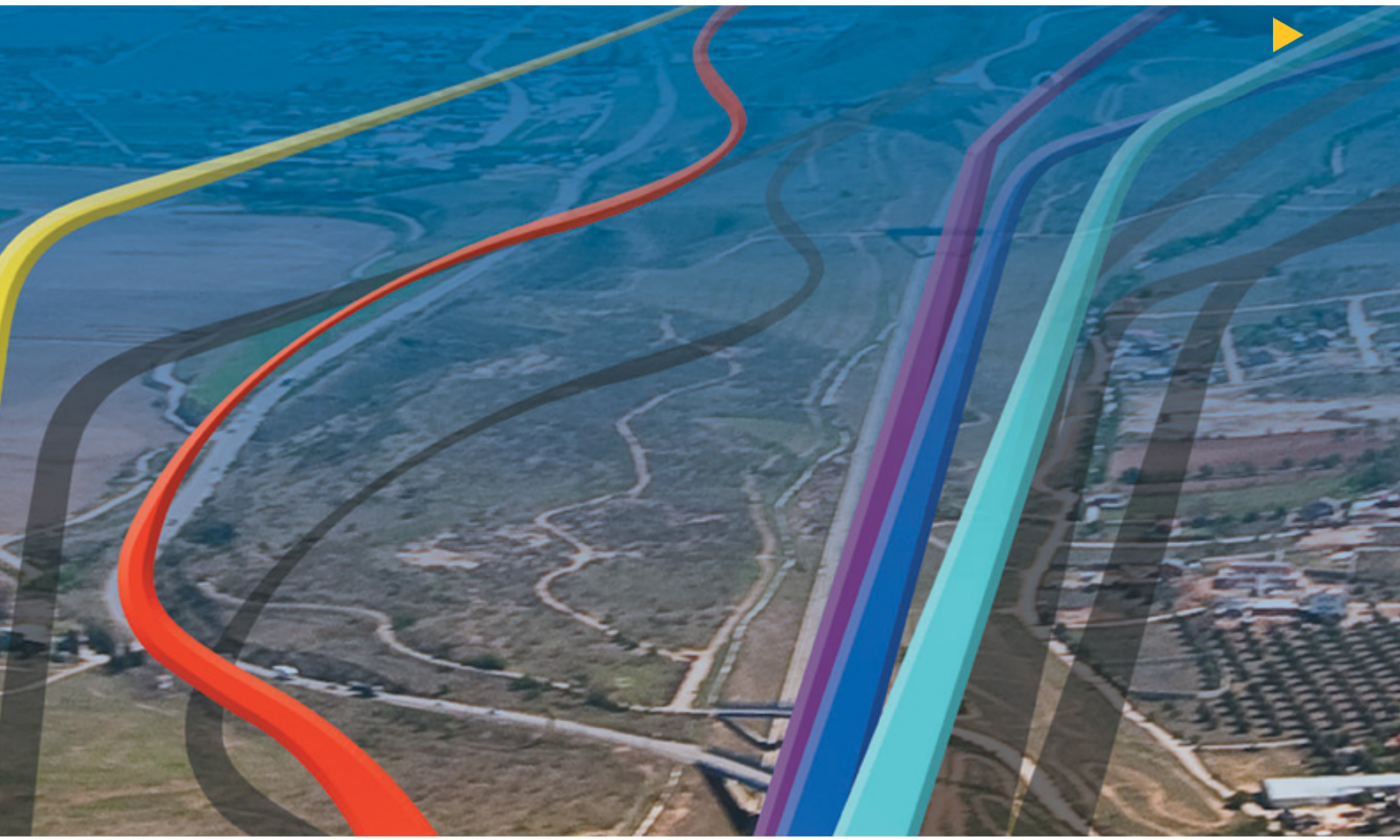
- Pre-measurement for maintenance reduces downtime and optimizes resource utilization
- Gather accurate inventory of assets using high speed data collection systems
- Manage the cost effectiveness of rail assets using engineering asset and maintenance management

SPATIAL INFORMATION IN RAILWAY MANAGEMENT

Efficient railway management requires accurate, timely information on the location and status of fixed and mobile assets. Geospatial information systems gather, manage, and utilize spatial and related data on tracks, buildings, and other assets that are distributed over large areas. Using geospatial solutions, railway operators collect and analyze data to produce actionable information for use throughout the organization and across the lifespan of fixed and mobile assets. Tailored, task-specific tools for measurement and analysis increase efficiency and reduce costs in railway planning, operations and maintenance.

Improve safety and compliance.
Reduce environmental impact.

Planning & Analysis: Taking The First Step



BETWEEN VISION & VIABILITY, THERE ARE IMPORTANT DECISIONS TO MAKE

Whether it's extending existing lines or creating an entirely new route, planning and feasibility are crucial tasks. Planners must consider geographic, environmental and social factors in selecting locations for improvements and facilities. Long-term success relies on accurate information and intelligent choices during the planning stages. Trimble railway solutions provide the tools to gather, manage, and analyze information to make informed decisions.

Alignment Selection

Determining the route for new rail lines is a complex process. Routing decisions affect both construction and long-term operations, and planners must make the best possible choices. Trimble solutions for alignment selection enable transportation teams to examine the effects of multiple, interdependent variables in selecting optimal alignments.

Economic Analysis

Railway feasibility studies include cost factors for construction, operation and maintenance. Subtle changes in design or alignment can produce significant, long-term effects on costs. Using rich data from mapping and sensor systems, Trimble solutions perform comprehensive analyses on the interrelated cost factors to identify cost-effective alignments and designs.

TRIMBLE SOLUTIONS FOR RAILWAY PLANNING & ANALYSIS

TRIMBLE AIRBORNE IMAGING AND MAPPING

- Aerial imaging and laser scanning
- Aerial cameras
- Software for aerial photogrammetry and laser scanning
- Unmanned aerial systems

TRIMBLE MOBILE MAPPING SOLUTIONS

- Mobile data capture for images and LiDAR
- Vehicle-and rail-mounted data collection
- Software for data analysis, interpretation and exchange

TRIMBLE QUANTM ALIGNMENT PLANNING SOLUTIONS

- Desktop and server-based systems
- Software for route location and optimization

Visualization & Presentations

Throughout the feasibility and planning process, it's vital to keep stakeholders informed and involved. Using advanced tools for visualization and simulation, Trimble railway solutions help the stakeholders to see and understand a proposed project. As public comments and other inputs affect project plans, changes and alternatives can be quickly incorporated.

TRIMBLE ALIGNMENT SOLUTIONS

Trimble Quantm® Alignment Planning supports railway planners in the complex process of evaluating and selecting transportation corridors. Trimble Quantm technology integrates engineering, environmental, social and economic factors into a simultaneous analysis of alternatives.

Railway designers use Trimble Quantm to optimize alignments for freight, passenger and high-speed rail projects. Scalable to handle projects of any size, Trimble Quantm enables rapid decision making and rapid analysis of design options. By analyzing large numbers of potential alignments, Trimble Quantm can reduce costs both for construction and operation.

Railway Design & Construction

KEEPING CONSTRUCTION PROJECTS ON TIME & IN-BUDGET

By integrating technologies for positioning, measurement, communications, and data management, Trimble engineering and construction solutions are tailored to provide task-specific benefits in productivity, safety, and cost efficiency throughout design and construction.

Underground & Superstructure

Trimble streamlines the heavy construction work on railbeds, track, bridges, tunnels and structures from initial clearing through final inspection. During earthwork, Trimble machine control lowers costs and improves material yields.

Track Construction

Track construction requires high accuracy and rapid verification of track geometry. Trimble systems handle stakeout, quality control and progress inspections with speed and precision, including precise positioning and alignment of track.

Trimble Connected Site

Trimble Connected Site utilizes real-time information flow to connect stakeholders at the job site and office. By ensuring up-to-date design and field information it streamlines construction processes and reduces rework.

TRIMBLE SOLUTIONS FOR RAILWAY DESIGN & CONSTRUCTION

TRIMBLE SURVEYING SOLUTIONS

- Precision optical and GNSS surveying systems
- Field applications software for alignments, tunneling and monitoring
- 3D laser scanning instruments and software

TRIMBLE GNSS INFRASTRUCTURE SOLUTIONS

- GNSS Reference Stations
- Software for GNSS networks
- Real-time positioning services

TRIMBLE CONSTRUCTION SOLUTIONS

- GNSS and optical site positioning systems
- 2D and 3D machine control systems
- Tekla® Building Information Management (BIM)
- Layout tools for building contractors

TRIMBLE GEDO CE SOLUTIONS

- Track measurement and adjustment
- Track positioning and documentation

TIME-LOCATION PLANNING

- TILOS software for special railway building functions
- Support track maintenance and repair projects
- Use also for track laying and train configuration

TRIMBLE CONNECTED SITE

- Integrated information for site and office
- Manage multiple job sites
- Wireless delivery of plans, reports and results

TRIMBLE MACHINE CONTROL SOLUTIONS

Time and cost savings in the earthwork phase can influence the overall profitability of a construction project. Trimble supplies 2D and 3D guidance and control solutions for excavation, rough grading, compaction, final grading, and inspections.

This highly accurate solution utilizes GNSS and optical measurements combined with onboard guidance and control systems to provide precise, real-time control of construction machines. In addition to improved productivity on site, machine control solutions manage costs by monitoring machine status and performance.

Maintenance

EFFICIENT WORKFLOWS FOR RAILWAY OPERATIONS

In a business that is based on moving objects from one place to another, it's important to cover large areas quickly, and to work while in motion. Trimble railway solutions integrate inspection and maintenance workflows to reduce downtime and streamline asset management.

Track Maintenance

Accurate information on track location and geometry is an essential component of tamping and rail bed maintenance. Utilizing advanced measuring technologies, Trimble systems gather precise 3D data and share the results in industry-standard formats. Using Trimble geospatial technologies for mobile mapping and high-speed data acquisition, railways can maintain current, comprehensive information over large areas.

Upgrades & Expansion

Planning and implementing railway improvements requires accurate information on existing facilities and conditions. Trimble systems improve productivity throughout the design, engineering, and construction processes.

TRIMBLE SOLUTIONS FOR RAILWAY MAINTENANCE

TRIMBLE GEDO CE SYSTEM

- Track measurement and documentation
- Pre-measurement for tamping
- Slab track construction and alignment
- Track clearance measurement

TRIMBLE GEOSPATIAL SYSTEMS

- Airborne imaging and data collection
- Unmanned aerial systems
- Photogrammetry
- Mobile data capture and mapping
- Image analysis and feature extraction

TRIMBLE SPATIAL IMAGING

- 3D laser scanning
- Software for 3D modeling and image rendering

TRIMBLE GEDO CE SYSTEM

Trimble GEDO CE is a suite of tools for measurement, recording, analysis, and applications for railway track location, construction and maintenance. Specially tailored for railway tasks and processes, Trimble GEDO CE hardware and software streamlines work in the field and office. The system uses standard techniques and data formats to share information with leading applications for railway track design and maintenance.

Safety & Railway Operations

SAFETY, EFFICIENCY, & COST CONTROL

Safety, efficiency and cost control are the watchwords for railway operators. Trimble solutions help enhance safety and optimize the utilization of assets and personnel. Use Trimble's information management solutions to track conditions over the entire network of track and facilities. Accurate, timely data provide valuable input into decision and enterprise resource planning.

Asset Management

Profitable railway operations rely on efficient tracking and maintenance of fixed assets and rolling stock. Trimble asset management solutions utilize positioning and data management to let you know where your assets are, and what they are doing. Trimble GPS, barcode and RFID technologies track equipment, supplies, tools and construction materials to reduce loss and optimize utilization. Trimble's rail asset lifecycle management provide an integrated suite of solutions that manage the lifecycle of rail transport assets from operation through maintenance and repair.

TRIMBLE SOLUTIONS FOR RAILWAY OPERATIONS

TRIMBLE RAIL ASSET LIFECYCLE MANAGEMENT

- Real-time remote diagnostic monitoring
- Engineering maintenance management
- Component condition monitoring
- Planning and performance management
- RFID and barcode asset tracking
- Mobile GIS solutions

TRIMBLE GEDO CE SYSTEM

- Track measurement, documentation, and quality check
- Track clearance

TRIMBLE MONITORING SYSTEMS

- Automated monitoring
- Deformation monitoring

TRIMBLE GEOSPATIAL SYSTEMS

- Airborne imaging and data collection
- Unmanned aerial systems
- Photogrammetry
- Mobile data capture and mapping
- Image analysis and feature extraction

TRIMBLE LOADRITE SYSTEMS

- Payload management
- Range of scales to accurately measure loadout onto rail cars

Monitoring Slopes & Structures

An essential contributor to railway safety, monitoring systems detect motion that may occur in railway structures and adjacent features. By measuring movement in landforms, bridges, buildings and other objects, monitoring systems can prevent injury and damage during construction and operation of rail lines and facilities.

Positive Train Control

Positive Train Control (PTC) requires detailed information on track and facilities together with real-time positioning of trains and equipment. Trimble mapping and geospatial systems provide fast, cost-effective tools to build and maintain spatial information. Rapid data acquisition and automated processing help operators collect and manage geographic information on railways, including the location of individual signs, crossings and control features.

HIGH SPEED DEMANDS HIGH PRECISION

Trimble solutions make key contributions to the success of high speed railways. Trimble Quantm technology has helped plan more than 5,500 km of high-speed rail, reducing construction costs and limiting environmental impacts. During construction, Trimble utilizes GNSS and optical technologies to increase productivity while maintaining high levels of accuracy and precision. Trimble GEDO CE systems are used for construction and maintenance of high-speed railways worldwide, including the 400 kph (250 mph) Beijing – Shanghai route in China.

From Technology To Solutions

Trimble solutions enable customers in public and private sectors to increase the performance of their assets, human resources and projects, and to simultaneously reduce costs, waste and risk. To deliver these benefits, Trimble pursues intimate domain knowledge and a complete understanding of user needs and opportunities.

Trimble solutions are built on applications that utilize spatial information, including surveying, construction, agriculture, fleet and asset management, public safety, and mapping.

Trimble integrates a wide range of positioning technologies including GPS and GNSS, laser, optical and inertial technologies with application software, wireless communication, and services to provide complete commercial solutions.

Trimble's strong emphasis on software and information management produces applications and processes that are tightly tailored to the customer needs. Trimble integrated solutions allow customers to collect, manage and analyze complex data, and to utilize the resulting information to make workflows and processes faster, easier, and more productive.

KEY TRIMBLE TECHNOLOGIES

POSITIONING

- GNSS, optical and inertial systems
- 2D and 3D machine guidance
- Track measurement

IMAGING

- High-speed digital imaging
- 3D laser scanning
- Software for 3D modeling and visualization

VISUALIZATION

- 3D modeling
- Simulation and virtual construction
- Photo-grammetry and feature extraction

INFORMATION MANAGEMENT

- Cloud-based applications and data management
- RFID asset tracking
- Mobile asset management

COMMUNICATIONS

- Site connectivity solutions
- Wireless communications

TRIMBLE RAIL ASSET MANAGEMENT SOLUTIONS

Trimble's rail asset lifecycle management products are an integrated suite of on premise and software-as-a-service (SaaS) solutions that manage the lifecycle of rail transport assets from operation through maintenance and repair.

The solutions address everything from full fleet maintenance, real-time remote vehicle diagnostics, and in-service vehicle performance, through to driver performance management and timetable adherence. They allow rail companies to plan for the future, improve operational efficiencies, manage service levels, and reduce costs, while ensuring that the service they provide is maintained to the highest level.

Customers using Trimble® solutions to manage the lifecycle of their rail transport assets include South West Trains, Eurostar, SNCF, Irish Rail, the Go-Ahead group, Siemens Transportation, Alstom, and Abellio Greater Anglia among others.

Trimble Railway Solutions In Action

Trimble railway solutions combine positioning, communications, data management and analysis, to produce systems tailored to railway processes and workflows. Trimble delivers flexible, powerful systems for railway planning, construction, and operations.

TRACK CONSTRUCTION:
Balfour Beatty Rail, Scotland

THE CHALLENGES:

- Construct 24 km (15 mi) of track between Bathgate and Airdrie
- Meet tight budget and construction schedule
- Reduce use of ballast material and tamping time

THE TRIMBLE SOLUTION:

As prime contractor, Balfour Beatty Rail (BBR) selected Trimble 3D machine control systems for rough earthmoving as well as final grading on the railbed. Design information was loaded into Trimble GCS900 grade control systems onboard the construction bulldozers. The GCS900 controlled the bulldozer blades to quickly build railbeds to design specifications, reducing the amount of ballast needed to bring the beds to grade. Once the track was laid, Trimble GEDO CE systems provided measurements used by the tamping machines to bring the track to final design alignment.

THE BENEFITS:

- Increased accuracy and productivity from construction machines
- Fast, accurate pre-tamping measurements
- Reduced manual measurement and potential for human error

TRACK RENEWAL:
Spitzke SE, Germany

THE CHALLENGES:

- Replace 8 km (5 mi) of rails and sleepers in central Germany
- Provide precise input for tamping machine
- Reduce labor costs and measurement time

THE TRIMBLE SOLUTION:

Working under a contract from Deutsche Bahn, Spitzke SE removed and replaced the old track. Once the new sleepers and rails were in place, Spitzke used a Trimble GEDO CE system to measure the track and compute the adjustments needed to bring the rails to the design alignment. This information was transferred electronically to the tamping machine, eliminating delays and possible errors. Once the tamping was complete, the Trimble system made final checks to validate the results. The Trimble system reduced staff costs by more than 80 percent and increased efficiency of the tamping operations.

THE BENEFITS:

- Smaller crews for pre-tamping measurements
- Fast delivery of information to tamping machines
- Reduced idle time for tamping machine

POSITIVE TRAIN CONTROL:
Norfolk Southern Railway, USA

THE CHALLENGES:

- Document, inspect and maintain assets along Norfolk Southern's network of track
- Implement Positive Train Control (PTC) technologies mandated by the Federal Railroad Administration (FRA)
- Maintain high spatial accuracy in the enterprise GIS

THE TRIMBLE SOLUTION:

Working with Trimble and Esri, Norfolk Southern developed a customized data collection application running on Trimble handheld GIS data collectors. Trimble provided software development tools and support to embed Trimble GNSS into ArcGIS for Windows Mobile based applications. The solution includes a post-processing component to ensure that the GNSS field data meets requirements for spatial accuracy and can move seamlessly into Norfolk Southern's enterprise GIS.

THE BENEFITS:

- Tight integration between field and GIS
- GNSS measurements meet PTC accuracy requirements
- Simple, efficient workflows for field data collection

REMOTE DIAGNOSTICS:
Abellio Greater Anglia, UK

THE CHALLENGES:

- Improve fleet performance, fleet safety, driver performance, timetabling data, infrastructure and energy analysis
- Increase unsatisfactory average Miles per Casualty (MPC) rates
- Minimize delay minutes through better fault diagnosis and performance data

THE TRIMBLE SOLUTION:

Through the adoption of the Trimble R2M system, Abellio Greater Anglia has increased the MPC rates for its intercity fleet by almost 60% and reduced delay minutes for these trains by 40%, whilst also delivering wider benefits in areas such as fleet safety, driver performance, timetabling data, infrastructure and energy analysis, thereby becoming a cross-departmental project, with even more benefits for customers and across the business. The Trimble remote diagnostic system is now being adopted as industry standard best practice.

THE BENEFITS:

- Real-time fault information supports intelligent decision making and planning
- Effective and rapid fault recovery ensured
- Overall fleet performance improved

About Trimble

Founded in 1978, Trimble is a publicly-traded company headquartered in Sunnyvale, California. Trimble serves its customers with employees and distribution partners in more than 100 countries. The Company's more than 1,800 patents provide the basis for the broadest portfolio of positioning solutions in the industry. Trimble's integrated solutions allow customers to collect, manage and analyze complex information faster and easier, making them more productive, efficient, and profitable.

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