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On the right track: driving innovation in European rail travel

Researchers across Europe are deploying advanced automation in rail transport and making it smarter, cleaner and more reliable for passengers and freight.

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Close to the beautiful coastline of Oslo, Norway, a bright blue tram rolls smoothly along the tracks of a local depot. At first glance, it looks like any other tram, but a careful observer will notice one crucial difference: there is no driver.

This tram is operated remotely using cutting-edge technologies developed under an EU-funded research initiative called FP2-R2DATO.

Supported by Europe's Rail Joint Undertaking (EU-Rail), the initiative runs until the end of May 2026. It brings together rail companies and engineering experts from 10 EU countries (Austria, Belgium, Czechia, France, Germany, Poland, Italy, the Netherlands, Spain, Sweden), plus Norway and Switzerland.

Together, they are testing technologies that could shape the future of Europe's railways. According to Eurostat, there are more than 200 000 km of rail tracks in the EU, including around 8 550 km of high-speed lines.

Digital rail

The team's aim is to make train travel easier, cheaper and greener by improving the capacity and efficiency of Europe's rail networks through increased digitalisation and automation.

"To meet the increasing demand from both passengers and freight transport, digitalisation is key," said Bettina Dötsch, an experienced rail engineer and senior project manager with Hitachi Rail in Germany.

Digital solutions are preferable to building new lines and trains, she said.

"Space is limited and new construction would have a significant impact on the environment. This is why we need to increase the efficiency and capacity of the existing infrastructure."

Eyes of the train

The FP2-R2DATO research team is developing and testing new technologies, such as remotely operated and fully autonomous trains, that could transform European travel.

Equipped with sensors, cameras and other innovative systems, trains – and trams like the one in Oslo – can be safely controlled from a distance by an operator in an office.

“Remote operation can be used for moving trains in and out of depots, limiting walking distances for drivers, saving time and making the process more efficient,” said Dötsch.

Remote driving has already been tested successfully in Norway, the Netherlands and Switzerland. These trials established the digital blueprints for sensing, connectivity and control that will support fully autonomous operations in the future.

Next, FP2-R2DATO partners will test fully autonomous trains using a specially developed perception system called the “eyes of the train”. The system continuously scans the environment, detects hazards and determines how the train should respond.

These technologies are being tested in a secure depot environment as the first step towards widespread deployment. Project partners also successfully trialled remote and autonomous operations on commercial tracks used for both passenger and freight traffic in Utrecht, the Netherlands, in September 2025.

“Once the technology is mature and approved, it could be used in various automated and autonomous operations, from urban public transport to long-distance trains and freight transport,” said Dötsch.

Seamless cross-border travel

The researchers aim to create a unified rail network across Europe, covering urban, regional, international and freight transport.

“One of our main objectives is to harmonise operations in Europe,” said Cédric Gallais, a senior manager at SNCF, France’s national state-owned railway company, which coordinates the FP2-R2DATO research.

For passengers, one of the most significant benefits will be smoother journeys across Europe’s borders. Currently, every European country has its own signalling system, complicating long-distance travel.

“Trains must be equipped with multiple systems to cross borders. We want a common architecture and integrated infrastructure to enable seamless cross-border travel,” said Gallais.

The same digital platforms that enable automation also create a “common language” of technical and operational standards between national systems, laying the groundwork for interoperable European railways.

Real-time tracking

The FP2-R2DATO team also aims to increase network capacity through Moving Block technology, which allows trains to travel closer together by continuously monitoring their positions.

Traditionally, tracks are divided into fixed sections (blocks), with only one train allowed per block at a time.

“The goal is to open up these blocks and allow for more flexible operations,” said Dötsch. Moving blocks create a “safe zone” that moves with each train and is dynamically recalculated by sensors and computers. Real-world tests are already being conducted at a test field in Annaberg-Buchholz, Germany.

Researchers are also testing geolocation on a train in France's Nouvelle-Aquitaine region as one example from eight different prototypes being tested in real environment.

The aim is to see how well satellite positioning can support rail safety systems, such as the European Rail Traffic Management System (ERTMS), in collaboration with the European Space Agency.

Full steam ahead

Support from EU-Rail has been instrumental to FP2-R2DATO's work. EU-Rail is a European public-private partnership that coordinates rail research projects and aligns them with key EU transport policies, including Europe's climate neutrality goals and a 90% cut in transport emissions by 2050.

The partnership also contributes to the EU's strategic milestones of doubling high-speed rail traffic by 2030 and tripling it by 2050 by developing the digital tools that will make trains faster, safer and more efficient when operating across borders.

"EU-Rail's goal is to drive innovation and address the challenges that European rails face today and in the future," said Dötsch.

She stressed the value of bringing the partnership's wide network of operators, industry and research centres together under one joint collaboration – a move that has proved essential for testing new systems on real tracks.

Thanks to the research currently underway, Dötsch sees great changes for rail transport on the horizon.

"We are building a smarter way of mobility. European railways will undergo a major transformation in the next 10 years," she said.

Gallais agreed. "This research can greatly advance the rail industry in Europe and make it very competitive. It will completely change how we operate trains."

These innovations should make rail transport more efficient, reliable and sustainable, reducing energy consumption while increasing capacity.

"If we succeed, passengers will have more trains to choose from," said Gallais. "Trains will be more punctual, reliable and responsive, making it easier to travel by rail throughout Europe."

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More info

- FP2-R2DATO (CORDIS)
- FP2-R2DATO project website
- Europe's Rail Joint Undertaking (EU-Rail)
- EU mobility and transport – Rail