Digital Rail for Germany

The future of rail.

Contents

Launching a new era of rail transportation

One of the greatest challenges Germany faces is taking consistent steps toward decarbonizing mobility to better protect our environment. Transport must be shifted to the rails to a massive degree for the country to meet its climate targets. That's because no other mode of transport is as eco-friendly as rail, nor can any other mode compete with its electric mobility.

As we shift more transport to the rails, we'll need a powerful, modern rail system, one which offers higher capacity, efficient production and intelligent control systems. To this end, we're investing billions of euros in innovative technologies and digitalizing our entire system to accommodate them.

Digital Rail for Germany marks the start of a new era for rail. We're upgrading our infrastructure with new technologies to better manage trains and make rail operations smarter. At the same time, we're engaging in new forms of cooperation across our industry.

The possibilities are endless. Consensus has been reached among the German government, the rail industry and the manufacturing industry, and the first few projects are already underway. We share a common objective: to make the rail system significantly more powerful, on time, flexible and less prone to disruptions – thereby offering more attractive mobility services for passenger and freight transport. Read on to delve further into all these topics. Join us on the fascinating journey to the future of rail.

Sincerely,
Ronald Pofalla

Transitioning to a digital world

Digital Rail for Germany consists of two phases. Firstly, the European train control system will be installed, as will digital signal boxes. Our new technologies will run on this equipment, enabling us to realize the future of rail operations.

There will be no more signal lights telling train drivers to stop or to continue on their way, but drivers will still know when to slow down and when their train has reached its next stop. Drivers will have their own display in the train's cab to see far ahead even as their ICE speeds down the tracks at some 186 mph. Instead of traditional signals along the route, trains will receive information by radio signal and from special transponders built into the tracks, sometimes called balises. Trains will begin braking automatically as they approach a virtual red signal. Speed-monitoring prevents trains from coming too close to other trains ahead of them and enables trains to maintain a safe distance from other vehicles when accelerating.

Since December 2017, ICE trains have been using ETCS – and no signals – to ply the route between the German cities of Nuremberg, Erfurt and Halle/Leipzig, marking the first step toward Digital Rail for Germany.

Rail is the answer

More capacity, higher quality and improved efficiency – this is how digitalization will impact rail operations in Germany. Implementing innovative technologies represents a brand-new opportunity for Germany's rail system. Digitalizing signaling equipment and implementing a comprehensive new train control system will combine to make rail more competitive and make a statement that rail is the answer to the growing demand for eco-friendly transportation.

By building a smart network of all its infrastructure and vehicle data, rail operations has the opportunity to completely revamp its structure. This network is key to increasing capacity on the existing rail network by up to 35% – without laying new track.

These changes will increase capacity, but they will also improve on-time figures and increase the reliability of the rail system. Additionally, standardized technology will reduce operating costs as well as maintenance and repair costs.

This innovative push will benefit the customers of all rail companies in Germany, the country's economy and the environment. A powerful rail industry translates to more people and more freight on the rails, less traffic on the roads, fewer traffic jams, less smog and significantly lower CO_2 emissions.

Every day, 40,000 passenger trains and 5,000 freight trains ply the 20,000 miles of track that make up the German rail network. Varying speeds, a blend of high-speed long-distance, local and regional trains making frequent stops and freight trains hauling thousands of tons of goods make it necessary to constantly be looking ahead when dispatching trains and managing rail operations.

In Germany's complex technical system, 2,700 signal boxes control over 245,000 miles of cables, some 67,000 switches and 160,000 signals.

In many cities, the German rail network is already at its limit. Many routes and major hubs simply have no more capacity for additional trains. In these areas, costly new construction projects would need to be completed before more transports could be shifted to eco-friendly rail.

The train-control principle of dividing trains into blocks has proven itself effective over multiple decades. However, it restricts the number of trains on the rails. In many cases, a train must travel three to five miles before the next train is given the green light to depart. That takes time and eats into capacity.

Phase 1: Shift to new technology based on ETCS

Digital Rail brings together multiple technologies, some of which are already in use.

The foundation is the European Train Control System (ETCS), a uniform European standard. Instead of conventional signals, the system uses radio signals to control trains. To realize the full potential of ETCS, Germany will connect the system to digital signal box technology (DSTW) – the second major component of Digital Rail. As of today, there are many types of signal boxes spread throughout Germany, ranging from the country's imperial age to electronic signal boxes, all of which will gradually be replaced by this innovative technology. This upgrade will allow rail operations to run more reliably and efficiently.

Digital Rail for Germany goes even further: all infrastructure components, including rails, switches, signal boxes and signals, will be connected to each other and to the trains relying on them. Standardized technical components will replace the different types of signal boxes.

Using ETCS and a radio system (currently GSM-R), trains will be safely guided along their lines without lighted signals. Data is shared among the train, line control centers and balises installed in the tracks. Train drivers will be able to view signal information directly on the display in their cab. These systems will ensure each train maintains the required distance from other trains and will safely bring them to a full stop.

Digital signaling technology: fiber optic network to replace copper cables

Digital signaling technology (DSTW) represents the latest generation of signal boxes and is the technological successor to electronic interlocking (ESTW). Humans interact with the two systems identically. Both types of signaling systems use redundant computer systems to review and process signal commands issued by dispatchers. However, ESTW uses conventional electrical switch technology to issue electronic commands through bundled cables to switches, signal boxes and rail crossings. Switches and signal boxes send information back the same way. In this system, each infrastructure component has its own cable connecting it to the signal box.

By contrast, DSTW sends digital signal commands to switches and signals and also receives digitalized information from tracks, switches and signals. In this new system, encrypted signal commands travel through loops of high-performance fiber optic cable to arrive at their destination.

Starter package agreed upon for launch

Digital Rail for Germany is launching. As the result of a feasibility study conducted by the German government, three plans were selected in the fall of 2018 which have great potential to increase capacity and improve quality.

The starter package for launching Digital Rail for Germany includes the following items:

- The high-speed line between Cologne and the Rhine/Main region
- The Trans-European Networks (TEN) corridor between Scandinavia and the Mediterranean Sea (routes: Maschen–Magdeburg–Halle, Nuremberg–Augsburg–Munich and Munich–Rosenheim–Kiefersfelden/Freilassing)
- Digitalizing the Stuttgart hub

A billion-euro plan for the coming decade: the German government has earmarked EUR 570 million solely for the implementation of the three priority projects by 2023.

In order to make an impact quickly, the economic areas adjacent to significant transport corridors in the TEN should be given priority for upgrades. By 2023, more than half of all border crossings to Germany's neighboring countries on the European corridors will have been upgraded to ETCS.

With an average investment of EUR 1.3 billion per year ininfrastructure and additional funds for rolling stock, German's rail system can be digitalized within 20 years.

"The German rail industry sees Digital Rail for Germany as a unique opportunity to catapult rail into a new era of technological innovation. **This effort will bolster Germany's image as a place to do business for the long term.** *"Digital rail technology – Made in Germany," a motto recognized the world over, will get a fresh coat of paint. Companies in the rail industry are prepared to do their part."*

Axel Schuppe | Managing director, German Railway Industry Association (VBD)

"Digital Rail will make it much more appealing to travel by train in Germany. **The program will lead to more on-time trains journeys and will increase the available capacity of existing infrastructure.** *These changes will enable local and regional trains to better synch up with long-distance trains. If additional rail tracks are built for local rail transport authorities, which are urgently needed, we can grow the number of passengers transported by local rail transport authorities as well."*

Susanne Henckel | President, German federal working group for local rail transport authorities (BAG-SPNV)

"Today's highly digitalized logistics systems for freight transport must close the gap in our rail system by providing a consistent stream of information and powerful efficiency-boosting production models which transcend borders. **Taking an open-data approach, we'll be able to provide customers with reliable data about the estimated arrival time of their shipments, even as we become more efficient across our entire intermodal supply chains."**

Michail Stahlhut | Managing director, Hupac Intermodal SA

"We want people in Germany to say, 'Wow! Deutsche Bahn got me to my destination simply, affordably, comfortably and reliably.' Cheering, not jeering – that's our goal. DB is making a huge contribution to this effort with its digitalization campaign. **Riding the rails can be more than just the most eco-friendly and cutting-edge way to get around – it can also inspire joy and ignite passion."**

Andreas Scheuer | German Federal Minister for Transport and Digital Infrastructure

"ETCS reduces costs, increases capacity and creates opportunities for automated rail transport. **These are the ideal conditions for significantly increasing the market share of rail in passenger and freight transport and for markedly reducing damage to the climate and environment caused by transportation."**

Martin Schmitz | Managing director for technology, Association of German Transport Companies (VDV)

"ETCS has the potential to significantly reduce the number of competitive obstacles faced by rail companies in German and international transport. *That's a good thing – for the jobs in this industry as well. That's because, as a union, we're demanding that the adoption of new technologies result in advantages for employees as well."*

Alexander Kirchner | Chairman of the Board, German Rail and Transport Workers' Union (EVG)

"Digitalization might be a word you don't hear much anymore, but the digitalization of rail infrastructure has the power to revolutionize rail travel. **More train journeys will be on time, more affordable and more attractive.** *The German government would do better to invest billions of euros in rail than in building new highways."*

Dirk Flege | Managing director, Pro-Rail Alliance (Allianz pro Schiene e. V.)

Phase 2: Digitalize rail operations

The development of digital technologies continues apace with smart software, highly sophisticated sensors, powerful real-time geolocation systems, strong data connections and data processing capabilities, creating completely new opportunities for modernizing rail operations. Given these changes, rail will offer attractive, modern career options in the future. Overview:

Real-time geolocation

To be able to optimally control transports at all times and achieve optimal capacity usage of the existing network, trains must constantly be tracking their own location throughout their journey. New digital technologies lend a helping hand for tracking as well. By combining digital maps, satellite geolocation and sensors on trains, it will soon be possible to track the exact location of trains on the tracks in real time. This will allow trains to travel at more flexible distances and run closer to each other as well. More trains will therefore be able to use the network at the same time, thereby significantly increasing capacity. In addition to the location of each train, its speed, acceleration and integrity will be reliably measured and communicated to traffic management.

Awareness of surroundings

Digital rail operations integrate technologies which gather information about trains' surroundings. Trains equipped with these technologies use various sensors such as cameras and radar to analyze their environment. Information collected by the sensors is compiled in real time by smart software.
Paired with a digital map and geolocation, these trains can evaluate whether it needs to classify an object in its environment as an obstacle. Companies in the rail industry are currently testing technologies like this.

Highly automated driving

Trains are being equipped with a type of autopilot system. The technology is called automatic train operation (ATO) and it carries out predetermined instructions in trains to accelerate and brake. This system ensures that trains are always moving at the optimal speed. Additionally, response times between sending and carrying out a driving instruction are much shorter and have much less variance than with manual controls. Using this technology, more trains arrive on time and their operations become more predictable. ATO can be used to improve acceleration and braking. The technology works hand in hand with the train control system ETCS (ATO over ETCS). The first pilot program in Germany is currently underway and focuses on Hamburg's suburban train, also known as the S-Bahn (turn to page 15 to learn more).

When it comes to automated driving, suburban trains are currently leading the pack, outstripping even cars. Automated trains are operating in more than three dozen major cities worldwide, including Barcelona, Copenhagen and Paris. In Nuremberg as well, automated subway trains have been in operation since 2008.

Thus far, these train have been running smoothly using technologies developed specifically to provide local transportation in subway and metro systems.

Using artificial intelligence to manage traffic

One significant characteristic of rail is scheduling and managing traffic, also referred to as capacity and traffic management. The growth plan through 2030 places enormous demands on traffic management. Optimizing existing network capacity and managing an increasing level of traffic are areas where artificial intelligence (AI) and self-improving, trainable algorithms can be put to good use. These technologies compile all available data, analyze it and finally translate it into optimized instructions for trains and infrastructure. AI can be used to optimally balance loads on the existing network and respond more rapidly to disruptions. AI and self-improving software are integral components of Digital Rail for Germany.

5G and cloud technologies

5G and the cloud are overarching technologies which combine the power of all available innovative technologies to work together in real time. With the use of digital technologies comes a much larger quantity of data. Most of the data collected by sensors and cameras in trains, stations and on tracks in the future will have to be transmitted, processed and analyzed in real time. In order to manage this, the rail system will need a powerful mobile data network for rail operations and secure, scalable data processing infrastructure based in the cloud. Germany's rail system currently uses the GSM-R mobile data network, which was developed in the 1990s. This network will not support technologies of the future, so it's extremely important that rail infrastructure across the entire network be upgraded to use the new Future Railway Mobile Communication System (FRMCS), which is based on 5G technology.

What Digital Rail for Germany aims to deliver

By digitalizing rail operations, we're ensuring that rail will be viable in the future. This major project will benefit the entire rail industry, the German government, the German economy and, of course, customers in particular.

All benefits which Digital Rail for Germany aims to deliver at a glance:

Digital Rail for Germany will increase capacity

Digital Rail for Germany will increase the number of trains that the current system can handle. Uniform digital signaling technology based on ETCS and DSTW combined with advanced digital rail operations technologies will increase rail network capacity by up to 35% without the need to build new tracks. That's because the European Train Control System (ETCS) will use radio signals to control trains rather than signal lights. Technologies such as real-time geolocation for trains and a traffic management system leveraging artificial intelligence will enable trains to run closer together, increase the flexibility of operations and considerably improve capacity utilization across the rail network. With Digital Rail for Germany, we're bringing more traffic to the rails. By 2030, the German government aims for twice as many passengers to be using the railroad and significantly more freight to be transported by eco-friendly rail.

Reliability will improve as well

Digital Rail for Germany will improve the quality of rail operations, and passengers and freight will reach their destination more reliably as a result. Standardized technical components and an optimized system dashboard which anticipates future conditions will improve reliability, increase on-time figures and improve customer satisfaction. Cutting-edge digital remote diagnostic systems will help keep disruptions to a minimum. Switch-mounted sensors will detect problems long before they can disrupt rail operations. Fiber optic sensors on tracks will automatically identify and report problems. These systems will make rail operations more stable, reduce the number of failures and enable more trains to use the rails.

Digital Rail for Germany will make rail operations more efficient

Digital Rail for Germany will allow for a complete revamping of rail operations. Improving the utilization of infrastructure capacity and optimizing the management of all workflows will revolutionize rail transport. Cutting-edge standardized technologies will ensure that reliability is high and that little time and effort are required for maintenance; additionally, disruptions will be easier to resolve. Uniform technology will make it easier to transport freight across Germany's borders – that's because, up until now, trains have had to stop and go through complex processes at border crossings. These changes will create the conditions for a higher level of interoperability across all of Europe, thereby making the rail system more efficient overall. All rail operators will benefit from lower infrastructure costs.

Digital Rail for Germany driving innovation in the industry

An unprecedented infusion of technology for the entire German rail industry, Digital Rail for Germany will benefit rail systems in Germany itself and beyond. The program will also create opportunities to export technology and expertise. As an economic hub and technology leader, Germany will leverage the potential to export new systems and capture new markets. In the manufacturing industry and at Deutsche Bahn, innovative technologies are changing the working world, too. Bleeding-edge professions are being created, employees are being trained to learn new skills and work processes are becoming easier to master. Digital Rail for Germany will benefit the entire German economy.

Good for the environment

Rail is already the most environmentally friendly mode of transport. With Digital Rail for Germany, the rail industry can expand on its position as a leader in environmental protection. That's because the program will create the conditions to shift even more traffic to the rails. Innovative signaling technology combined with new technologies for digital rail operations will increase the capacity of the existing network. When all is said and done, we'll be in a better position to protect the environment as a result. Completely revamping the structure of rail operations and making the best possible use of existing resources will reduce energy consumption and decrease harmful CO_2 emissions – it is estimated that rail transport will reduce CO_2 emissions by more than 10 million metric tons by 2030. Of this amount, 1.6 million metric tons will be attributable solely to the steps we take as part of Digital Rail for Germany.

Installing ETCS and digital signaling technology: Our plans

Starting in 2020: Starter package with three projects

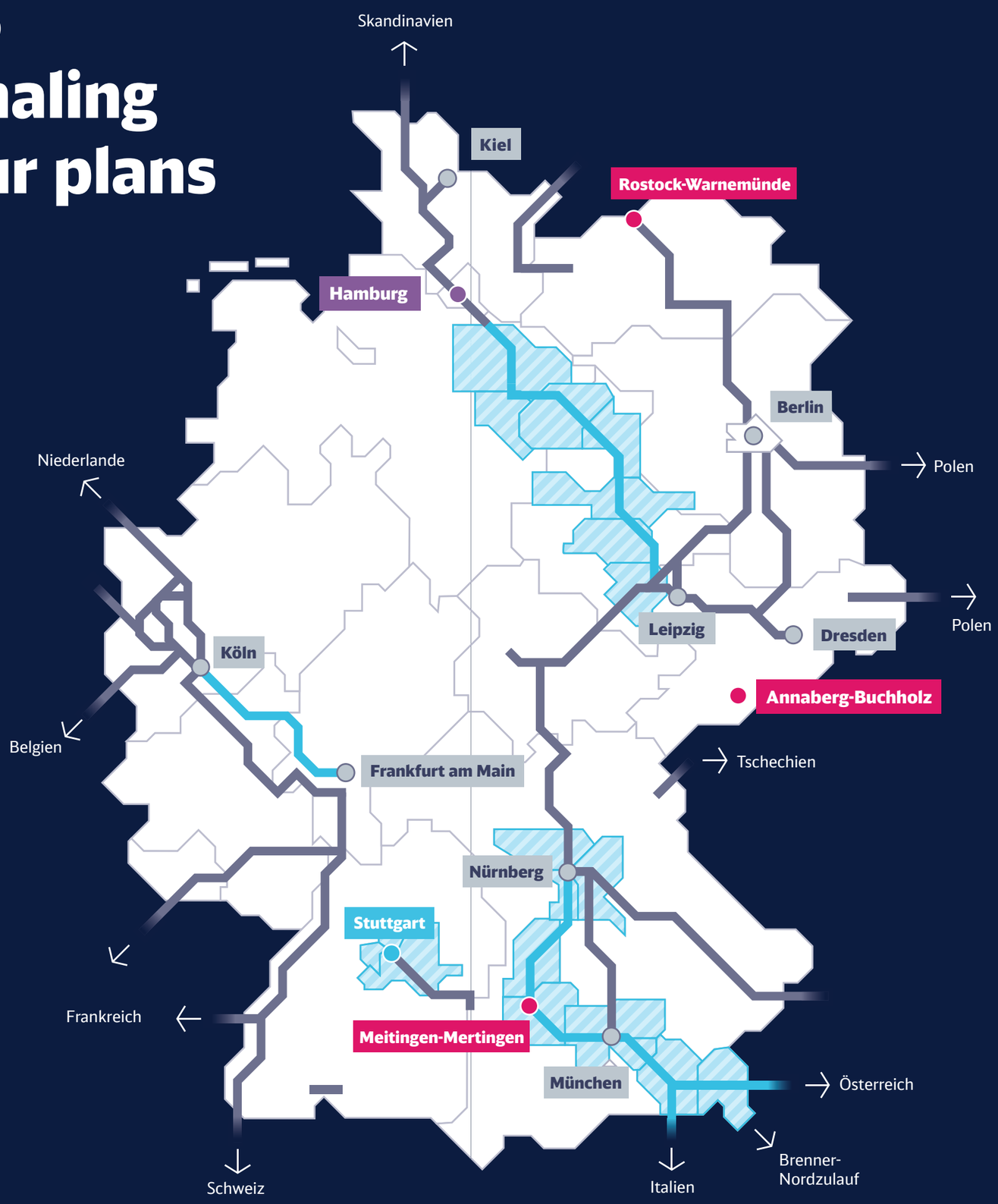
Included in the first phase:

The high-speed line between Cologne and the Rhine-Main region
The TEN corridor connecting Scandinavia with the Mediterranean Sea (routes: Maschen–Magdeburg–Halle, Nuremberg–Munich and Munich–Rosenheim–Kiefersfelden/Freilassing)
Digitalizing the Stuttgart hub

These three projects have the potential to have a major impact on efforts to increase capacity and improve network quality. These routes will be equipped with ETCS and digital signaling technology by 2030.

Digital signaling technology – DSTW

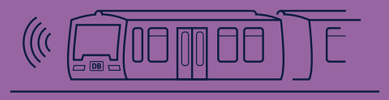
This new signal box technology is the second core element of Digital Rail for Germany. The cables these boxes need won't be nearly as complex or expensive; they'll cover larger areas and provide employees with modern, highly sophisticated jobs.



Starter package: routes to be equipped

Starter package: network districts to be equipped

Existing/planned ETCS installation beyond the starter package (EDP; requirements plan) – selection



Hamburg's digital S-Bahn Premiere of highly automated driving

When the ITS World Congress for intelligent transport systems is held in the fall of 2021, Hamburg will showcase the first highly automated rail operations in Germany. Four digitally controlled suburban trains, also known as S-Bahn trains, will traverse a 14-mile route from Berliner Tor station to Bergedorf, a borough of Hamburg. This pilot project, which started in mid-2018, is a joint effort between the German city of Hamburg, Siemens and Deutsche Bahn.

Every 30 minutes, around the clock – the Germany-wide integrated regular-interval timetable

Enak Ferlemann, Parliamentary State Secretary under the German Federal Minister for Transport and Digital Infrastructure

Mr. State Secretary, what is your personal connection to the Germany-wide integrated regular-interval timetable?
I'm one of the people who believed in the integrated timetable from very early on, so I advocated for it. That's because the Germany-wide integrated timetable will help us expand our infrastructure such that services running on regular-interval timetables can be offered across Germany. This will make rail transport much more attractive and we'll see more passengers choose to travel by rail, the eco-friendly option. Additionally, Germany-wide integrated regular-interval timetables will free up more infrastructure capacity for freight transport, thereby enabling us to shift more transports from the road to the rails. From 2013 to 2015, the German Federal Ministry of Transport and Digital Infrastructure conducted a feasibility study on putting an integrated regular-interval timetable into action in Germany. The study showed that an integrated regular-interval timetable for passenger transport could be implemented on the German rail network from operational, technical and legal standpoints. The infrastructure requirements to make this a reality are currently being determined as we draw up a roadmap with targets for the integrated regular-interval timetable.

You live in Cuxhaven. How would you explain the Germany-wide integrated regular-interval timetable to your neighbor?
The idea behind a country-wide regular-interval timetable is that passenger trains arrive at train stations at pre-determined times – mostly on the hour or half hour – and remain at the station long enough for rail passengers to comfortably board their connecting train. For instance, if someone from Cuxhaven wanted to travel to Berlin, Hamburg's individual lines would be synched up so the passenger would be able to connect to a long-distance train from a regional train without a long layover. In order to implement this in the future, we'll need to expand infrastructure in a precise way to effectively connect lines to each other across Germany.

Why don't you adjust frequencies based on demand?
The model of the Germany-wide regular-interval timetable doesn't prevent us from adding more trains or offering trains with more seats at peak times of the day. However, the core concept of this new timetable is offering rail services with synched intervals which are easy for passengers to remember across Germany's entire rail network – all day, every day. Additionally, with connections offered at convenient half-hour intervals, taking the train will become more flexible, a significant advantage when going head to head with air and car travel.

What good is digitalization if German hubs like Cologne or Hamburg are simply too crowded?
The rail requirements plan calls for both of those hubs to undergo major expansion. That means we're not solely relying on digitalization, though it will help us keep trains running close together and utilize the existing platform infrastructure in the best way possible. In these ways, digitalization will contribute significantly to ensuring trains will be able to pass through quickly, even at busy hubs.

Is rail transportation too far behind?
Digitalizing the German rail network – some 20,000 miles of track – is a huge challenge. Despite this, the process of digitalization is moving ahead at full steam. As an intermediary step toward adopting digital signaling technology, some 400 electronic signal boxes are already in operation. The first digital signal box is already up and running as well – with no problems. This new signal box will be followed by many more as part of the effort to install new train control technology (ETCS) and modern signal boxes on the rail network; as this work continues, the network will be gradually updated.

Germany's neighbors such as Denmark and Belgium have a huge head start in digitalizing their rail networks (ETCS).
The train control systems currently in place in Germany are advanced and modern. The intermittent and continuous automatic train-running control systems (PZB and LZB, respectively) provide a similar level of performance as ETCS Level 1 (LS) and ETCS Level 2. As such, there wasn't as much pressure to replace our existing technology as in other countries. Nevertheless, the German government has been making significant funds available to digitalize the country's rail network for over five years in order to lay the foundation for modern rail operations.

Without more rail transportation, it will be virtually impossible for Germany to achieve its climate targets. How much do you expect the Digital Rail project to reduce CO_2 emissions?
The Digital Rail project has the potential to make a significant contribution to reducing CO_2 emissions. If we're successful in making rail transport faster with more on-time trains through digitalization and the German-wide integrated regular-interval timetable, more people will switch to traveling by eco-friendly rail. Freight transport will benefit from these changes as well. Finally, the ongoing electrification of our rail network and the use of trains with alternative drive systems such as hydrogen will significantly contribute to reducing CO_2 emissions.

When it comes to freight transport, rail lags far behind the road. What will digitalization and the Germany-wide timetable do to change that?
The second expert draft of the target roadmap for the Germany-wide timetable lays out a plan to add significantly more track, which will allow freight transport services to grow. At the same time, the plan also calls for the addition of flexible tracks, which enable freight operating companies to respond flexibly to high-volume order periods and disruptions to operations. These additions will significantly improve reliability and the quality of operations in rail freight transport.

Higher utilization of network capacity means more trains will run closer together. How is the German government helping upgrade trains to use new radio technology?
No specifications have been released for "new radio technology." Frequencies which are available across Europe are being identified for the railroad's new mobile data system, and the corresponding standards are being developed. The aim is to make the new system compatible with GSM-R. As Sweden and the Netherlands are already doing, the German government would like to invest in improving the resilience of current GSM-R equipment to prevent disruptions. Some EUR 50 million have been earmarked in the budget for updating trains with this new technology. Because the new system will be compatible with GSM-R, we expect a smooth transition to the future system without the need for major investments.

Let's get back to your hometown, Mr. State Secretary. What do you imagine a train journey from Berlin to Cuxhaven will look like in 2030?
Once all of the steps planned for the Germany-wide timetable have been taken, a journey from Berlin to Cuxhaven will look like this: rail passengers will first be able to catch a train from Berlin for Hamburg on every half hour since the Germany-wide timetable stipulates 30-minute intervals for the main long-distance corridors. Thanks to optimal links between long-distance and regional lines at hub stations, passengers will then be able to easily connect to a Cuxhaven-bound train from Hamburg without experiencing long wait times.

Focus on: Hamburg, Stuttgart, and Betuweroute

Insight and reflections on two future projects from a train driver already using ETCS between the German city of Emmerich and Rotterdam in the Netherlands.

Hamburg's suburban train: the premiere of highly automated driving

Swinging into 2021: "Highly automated suburban trains offer many advantages. On a given route, a considerably larger number of automated trains can run at higher capacity. Trains currently run every three minutes, which we'll shorten to as little as 90 seconds, even as we reduce energy consumption and operating costs," says Jan Schröder, project manager for the digital S-Bahn project in Hamburg. "What we're creating here is a blueprint for designing smart rail networks, particularly in major metropolitan areas." If everything goes according to plan, Hamburg's entire suburban train network will be gradually digitalized. Across Germany, most trains and routes used for local, regional and long-distance transportation could follow in the coming 15 to 20 years, so expectations are quite high for Hamburg's pilot project.

Initial test runs slated for early 2020

Hamburg's digital S-Bahn project is the first of its kind being implemented as part of Digital Rail for Germany. "With this project, we're paving the way to digitalize Hamburg's entire suburban train network in the coming decade and beyond," says Schröder. The goal is to have four highly automated S-Bahn trains shuttling along a 14-mile route of the S21 line between Berliner Tor station and Bergedorf/Aumühle station in a little less than two years, just in time for the ITS World Congress on October 11, 2021, in Hamburg. A train driver will still be on board. "In the future, the driver won't need to intervene unless there is a disruption or irregularity. The train takes care of everything else: starting, accelerating, braking and stopping," says Schröder. When the train reaches the platform in Bergedorf, the passengers and driver exit the vehicle. The empty train will then drive itself – completely autonomously – to a shunting track, turn around and head back to the S-Bahn station, where new passengers and the driver will board once again. The train will depart and continue on its highly automated way.

From a technical standpoint, the implementation will be based on the automatic train operation (ATO) system and the European train control system (ETCS).

While initial test runs are planned for early 2020, the infrastructure along the route and the trains themselves must first be updated with digital technology.

A new type of industry cooperation was selected for the project: Deutsche Bahn will share the total cost of the project with the city of Hamburg and Siemens, a manufacturing partner, which amounts to some EUR 60 million. Most of the research and development unit founded independently by DB and Siemens is located in Berlin. The team is currently made up of around 200 employees from various corporate units and subsidiaries of both organizations. In an open co-working space, designers, software developers, system architects, regulatory experts and other specialists are working on the project's design and roll-out. "We're all on uncharted territory, and we're learning new things every day," says Schröder. "However, in this group environment, we're much more agile and can talk about problems and solutions as equals." According to Schröder, the unit's flat hierarchy, rapid decision-making processes and a culture of open discussion are fostering an atmosphere of innovation.

The next major milestone for the project? Upgrading the four S-Bahn trains. The trains are being upgraded with new vehicle components such as balise antennas, monitors and an ETCS and ATO computer at the DB depots in Neumünster and Ohlsdorf.

Jan Schröder, project manager Hamburg's digital S-Bahn

"What we're creating here is a blueprint for designing smart rail networks, particularly in major metropolitan areas."

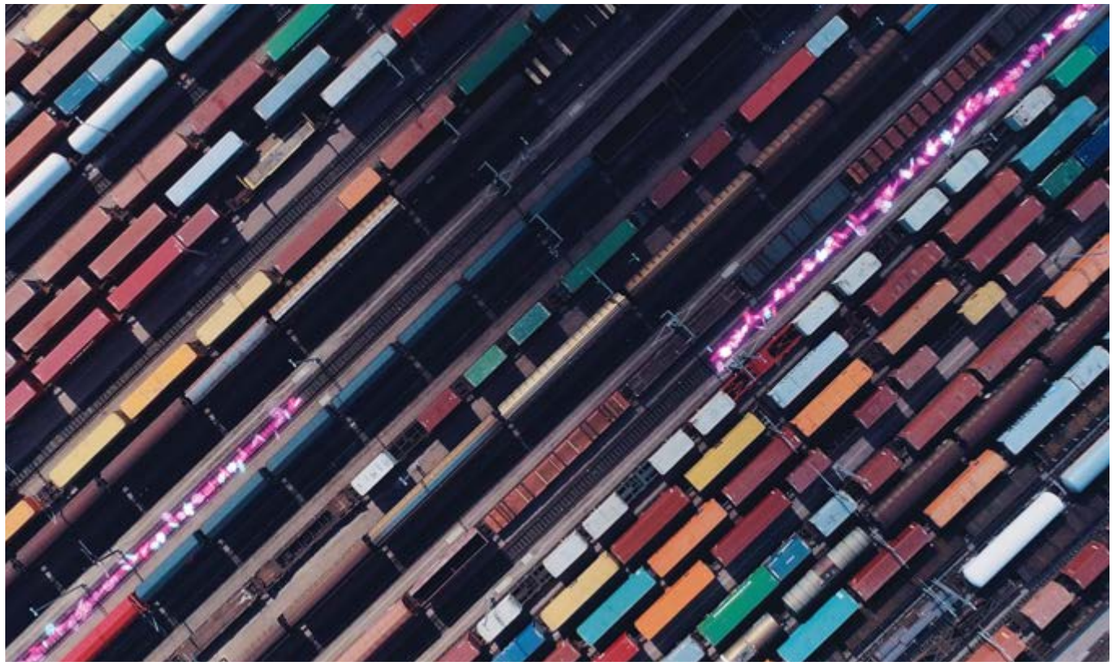
Stuttgart, major metropolitan regionand the first digitalized rail hub

Better quality and higher capacity – these are the goals of the project to digitalize the Stuttgart metropolitan region. The plan to digitalize a major hub – both the city itself and the surrounding region – will be the first of its kind in Germany. Stuttgart was selected because the transportation hub was already being modernized as part of the Stuttgart 21 project, which entailed installing new train control technology.

In addition to the new central station and other new stations, around 62 miles of long-distance, regional and suburban lines will be upgraded with digital signal boxes, ETCS and highly automated driving systems, which will involve a driver. The upgrades will, for instance, improve performance on the main S-Bahn line by at least 20%, reduce the number of delays and allow for more trains to be added, as a detailed analysis showed. These are all good reasons to make all trains highly automated with ETCS – for rail, the German state of Baden-Württemberg and the political entity (Regionalverband) overseeing the greater Stuttgart region. To this end, some 400 suburban and regional trains are slated to be equipped with ETCS and automatic train operation (ATO) systems.

When the first of these ETCS-equipped trains roll down the tracks in 2025, this will mark a major milestone. Building on this future achievement, additional improvements are planned to be introduced gradually – including the use of a traffic management system (TMS) for dynamic operations optimization and digitalizing the rest of the region. More than half a million passengers will benefit every day from the significant improvements.

An artist's rendering of the new Stuttgart Central Station.



Border crossing in Emmerich: The monitor switches over

Digitalization is bringing Europeans closer together. The countries of the EU want to replace their various country-specific train control systems with ETCS to simplify cross-border transport. The Betuweroute is a length of track which runs from the German city of Emmerich am Niederrhein to the port of Rotterdam in the Netherlands and back. This entire route has already been upgraded with ETCS technology.

René Schedifka, a DB Cargo employee, knows the route like the back of his hand. After all, he's been a train driver on the Betuweroute since 2007. But how has his daily routine as a train driver changed since ETCS was introduced? "When I reach Emmerich, I cross the border from Germany to the Netherlands, and the view on my monitor changes automatically. I just press a button to confirm the switch. Then I head for Rotterdam on a route equipped with ETCS Level 2," says Schedifka. "There are no more signals anywhere along that route. I can see all the information for this stretch on my display. The dispatcher notifies me through the system when I'm allowed to proceed, the speed I can travel and how far I can drive."

On most routes in Germany, Schedifka would currently need to keep an eye out for distant and main signals to glean this information. That's why he strongly believes in the benefits of the new system. "I especially like that I can see what's coming up as I drive the train. I can see the next 20 miles or so of my route on my display. The system tells me in advance when I'm approaching a section where I need to drive more slowly or when there's a train ahead of me that I need to keep my distance from." Using this information, he can adjust his speed accordingly and doesn't need to keep braking and accelerating.

That also just happens to save energy, he says. "Most of the modern locomotives show me exactly how much energy I'm using over the course of the journey. That creates an incentive to perform well, and with ECTS, I can squeeze out quite a bit more."

"ETCS eliminates obstacles to cross-border transport and is a necessary component of a European digitalization strategy. The system improves the efficiency of rail,including when it's compared to other modes of transport. Many European countries have made a great deal of progress already. The quicker we adopt ETCS, the better rail will be able to help combat climate change."

Matthias Ruete | ERTMS Coordinator for the European Commission

Large number of people, Limited space, Maximum efficiency

Imagining the future of mobility in Germany:
A publication on the significance of rail transportation, intermodal mobility services and personal trainers on trains – with commentary by Thomas Siefer, Professor of Transport, Railway Construction and Operation.

Drone taxis and gondola lifts whisk passengers through the air during rush hour in large cities. Capsules speed through underground systems of tubes. Having been electrified and digitalized, long-distance, regional and local rail transport is on time down to the minute – and carbon neutral. Traffic jams on highways are also a thing of the past because long electric freight trains have replaced caravans of diesel tractor-trailer trucks on the road. Envisioning the future of mobility can spark the imagination of scientists and companies like almost nothing else.

Train transport is booming

Prof. Thomas Siefer, managing director of the Institute of Transport, Railway Construction and Operation at the Technische Universität Braunschweig, is a leading expert in his field. "Although the positive image enjoyed by the car and its importance as a status symbol continue to decline, car travel for personal use will increase by 10% and truck travel by almost 40% by 2030 if no attractive alternatives are made available," says Siefer. What about rail? "Rail has a decisive role to play when it comes to the future of transportation. When it comes down to it, no other mode of transportation can get so many people from point A to point B as quickly while taking up so little space," says Siefer. "Rail will grow more than any other mode of transportation by 2030, when it will transport twice as many people as it does today – that translates to 300 million passengers. Particularly when travel time is four hours or less, acceptance of rail is increasing."

Mobile yet eco-friendly

Siefer is certain that eco-friendliness will play an even larger role in the future when people are choosing how to travel. Rail has clear-cut advantages in this respect: in terms of long-distance transportation, the ICE, Intercity and EuroCity trains traveling within Germany are already powered entirely by renewable energy. "The continued electrification of the rail network is another milestone," says Siefer. Almost 12,000 of Germany's 20,000 miles of track have already been electrified. According to the rail industry's plans, up to 80% of all routes could be equipped with overhead lines by 2030. According to Siefer, another challenge is that "people and freight are only becoming more mobile. This means more passengers, more trains, higher speeds and shorter intervals. These demands will be placed on our public transportation networks – and not just in major metropolitan areas."

Digitalization levels the playing field Rail network of the future

As suburban areas continue to grow in German cities like Berlin, Munich and Stuttgart, the number of commuters is growing with them. "We'll need to expand our infrastructure on a massive scale to meet this demand," says Siefer. The only way to meet commuters' transportation needs is to move away from a car-focused city model and offer attractive public transportation options. This could be a way to avoid caps on the number of cars allowed in cities such as those seen in Singapore and Hong Kong. "For local and regional transport, we'd need to resurrect old routes. For long-distance transportation, we'd need to create multi-track corridors on the main routes to separate passenger trains from freight trains. Across the board, we'd need to use ETCS and ATO modules, which are radio-based train control systems, to enable highly automated driving," says Siefer. With its Digital Rail for Germany program, Deutsche Bahn is launching the largest technological shift in years and is paving the way for digital rail operations which use smart software, highly advanced sensors, real-time geolocation systems and a high level of data connectivity.

Traveling by train is becoming more personalized

Improved data connections are shifting the focus to rail passengers who want to be constantly connected to the Internet. 5G, the new mobile data standard, is providing the innovative leap to make this a reality. As soon as 2022, the most highly trafficked rail routes are slated to offer 100 Mbps connections. This kind of speed will open the door to new opportunities for infotainment and connectivity. After all, passengers want to use their travel time as productively as possible, and when self-driving cars soon become a reality, trains will need to woo passengers with new and appealing features. "Trains must be designed to handle mass transportation and highly reliable while at the same time catering to the varying preferences of their passengers," says Siefer. The broad range of possibilities for interior train spaces includes fitness compartments with electronic personal trainers, shops, lounges and seat-mounted screens – even a large screen and seating for watching major events.

It's all in the mobility mix

The future won't pass transit stops and stations by. Ideas include integrating trains stations into mixed-use spaces which house offices, apartments and parks. "Additionally, stations are becoming increasingly important as central hubs that connect different modes of transportation," says Siefer. The key word is intermodal. When people step outside their homes or visit a new city these days, they're choosing from a veritable bounty of transportation options: public local, regional and long-distance transportation such as buses, subways and trains; ride-hailing and car-sharing options; and e-bikes and e-scooters for rent. In a few years, self-driving vehicles will be added to the mix. "Trains will play a decisive role in the future," says Siefer. "We'll manage to decarbonize mobility only if different modes of transport can coexist and connect to each other. In the future, we'll have a flexible network of connections – with rail leading the way."

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