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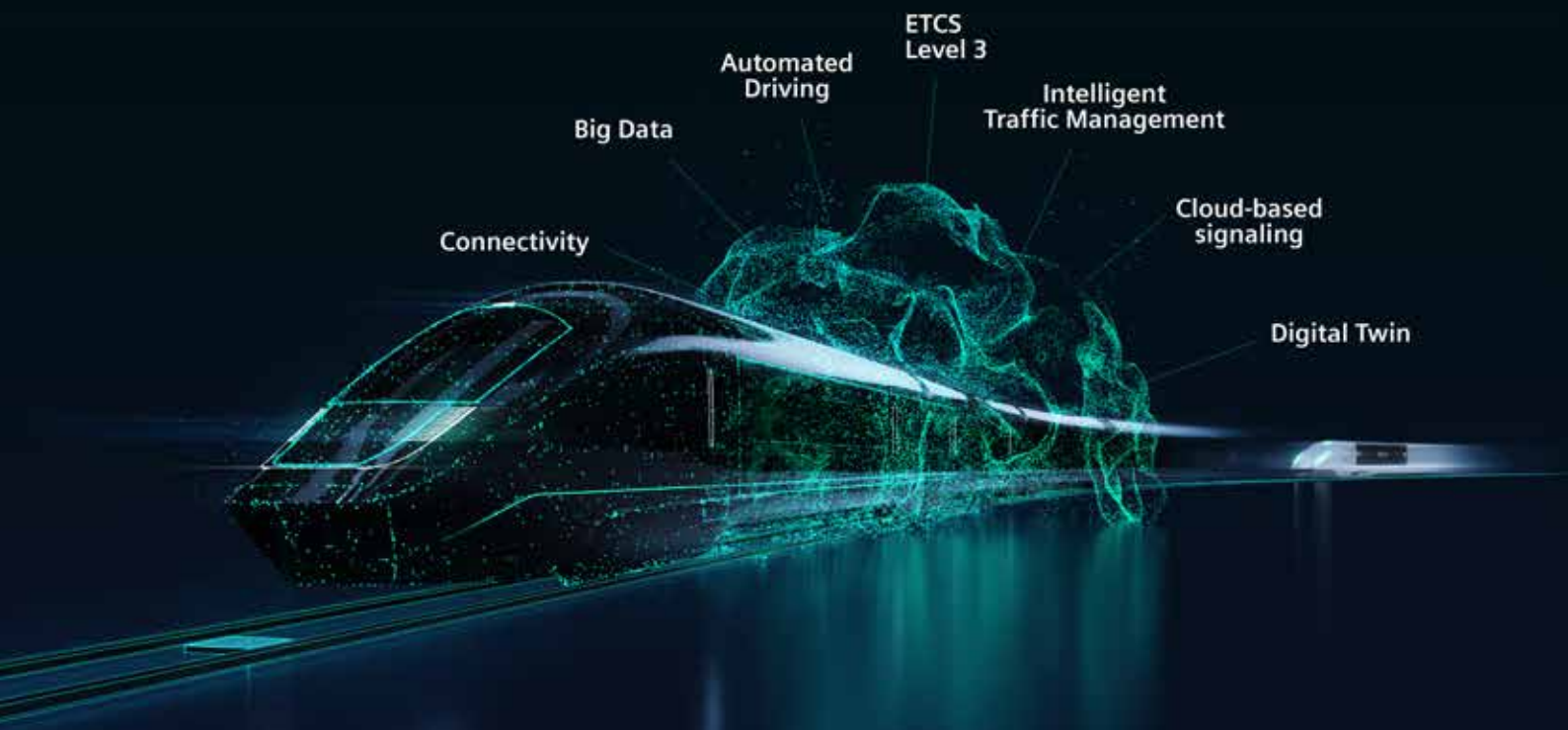

TRENDS AND SOLUTIONS FOR TOMORROW'S NETWORKED RAIL TRANSPORTATION

How digitalization is transforming rail infrastructure

Railways are the backbone of our economy and society. Growing traffic density presents a challenge to many urban areas. Now is the time to look ahead. It is time for ambitious goals and innovative solutions.

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The future of digital infrastructure

Digitalization is the key to increased availability, automation, connectivity, and sustainability in rail infrastructure.

Recent innovations have advanced the expansion of digital technologies in our society to a hitherto unknown extent – and the pandemic has accelerated this trend even more.

Every smartphone has a computing capacity that just 20 years ago was only available to large organizations due to the enormous costs involved. Massive computing power and gigantic memories are available everywhere via mobile broadband communication. This integration of technology into all areas of our lives is called digitalization, and it is characterized by a previously unimaginable networking of people via social platforms and of material objects via the Internet of Things (IoT). It enables the development of entirely new and almost inconceivable innovations. For example, did you know that the IP6 Internet protocol could theoretically assign a separate identity to every grain of sand?

The transformation of rail transportation is picking up speed

Just as all areas of life are undergoing a digital transformation, rail traffic is also in the process of being transformed by digitalization. We are already deep in this process.

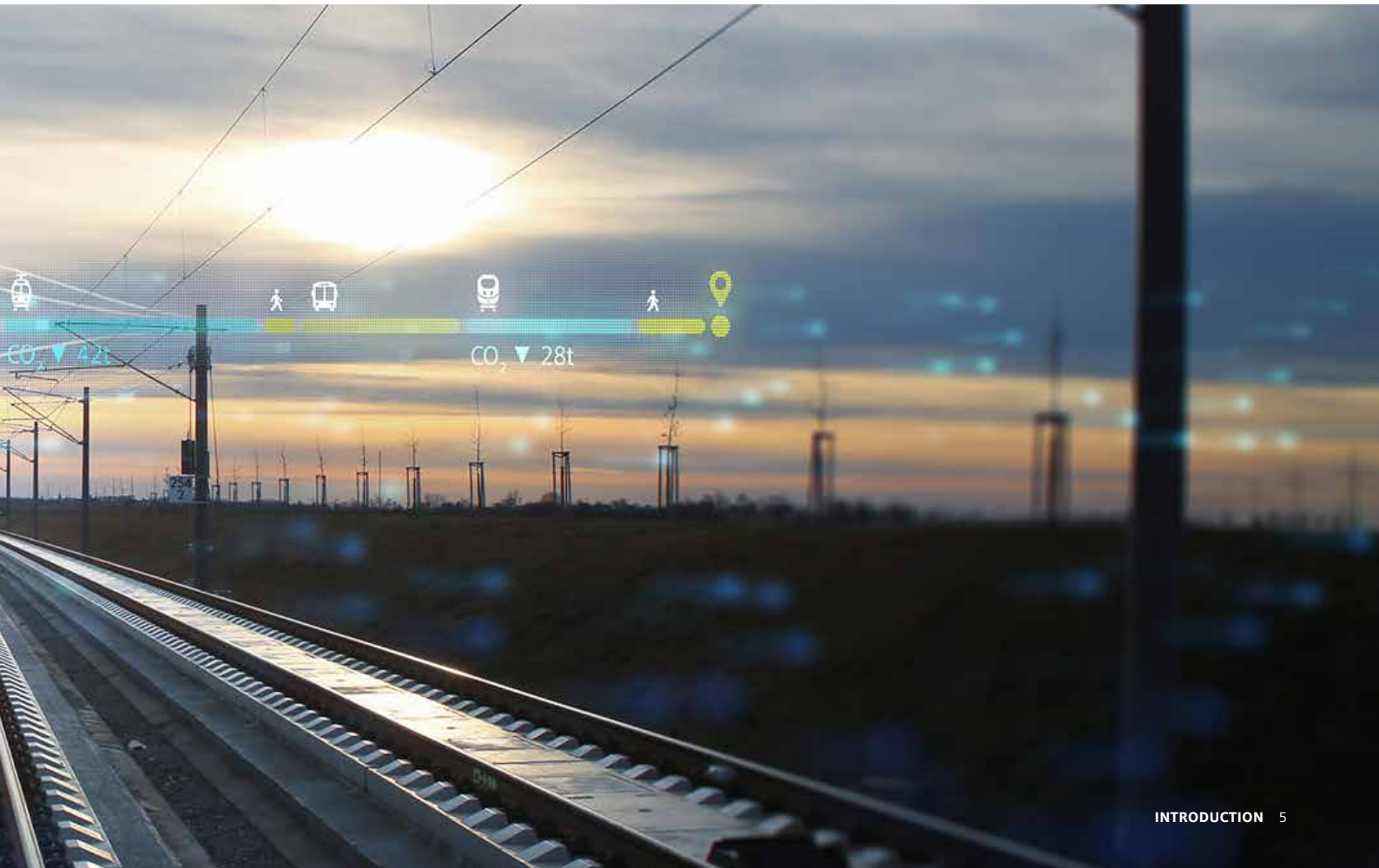
Digitalization will give rail-based mobility an unprecedented boost. It offers greater flexibility, effectiveness, and efficiency and significantly advances the networking of mobility offerings.

Above all, Internet and smartphone applications have dramatically influenced individual mobility options and made multimodal travel opportunities available to all passengers. At the same time, new competitors and offerings have put greater pressure on traditional transportation companies. To maintain an attractive position in the future transportation network, these companies need to expand, improve, and future-proof their offerings. The winners will be those who network the existing infrastructure using smart media, expand transportation capacities, and prepare the infrastructure for a digital future.

One of the most exciting questions is how the ever-increasing networking, cloud-driven automation, big data, machine learning, augmented reality, and blockchain – to name just a few key technological trends – will shape this transformation.

Tremendous opportunities for operators and passengers

First of all, we believe that these trends represent a tremendous opportunity for infrastructure providers, technology companies, freight traffic, and travelers alike: an opportunity to master high traffic volume without having to lay new tracks; an opportunity for sustainable, fast, and comfortable travel; and an opportunity for greater efficiency and significant value creation with comparatively low investments.



Digitalizing the transportation infrastructure can radically optimize resources during installation and operation and can intelligently simplify the extreme technological complexity of the railway system. Previously closed island solutions can be securely opened and safely networked. Digital interlockings, for example, have already become the new state of the art. However, our plans go much further.

As a partner and trailblazer for our customers and suppliers, we develop the products and digital solutions necessary for enabling maximum reliability in passenger and freight transportation, an almost 100 percent availability of rail vehicles and their infrastructure, and optimal costs for maintenance and repair – all while significantly enhancing the travel experience for passengers.

Our vision: A fully networked rail infrastructure

In the Siemens Mobility vision of an entirely digitally networked rail infrastructure, only elements like point machines and balises will remain in the field. All other components and controls will reside in the cloud. Data can be used to control traffic flows and dynamically adjust them to environmental conditions. A networked infrastructure will allow trains, cars, buses, bicycles, and more to be seamlessly interconnected. Our vision of an intermodal traffic system will become a reality.

The more data that is available, the greater its value. New and ingenious algorithms will trace potential causes of error and correct potential faults before they even can occur. An unimaginable depth of detail will yield the business models for tomorrow's mobility.

Rail transportation that is future-ready, safe, secure, and green

Only secure and reaction-free connectivity can support the transmission and real-time analysis of data obtained from vehicles and lines. To give our vision a more concrete form, Siemens Mobility devotes a major portion of its research and development expenditures to developing innovative components that are able to interconnect via the IoT – specifically, via the "Internet of Trains" – and that are protected from unauthorized access. New technologies are IoT-capable ex works and remain compatible with the highest Safety Integrity Level, SIL 4.

Nevertheless, competition from road and air traffic is intense. That is why we need to continue developing the benefits of rail transportation through digitalization, design it to be flexible and adaptable, and expand its capacities – in short, make rail transportation fit for the future.

The key is more intelligence and maximum security in every component. This will allow railways to succeed as an extremely eco-friendly and sustainable carrier of the future. The technologies are there. Let us take advantage of them together!

"We will continue to develop the benefits of rail transportation through digitalization to enable railways to succeed as an extremely ecofriendly and sustainable carrier of the future.

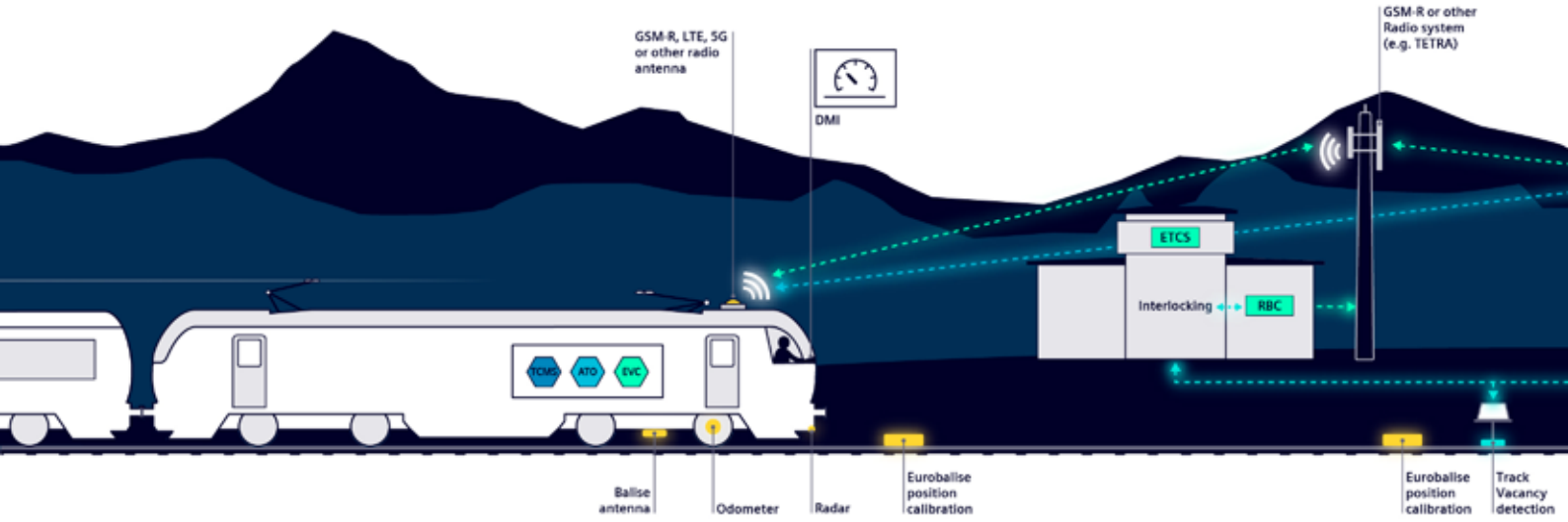
The first step: **Automated driving**

One of the greatest challenges of our time is to ensure economical and sustainable mobility in the face of growing demand and limited possibilities for network expansion. In particular, the demand for safe and secure rail services with high operational availability is increasing. Automated rail services can provide solutions to these very problems and permanently improve rail transportation.

Long before trains arrive at overloaded transportation nodes in the network, they can be coordinated so they can pass through these nodes successively and with no delays. In the future, it will be possible for vehicles to be automatically routed and successfully controlled along the braking curve, even in complex networks. The provision of vehicles at the platform can also be fully autonomous, thanks to automated railway operation. When the train is moving, drivers take on a supervisory role that allows them, for example, to pay even more attention to events on the platform or to concentrate on the proper procedures in emergency situations.

Higher efficiency and added value

The advantages for operators and passengers of a digital and therefore smart infrastructure are enormous. In the future, automated train operation will allow railways to transport more people on the same lines while also significantly reducing energy consumption. Optimized trip profiles will also permit more energy-efficient braking, which means less wear and tear and reduced maintenance and other operating costs. As a result, the value of assets will be sustainably increased over their entire lifecycle. Passenger experience will also be enhanced, not least because of the optimized passenger flow and improved punctuality as well as maximum availability and safety.



ATO over ETCS: How it works
The ATO trackside system collects both static and dynamic data on the line and timetables provided by the traffic management systems and transfers it to the vehicle. Based on the available data on the infrastructure, track, and timetables, the onboard system calculates the optimal trip profile at any given time and controls the vehicle's traction and braking systems on automated train runs. The engine driver is continuously informed of all procedures via a display. As a result, energy consumption is reduced and traffic flow and capacity are significantly improved. Thanks to automated braking, ATO over ETCS shortens braking distances, which in turn greatly improves headways.

Proven in regional service and pioneering in mainline service

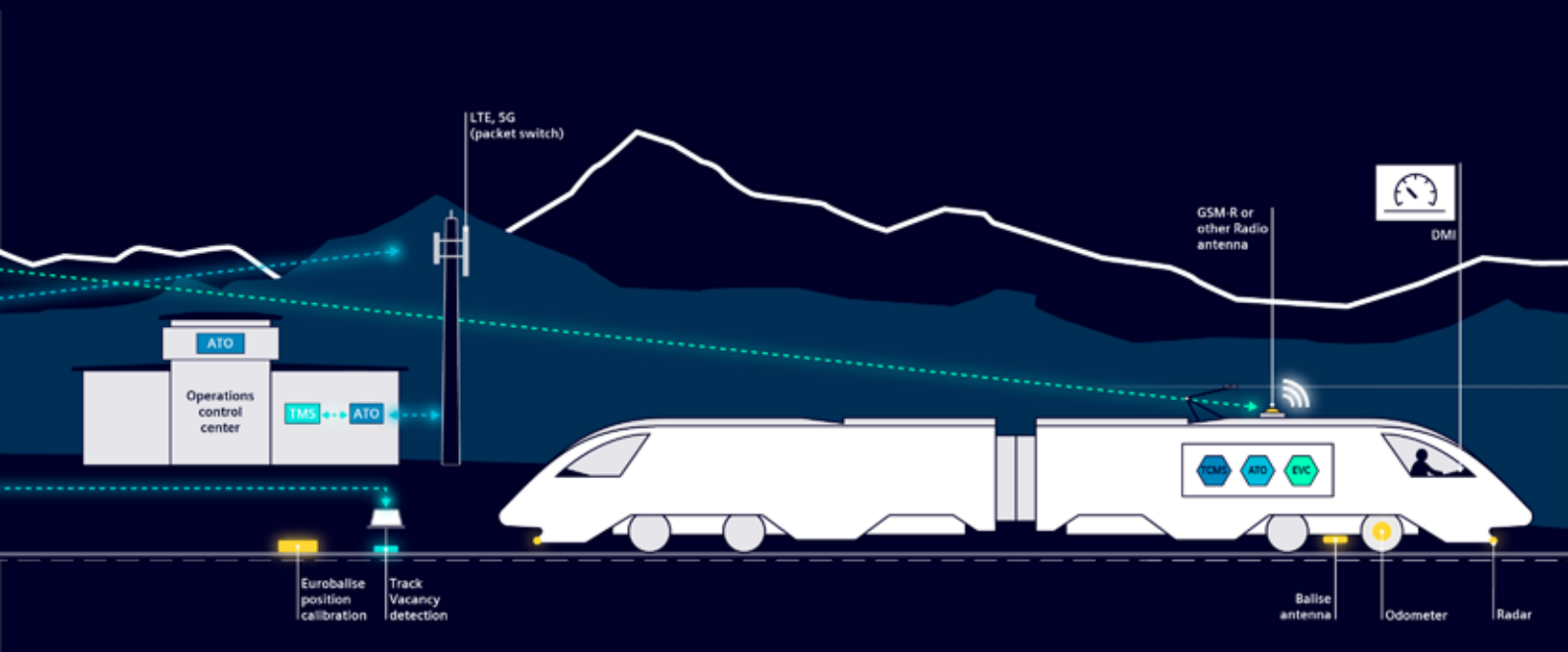
Siemens is a market leader in fully and highly automated mass transit solutions and a pioneer in the implementation of these solutions in mainline traffic.

Automated rail systems are already established in urban transportation. In mass transit systems, standardized vehicles operate within a closed network, which makes automated train operation much easier. At present, multiple automated train solutions are already in operation throughout Europe, including metro lines in Paris, Budapest, and Barcelona.

Automatic train operation (ATO) also covers a wide range of applications in mainline service, from highly automated trains to completely driverless operation. ATO technology accesses information from components like traffic management solutions. Compared with regional service, automated railway operation in mainline service has to take into account numerous additional parameters that make the process much more complex. As a result, different rail operators in mainline service operate in an open infrastructure, with different vehicle types and mixed traffic adding to the complexity. In addition, standardized solutions are required to allow interoperability, the ability of vehicle fleets to operate throughout the entire rail network.

ATO over ETCS

Automatic train operation (ATO) and the European Train Control System (ETCS) are important basic technologies for increasing the efficiency of rail transportation systems and for creating standardized, transnational automation. The combination is referred to as ATO over ETCS.



The technological basis for "ATO over ETCS"
All over Europe, operators are looking for new solutions to increase capacity and reduce energy consumption. The European Train Control System (ETCS), which is already established in mainline service, monitors speed on the rails and ensures that train intervals are safely observed. ETCS is also a key component in the integration of rail transportation in Europe. The goal is to replace the more than 20 different national railway control and safety systems currently being used on the European continent in order to allow the interoperability of cross-border rail traffic.

This makes ETCS an important basic technology for increasing the efficiency of rail transportation systems and for creating standardized, transnational automation. It enables IoT-based networking and increased digital services on a profound and reliable basis. This phenomenon is referred to as "ATO over ETCS".

ETCS Level 2 has long been state of the art, eliminating the need for physical signals as train and trackside elements communicate directly with each other. And ETCS Level 3 Hybrid, which is based entirely on radio solutions, is now being implemented commercially for the first time. The trackside and trainside components are already available. ETCS Level 3 promises maximum flexibility with a minimal use of resources, without the need for trackside track vacancy detection. The technology is currently under development. Siemens Mobility is a driver of this development and is implementing a hybrid variant of ETCS Level 3 for the first time in Norway.

Radio block center simulation: Test ETCS Level 2 with no trackside ETCS equipment!
Using an RBC (radio block center) solution, Siemens Mobility can test ETCS Level 2 on any line, including those not equipped with ETCS. The missing ETCS trackside equipment is replicated by a simulated RBC that is installed in the vehicle based on the plug-and-play principle. Reference points are produced on the track using line balises, which enables the flexible planning and implementation of ETCS Level 2 test runs.

Thameslink

The Thameslink program – the world's first-ever commercial ATO over ETCS application in mainline traffic – was implemented in 2018. It serves to increase the capacity of London's north-south link and provides an enormous boost to the public mass transit system in the metropolis.

Digital S-Bahn Hamburg

In collaboration with Deutsche Bahn AG (DB) and S-Bahn Hamburg, Siemens Mobility is providing the blueprint for ATO over ETCS solutions in Germany. As part of DB's "Digital Railway Germany" strategy, we are equipping 23 kilometers of track and four S-Bahn trains with ATO and ETCS in order to enable highly automated train operation.

Schweizerische Bundesbahnen (SBB)

Working with Swiss Federal Railways SBB, Siemens implemented an ATO demonstrator that performed the first train trips using ATO over ETCS in compliance with UNISIG (Union of Signaling Industry) standards. The project took place in 2018 and 2020 on a route along Lake Geneva between Lausanne and Villeneuve, Switzerland.

Intelligently networked: The enormous **potential of big data**

Trackside and trainside systems supply a tremendous amount of data. For some time, hundreds of sensors and control devices in trains, locomotives, buildings, and products – in other words, all assets – have been recording vast amounts of information, from the temperature of axle bearings and traction data to the currents of door-coupling operating mechanisms and information on defective copper bearings and shock absorbers. Thanks to comprehensive storage technologies and cloud-based services, we can now collect extensive data, store it over the long term and – networked via the IoT – process it further. The devices exchange information, and this opens the door to a veritable data universe that is been inaccessible until now.

Optimized maintenance and operation planning

By partially or fully automating fleets and lines, railway operators can significantly improve their operating sequence, which will in turn increase their cost-effectiveness. For example, comprehensive connectivity enables precise predictive maintenance and need-based component and system repair in the vehicle and on the tracks. Fixed maintenance cycles will be a thing of the past, because products will let us know when and what type of service they need. Predictive maintenance makes it possible to significantly reduce unplanned downtime and repair effort.

Today the latest analytical tools allow a broad and in-depth analysis of digital information so that railway operators in the future won't just be able to optimize the operation of individual vehicles – they will also be able to monitor and optimally control their entire rail network, including their fleet, as needed.

In addition to standard KPIs, our user-oriented design processes also deliver customized processing of KPIs for different user groups – for example, infrastructure managers, maintenance personnel, and operations managers – to ensure the best possible user experience.

However, the following three elements must be taken into account in order for you as a customer to profitably use this data to achieve the sustainable rail service of the future:

1.

Useful data:
To achieve the greatest utility, we need to record the data that is most valuable to you. The more data the systems record, the greater the benefits derived from the information.

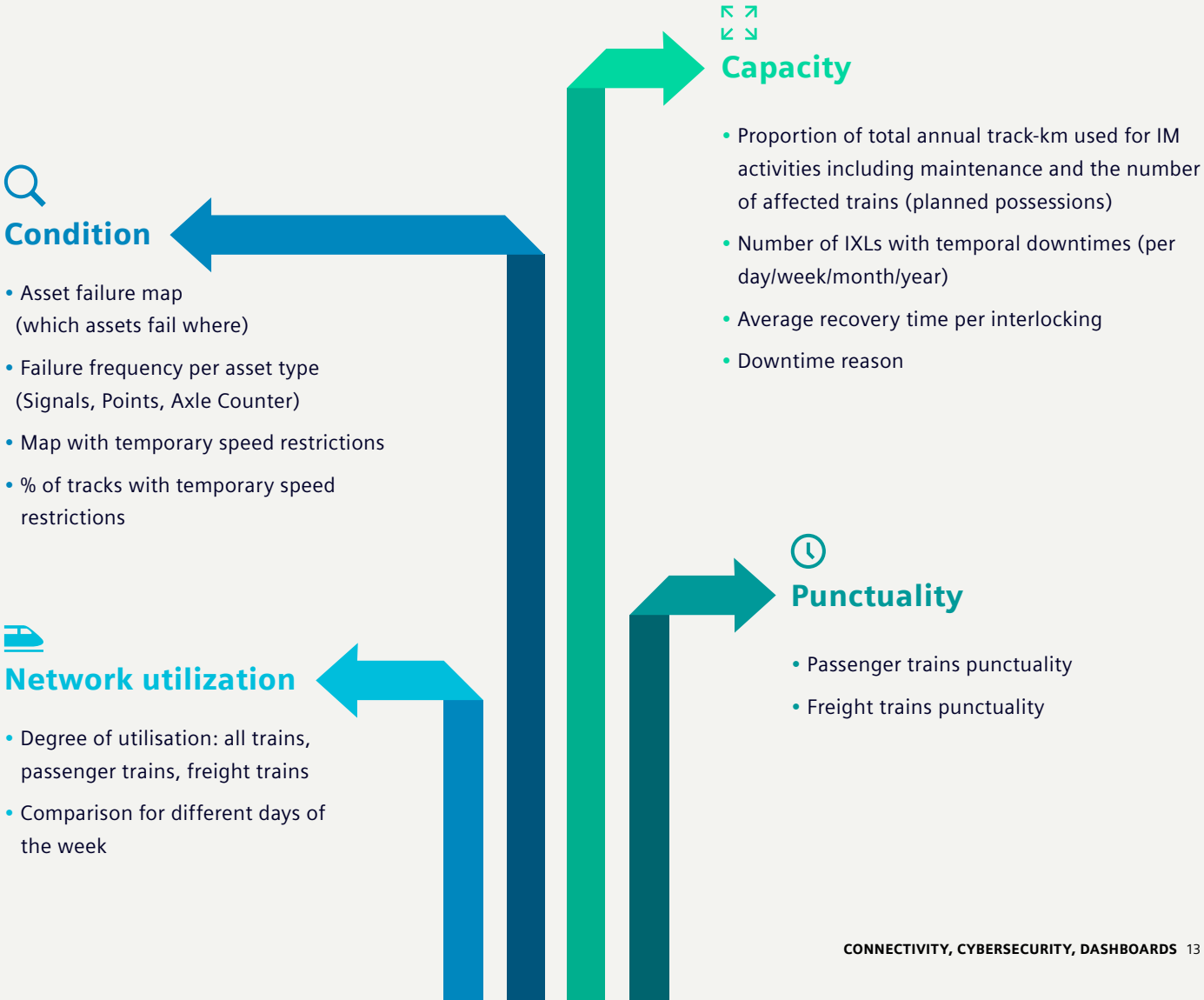
2.

Robust protection and cybersecurity:
Before we interconnect everything, we have to take all possible measures to protect people and data.

3.

Smart analysis and simple processing:
This data must be efficiently and intelligently analyzed and made comprehensible using special algorithms and, if necessary, processed with recommendations for action.

As a strong partner and consultant, Siemens Mobility supports you in the safe and secure digitalization and networking of your railway network with a large number of seamlessly coordinated products and services, including analyses. Whether you operate smaller systems or an entire network, as a Siemens customer you will receive a solution that is modified and scaled to your requirements.



Recording the necessary data – with CTmobile and CTcentral

How fully loaded is a waggon? When are the products arriving? Where are they now? Thanks to sensors, railway operators can already answer these and many other questions today.
CTmobile, CTsensor, and CTcentral are new telematic solutions from Siemens that optimally complement each another. Siemens CTmobile is a hardware component box installed on the vehicle that receives data from the CTsensor solutions.
Siemens CTcentral is a software platform that can run locally or in a private cloud application.
In both cases, customers remain within their own network while enjoying the many benefits of a digitally networked infrastructure.

Railigent® makes intelligent use of data to create added value for operators: Up to a 100 percent increase in system availability, thanks to condition-based monitoring, data analysis, and predictive maintenance concepts.

Networking? Yes, but safe and secure!

Safety and security are our top priorities.
This means protecting people and providing total information security. Only when functional safety and IT security/cybersecurity are guaranteed throughout the entire production chain will companies be able to fully exploit their digital potential.

The Charter of Trust

To comprehensively network the rail infrastructure, there must be a secure connection to an open, digital ecosystem. Railigent® is the solution from Siemens Mobility Rail Services for smart asset management. It is a secure, state-of-the-art platform for analytics that relies on secure interfaces and transmission paths. With this in mind, Siemens co-founded the Charter of Trust in 2018. Along with IoT market leaders like Daimler and IBM, we established in the Charter that future products from all partner companies will be designed and implemented based on ambitious cybersecurity principles.

Recommended by experts: Data diodes

Cybersecurity is especially important for networking in safety- and security-related infrastructures. These networks are typically protected by firewalls and/or air gaps, meaning that they're completely isolated. Both solutions have their weaknesses. With air gaps – a typical solution for power plant networks – no transmission of live data to a recipient outside the network is possible, and this greatly limits the benefits available from the abundance of data. Firewalls are prone to misconfiguration and vulnerabilities. That is why experts recommend using data diodes as an additional security measure for network segments that are in special danger, because data diodes only allow data to pass in the predefined direction (unidirectional).

Using data diodes, customers can, for example, merge operational train data with historical consumption data, weather forecasts, and information on major city events via the Railigent® digital ecosystem. The result is a smooth and economically optimized flow of traffic – controlled by the cloud.

It is all a matter of valuable data, robust cybersecurity, and the right data processing.

Controlled monitoring with the Data Capture Unit

One development offered by Siemens is a compact, easy-to-install, and highly effective data diode. It provides comprehensive connectivity and controlled monitoring, including for security-relevant networks. The Data Capture Unit (DCU) connects a closed network to a storage medium, server, or the IoT via a unidirectional data gateway, reaction-free and therefore securely. This one-way data street offers tremendous potential. In the transportation infrastructure, the diode can improve the connected control, safety, and security systems used in the rail infrastructure. The DCU is embedded in the Mind-Connect Rail Edge platform hardware and software solution, and the combination allows for secure connectivity. Siemens has been supplying its products with data diodes as standard since 2018. It is also possible to integrate them into existing systems.

Data analysis: Full transparency at a glance

The secret is not just having the right data – it also entails processing it as valuable information. The new System Performance Dashboard is a cloud-based solution for the in-depth analysis of your systems. Let us assume that all the data previously defined for your rail network has been recorded, securely stored, categorized, processed, and analyzed. How can you now access the information you need?

For example, you might have the following questions: How punctual are your trains? What sections of the network are well utilized and what sections are being over- or underutilized? Have field elements failed, and if yes, which ones? Is any construction planned? If yes, what trains will be affected, and do they need to be rerouted? You can find answers to all these questions on Siemens Mobility's extremely user-friendly dashboard.

With just a few clicks, you will see a clear presentation of the data based on customer-specific key performance indicators (KPIs). You can retrieve the desired information as a function of your profile, whether you're the CEO or the operator. The KPIs give you the information you need to for rapid, strategic decision-making. The pre-defined standard KPIs include the punctuality, network utilization, condition, and capacity of the rail network being monitored. Working in co-creation for and with our customers, at Siemens Mobility we specifically adapt these KPIs to the customers' requirements in a user-centric process. The dashboard runs in Railigent®, the secure, high-performance analytics platform from Siemens Mobility.

Straightforward, thanks to the heat map function

Users can filter the analyses chronologically and, for example, display data for the past hours, weeks, or year in a heat map. The color scale allows them to identify bottlenecks or system vulnerabilities at a glance and with 100 percent transparency.

Another feature of the dashboard: The more data, the higher the quality of diagnostics and the higher the level of automation that is possible. The system can identify bottlenecks in the rail network with meter accuracy and name the cause of the problem. This broad and in-depth correlation of a variety of parameters is unique on the market.

Maintenance optimization

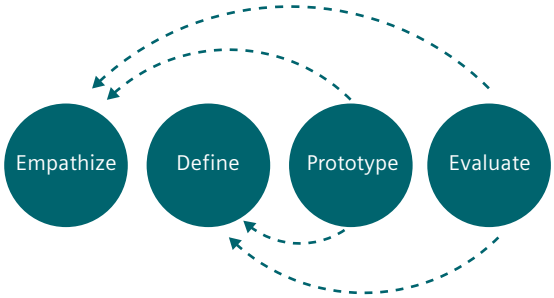
Identify how intensively equipment is being used both by traffic and switching operations. Use this to optimize maintenance intervals or even take it out of service completely. Deploy maintenance staff and money more efficiently.

Capacity analysis

Explore capacities on the network and increase traffic volumes. Find spare capacity and use it for innovative new routes and timetable optimization.

Bottleneck mitigation

Detect bottlenecks in the network caused by overused equipment or timetable constraints. Avoid them by planning new and different routes or by adapting the network to relieve the strain.



Our dashboard projects follow an iterative process to achieve best results regarding user experience.

The Mobile Infrastructure Analyzer (MIA): Simulate your infrastructure using live data!
MIA is a mobile analysis tool for simulating and analyzing problems and faults in your rail infrastructure. It can be flexibly deployed at different locations and stored in a small space. All it needs to work its magic is an on-site power outlet and Internet access (it already comes with mobile LTE/5G access). To simulate realistic customer scenarios with live infrastructure data feeds, for example, it is possible to import line plans from the traffic management system, interlocking data, and/or ETCS line elements. This enables MIA to identify bottlenecks in the network, analyze problems, and optimize the infrastructure based on the results.

Other applications include optimizing maintenance and analyzing network capacity in order, for example, to increase throughput via new routes. What's special about MIA is that it can also be subscribed to as a service. Our experts then come to you, the customer, and work with you to evaluate the results of the technical analysis.

The digital revolution in interlockings

Interlockings are the centerpiece of rail infrastructures around the world. The relay interlockings that were set up many decades ago have already been followed by the second generation of interlocking technology, the electronic interlocking. This modernization resulted in significant improvements.
Based on this state-of-the-art technology, Siemens Mobility and DB Netz AG have now developed a newer and more modern technology as part of the Digital Rail for Germany (DSD) initiative: the digital interlocking (DSTW).

The new interlocking technology features an IP-based architecture and standardized interfaces. The dispatcher's switching commands are digitally transmitted to the points, signals, and track contacts via network technology. The tremendous advantage is that the previously required individual connections via kilometer-long cable bundles to single interlocking elements have been eliminated. In addition, signals and points can be controlled at much greater distances via a data line, thanks to the network connection.
We believe that the new interlocking technology is a milestone in the digitalization of the infrastructure as well as the basis for higher capacities and improved punctuality in rail transportation.

Successful pilot projects
The first trains controlled by a DSTW are already operating safely and punctually. In the town of Warnemünde in northern Germany, Siemens Mobility commissioned Germany's second digital interlocking and the first to be used in mainline service in September 2019. In 2018, we implemented a pilot project in Annaberg-Buchholz in which Europe's first DSTW began operation, ushering in a revolution in rail control and safety systems.
The two projects were important steps toward operating interlockings in the cloud. For the first time ever, an interlocking transmits its IP-based commands to the system's field elements, including points, signals, and axle counters. This allows brand-new flexibility in planning, makes it possible to use intelligent field elements, and generates positive cost effects over the longer term. All this is achieved while meeting the strictest safety standards in operation.

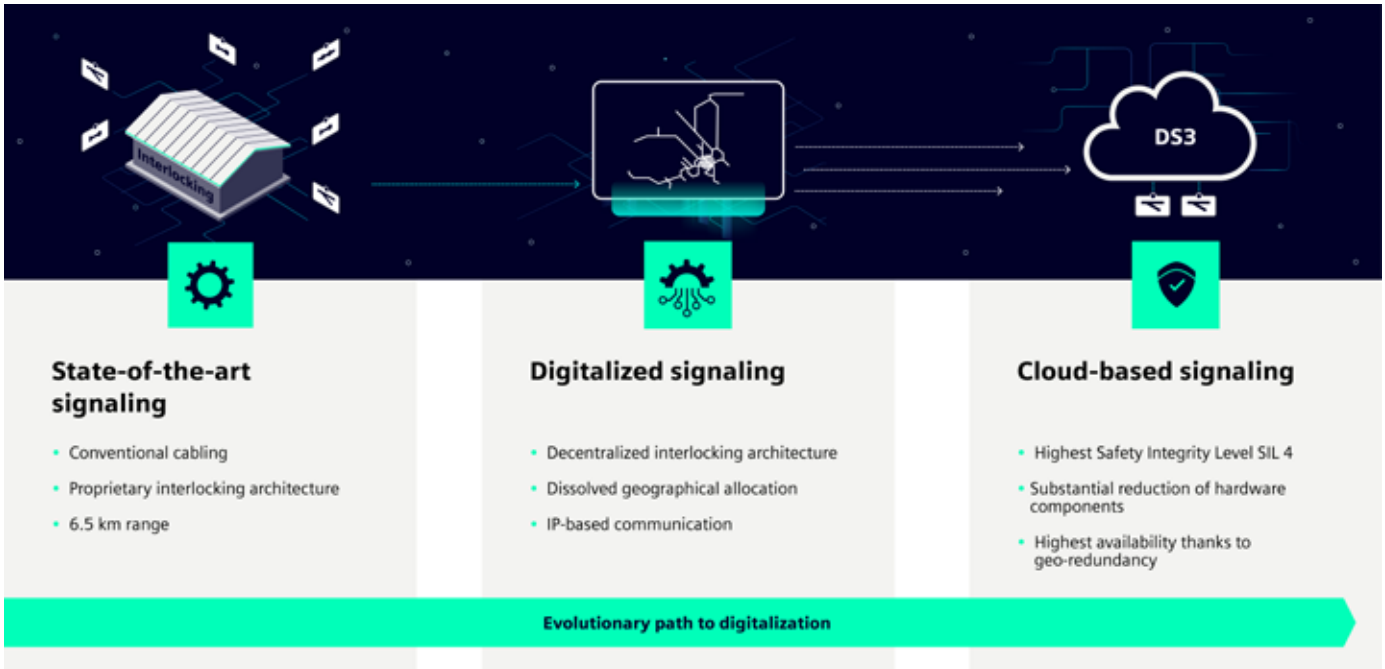
Norway's rail network goes digital: First country-wide rollout

Another early adopter of the new, digital signaling technology can be found in Norway. Together with the state-owned agency responsible for the national railway infrastructure, we are installing interlockings, outdoor facilities, and ETCS (European Train Control System) Level 2 throughout the entire Norwegian railway network. [see page 20/21]

Looking to the future

As Siemens Mobility, we want to go one step further. In our vision of an entirely digitally networked rail infrastructure, only elements like point machines and balises will remain in the field: All other components will be virtualized. In this future, axle counters, track circuits, and signals will disappear. Over the long term, the control logic behind this vision – the interlockings and radio block center – will permanently reside in the cloud. The trains will report their position to the central, secure system via radio control and will receive their movement authority accordingly.
In an initial project, we have already been able to verify the safe and secure operation of an interlocking based on commercial-off-the-shelf (COTS) Multicore technology:

In Achau, Austria, ÖBB-Infrastruktur AG and Siemens Mobility commissioned the first hardware-independent Simis AT interlocking on the DS3 (Distributed Smart Safe System) platform. It is the first approval of a digital SIL4 interlocking based on COTS Multicore server hardware. The DS3 platform is a brand-new, software-based security platform that serves as the foundation for secure rail applications in the cloud. We will continue to work with our customers and partners to make our vision of rail security technology in the cloud a reality.



Norway: Creating a veritable **Internet of Trains**

Working with Bane NOR, Siemens Mobility will transform the entire Norwegian rail network into a fully digitalized, IP-based system. This will create an Internet of Things – a veritable Internet of Trains – that will significantly reduce infrastructure costs and maximize capacity.

Passengers will benefit from improved punctuality, increased capacity, and higher train frequency.
The nationwide system is controlled by an ETCS Level 2 solution from Siemens that is located in a central interlocking and a radio block center in Oslo and issues movement authority to the trains. All lines are expected to be in operation by 2034.

Digital twin
of the infrastructure

As we did in Norway, we can migrate entire rail networks to digital technologies. Such a move doesn't happen overnight; it requires elaborate preparation and sophisticated methods. From tracks and vehicles to buildings and the environment, it is important that all components and interactions be mapped in a digital infrastructure model: a digital twin. This includes precise data recording, digital planning, digital expansion, and digital maintenance.

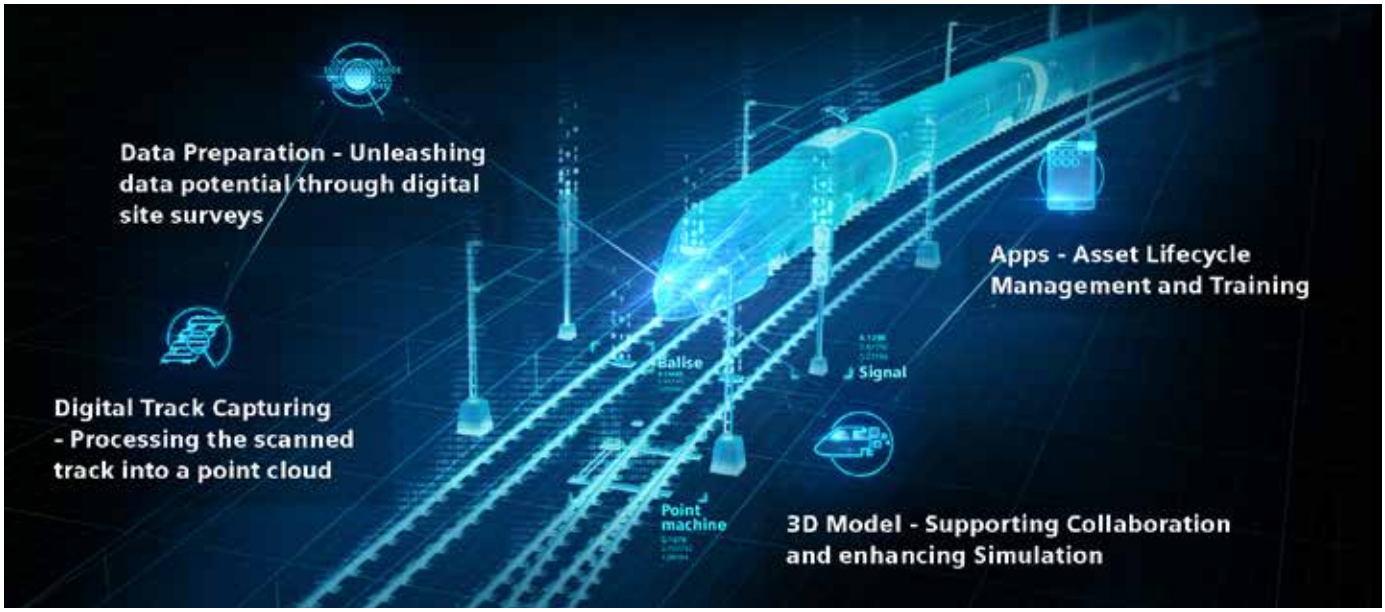
BIM improves and accelerates collaborations between different partners across time zones, companies, and national borders.

Building information modeling

At Siemens Mobility, we use BIM (building information modeling) that is fully integrated in all project phases. Originally used in the construction industry, BIM is a state-of-the-art methodology for complete virtual planning: Its advantage is that it integrates all planning partners and available information and improves collaboration, planning quality, and productivity for the entire project. The data is fully transparent to all stakeholders and lays the groundwork for efficient, data-driven repair and maintenance. Once the model meets all the specifications, it is tested virtually before being installed.

BIM Services

The foundation is the recording of the entire rail environment with millimeter precision. For a long time, employees measured tracks manually using measuring wheels to capture the necessary data. In the future, this will be done digitally using scanners and drones. The entire line must be covered, which is a resource-intensive process. On Germany's tracks alone, it would amount to around 33,000 track kilometers, and therefore digital track capturing is all the more essential. In addition to the lidar scanners typical of the industry, Siemens Mobility uses a 360-degree camera. A geo-referenced point cloud is generated from the scan data, meaning that each data point can be assigned an exact geographic position. The camera images augment the point cloud.



Digital integration concepts

As a supplement to BIM, Siemens Mobility also uses a combination of digital measuring tools on the vehicle side and augmented reality (AR) applications. This allows us to virtually plan installation scenarios for ETCS components at the vehicle on-site or modernize vehicles as part of a retrofit – which is especially relevant when upgrading to ETCS and installing the requisite components for this upgrade. We accomplish this, using tools like AR goggles: for example, HoloLens from Microsoft. To facilitate communication, the technician's work on the vehicle can be mirrored on a tablet in real time.

Engineers wearing augmented reality goggles can see the ETCS components in the real train environment during the installation analysis

Other benefits of the method

All design partners have unlimited access to the latest design status and an inclusive CAD model of the entire rail infrastructure and processing. They use a shared database that serves as the "single source of truth." This is how BIM improves and accelerates collaborations between different partners across time zones, companies, and national borders and how planning risks are minimized.

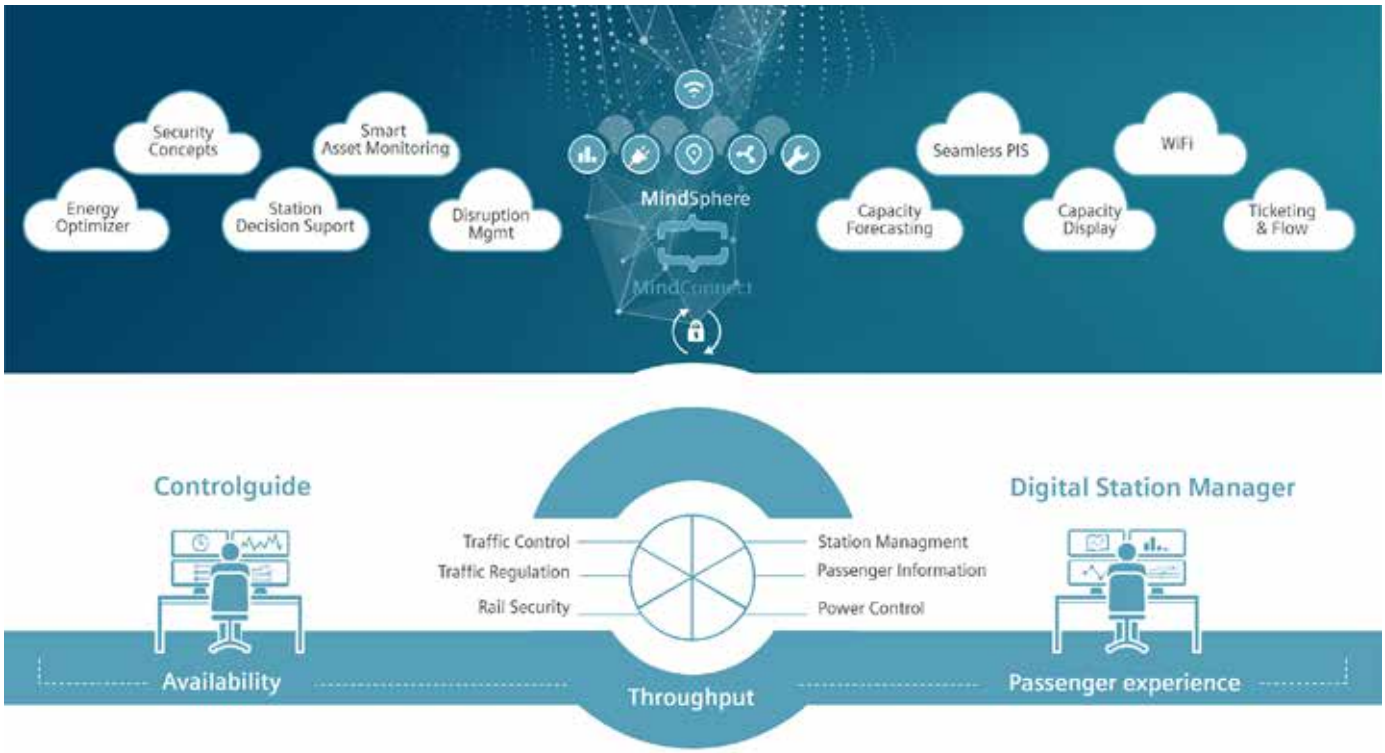
After the data is captured, a digital site survey is performed in which we label all relevant signaling objects across the track and in the control room. A precise model of the environment is created – a full-scale site plan that can easily be processed further in the office. We generate 3D models of entire routes, interlocking buildings, and control rooms that our customers can use for simulations, testing, and training. Our BIM Services can be subscribed to individually and in packages.

As our customer, you can inspect and experience a 3D model virtually in an early project phase. This visual support assists you in meetings with stakeholders and governments and when informing the public and reduces the risk of non-budgeted changes. We thoroughly test the design before starting construction. This means that we have already detected collisions – for example, with existing structures – on the screen and not on the track.

The digital station

For as long as railways have connected the world, railway stations have been at the heart of inter-modal travel. The challenge today is to efficiently operate nodes as they become increasingly complex. Control systems from Siemens Mobility do exactly that, thanks to complete IoT integration and cloud-based operating solutions. This is how we are bringing railway stations into a new, digital, and efficient era.

At the core of this move is the data that is being collected. In the digital station, infrastructure and vehicle data is linked via secure interfaces: for example, with the help of the DCU (Data Capture Unit). Our solution is the DSM (Digital Station Manager).
The system gives operators digital, automated control of railway stations and optimally guides travelers to their desired mode of transportation, and even to an empty seat. This allows operators to ideally adjust railway stations to the volume of passenger traffic, enhance passenger experience, and boost capacity and cost-effectiveness.



Controlling passenger flows

In a digital station, for example, state-of-the-art camera, control, and sensor technology makes it possible to modify the speed of escalators to the volume of passenger traffic – automatically and in real time to save energy and optimally control the passenger flow. The DSM can also start the air-conditioner when many people are expected and turn it down in the opposite case. These tools are especially useful when large numbers of people are attending major events like concerts and sport events.

The system supplies precise data on the current and expected passenger volume and a comprehensive overview of all procedures in railway stations and on platforms. Operators are then able to safely transport the maximum number of passengers, stagger people gathering at specific locations, and take into account any government restrictions. A special decision-support tool offers recommendations on how and where people can navigate the station most efficiently. Passengers can also pay for their trip wirelessly, without using a ticket vending machine.
Until now, no other provider of rail infrastructure solutions has combined information from different systems and networks in this form.

COVID-19 and beyond

The above-mentioned functions not only increase efficiency, they can also help during the COVID-19 pandemic. For example, the system can be used to direct passenger streams through narrow corridors in only one direction, or to determine whether passengers are maintaining the recommended physical distance. Siemens Mobility has already piloted this application with the German public utility Stadtwerke München, and it is also being used by ProRail in the Netherlands.

The benefits

The Digital Station Manager from Siemens offers innumerable benefits to operators, infrastructure owners, and passengers. Operators can optimally synchronize and efficiently adjust all station operations – if desired, IoT-based in their own or an external cloud. Passengers enjoy enhanced comfort, thanks to better orientation and up-to-date information. Infrastructure owners can, for example, reduce their CAPEX thanks to network- and hardware-optimized SCADA, PIS, CCTV, and PA solutions that raise the level of virtualization.

The Digital Station Manager can be connected to an external or local cloud.

Optimal orientation, thanks to smartphones and beacons

Smartphone apps and beacons are important sources of information for the DSM. Beacons are tiny transmitters inside buildings that send signals at specific intervals to facilitate routing and orientation. Travelers have the option to receive beacon signals via app: The latest information is automatically displayed when they move past certain points.

New business models: **Mobility as a Service**

Take advantage of mobility whenever it is needed. More and more, mobility is becoming a service for both operators and travelers. Individual services are combined in comprehensive packages that are available on demand at all times. For operators, this means an additional business model and lower costs; for travelers, it means flexibility and enhanced travel comfort. As a result, railway companies today can control their trains without having to own any control system hardware. Travelers in the age of intermodal travel can expect smartphone apps to seamlessly guide them from point A to point B across all modes of transportation – and all with a single ticket.

Control technology in the cloud

The traffic control and information system Iltis, for example, can run entirely on cloud servers. This networked solution is called "Iltis as a Service" (ILaaS). It enables railway companies to operate without owning control technology hardware and purchase the functions as a flexible service. As suppliers, we ensure that the control technology infrastructure always complies with the latest, mandatory IT security standards. ILaaS is also designed as a platform and can be easily expanded with additional digital solutions.

Two private railway companies in Switzerland are already operating their control technology in the cloud with ILaaS: Gornergrat Bahn as a pioneer since 2017, followed by Berner Oberland-Bahn in 2019. Their advantages include reduced investment and maintenance costs with the same level of operational reliability. Even the environment profits, because producing and installing less hardware also means using fewer resources. Mobility as a Service is not just a reality today: Mobility as a Service is the future.

Conveniently going from A to B – without a private car

Metropolitan regions are constantly growing, as is the use of private cars. Expanding public transportation to include new options like bike sharing, car sharing, and on-demand offerings and intelligently integrating them all into an app creates a genuine alternative to driving a private car. Digital solutions give travelers exactly what they need: intermodal route planning before departure, uncomplicated booking – including ticketing and payment – as well as the latest information throughout the trip.

The technologies necessary for travelling seamlessly from point A to point B using all modes of transportation already exist today. The Mobility as a Service (MaaS) platform from Siemens Mobility and its subsidiaries Hacon, eos.uptrade, and Bytemark interconnect the individual mobility providers and offer end users a central point of contact for all their mobility needs in the form of a smartphone app.

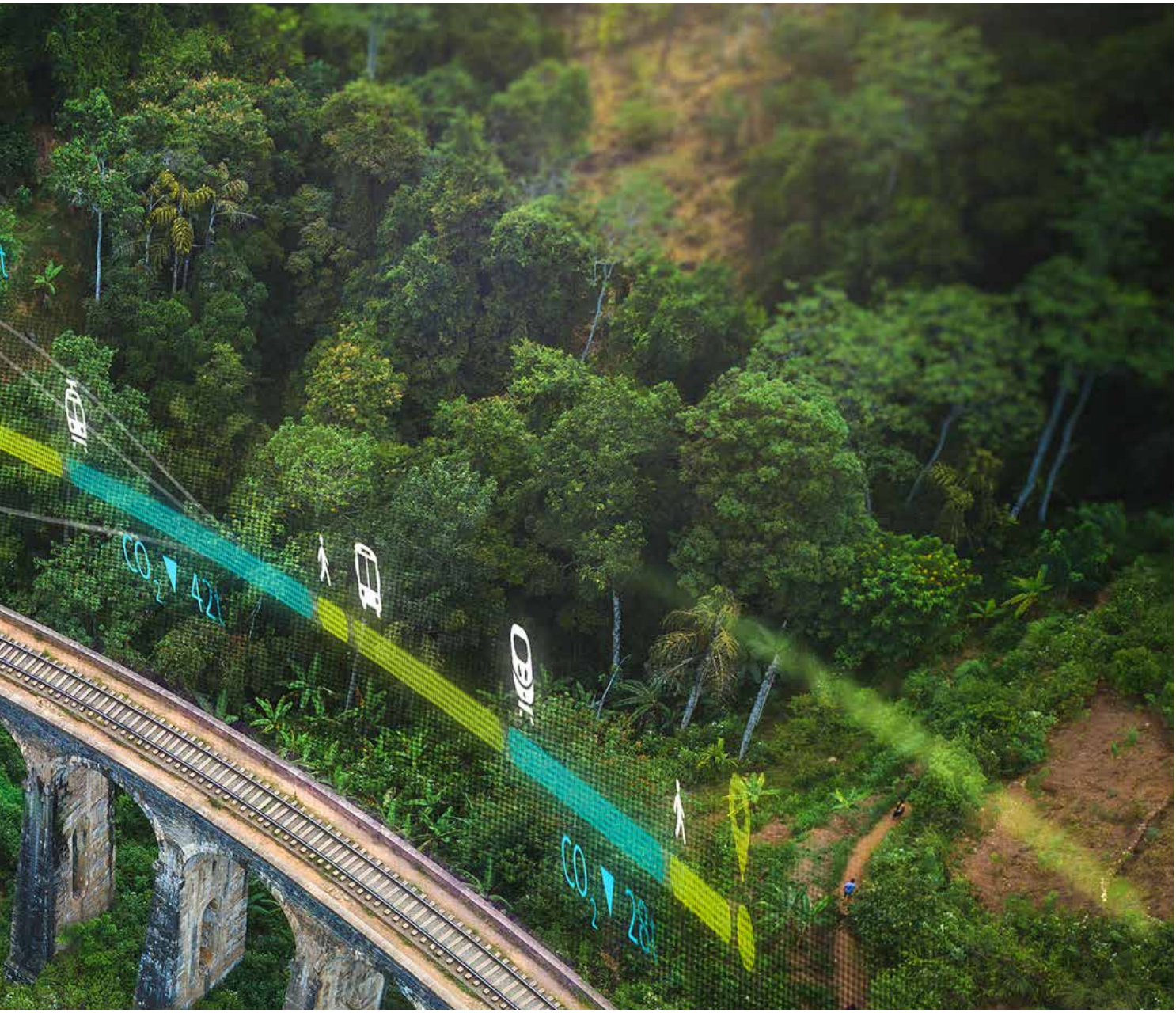
Case study: Congestion-free travel in Luxembourg

Siemens Mobility was commissioned by Verkéiersverbond Luxembourg to develop an intermodal mobility platform that provides users with comprehensive, up-to-date, and customized information on their travel options using public transportation and rental cars and bikes. Commuters in particular are offered smart alternatives to driving their own car.

For a future-ready railway

In our vision of the future, rail transportation is not only digital and highly automated – it is also safely, securely, and seamlessly linked to other environmentally friendly modes of transportation.

We believe that thanks to their ingenious, innovative solutions and business models, companies like Siemens Mobility will collaborate with rail infrastructure operators to make rails the number-one sustainable and future-ready means of transportation in the future – smart, green, and competitive! We will work together to reduce the workload of future traffic systems, thanks to digitalization. This is an important opportunity for operators and travelers alike that we need to take advantage of now. We want to use our solutions to increase availability to almost 100 percent, maximize throughput, and enhance the travel experience for passengers.



The digital transformation is already underway.
Let us shape it together!
For the safe and secure mobility of tomorrow.
For our planet.
For our future.

Our vision and innovations at a glance

Expand digital infrastructures:
The non-networked transportation infrastructure has reached its limits. Digitalization is the necessary game-changer.

Automation is the foundation:
Europe-wide standards like ERTMS/ETCS and technologies like ATO over ETCS are the basis for comprehensive data recording and automation.

Process data sensibly:
Ultimately, big data needs to be in a form that our customers can use. Smart data analysis procedures transparently prepare the most useful data from your fleet – anywhere, at any time.

Everything runs in the cloud:
In our vision of a digitally linked railway infrastructure, all trackside components other than point machines and balises are virtualized.
Railigent® is the open, digital ecosystem for smart asset management: the solution for the Internet of Things (IoT) as a service.

Ceaseless research and development:
To realize this vision, we are investing a major portion of our research and development expenditures in IoT-capable components.

Safety and security as the top priorities:
The transportation infrastructure of the future will also meet the highest security standards (Safety Integrity Level 4), supported by innovative developments like the data capture unit (DCU).

Think in terms of new business models:
Mobility is becoming a service. Large investment and maintenance volumes lead to flexible business models. Railway companies in Switzerland are already operating their control technology in the cloud.

We stand for sustainability and trust:
As a global enterprise, our partners trust that we will work with them to realize pioneering work in the transportation industry and to sustainably and seamlessly transport people and freight from the first mile to the last.

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The potential and value of digitalization are far from exhausted. Seize this opportunity today – with Siemens Mobility as a strong partner supporting you every step of the way!

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Article No. MOMM-B10228-00-7600