



Rail Crossings at Deutsche Bahn

How Germany's railroad tackles its biggest crossing challenges

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Deutsche Bahn (DB) is Germany's infrastructure owner and the main operator



220,000
employees worldwide

15,000+
At-grade crossings

21,000 miles
of track in operation

24,000
trains per day

760
tunnels

10 TWh
per year of traction energy

25,000
bridges

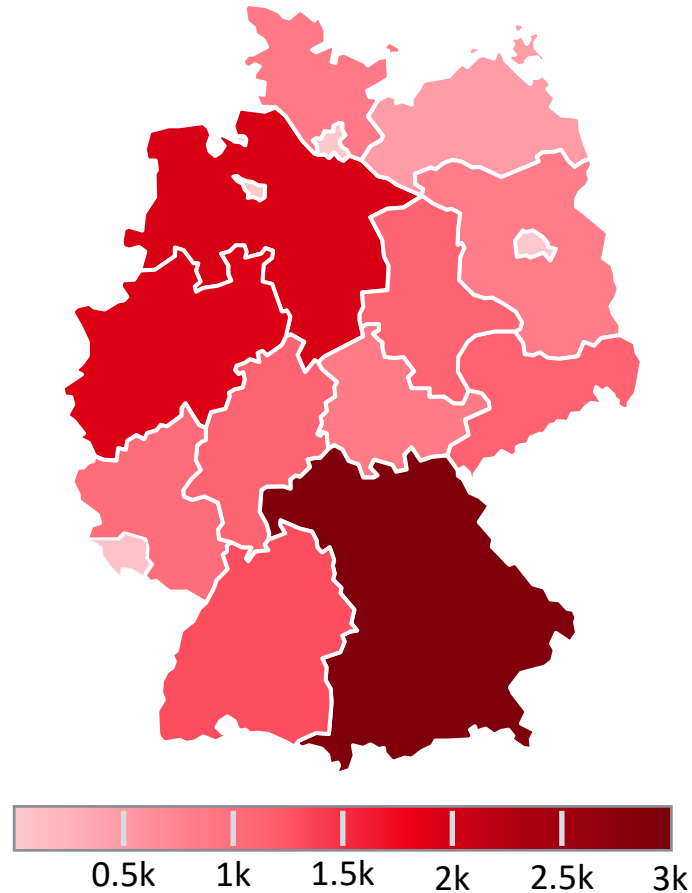
6.5 million
passengers per day

5,700
stations

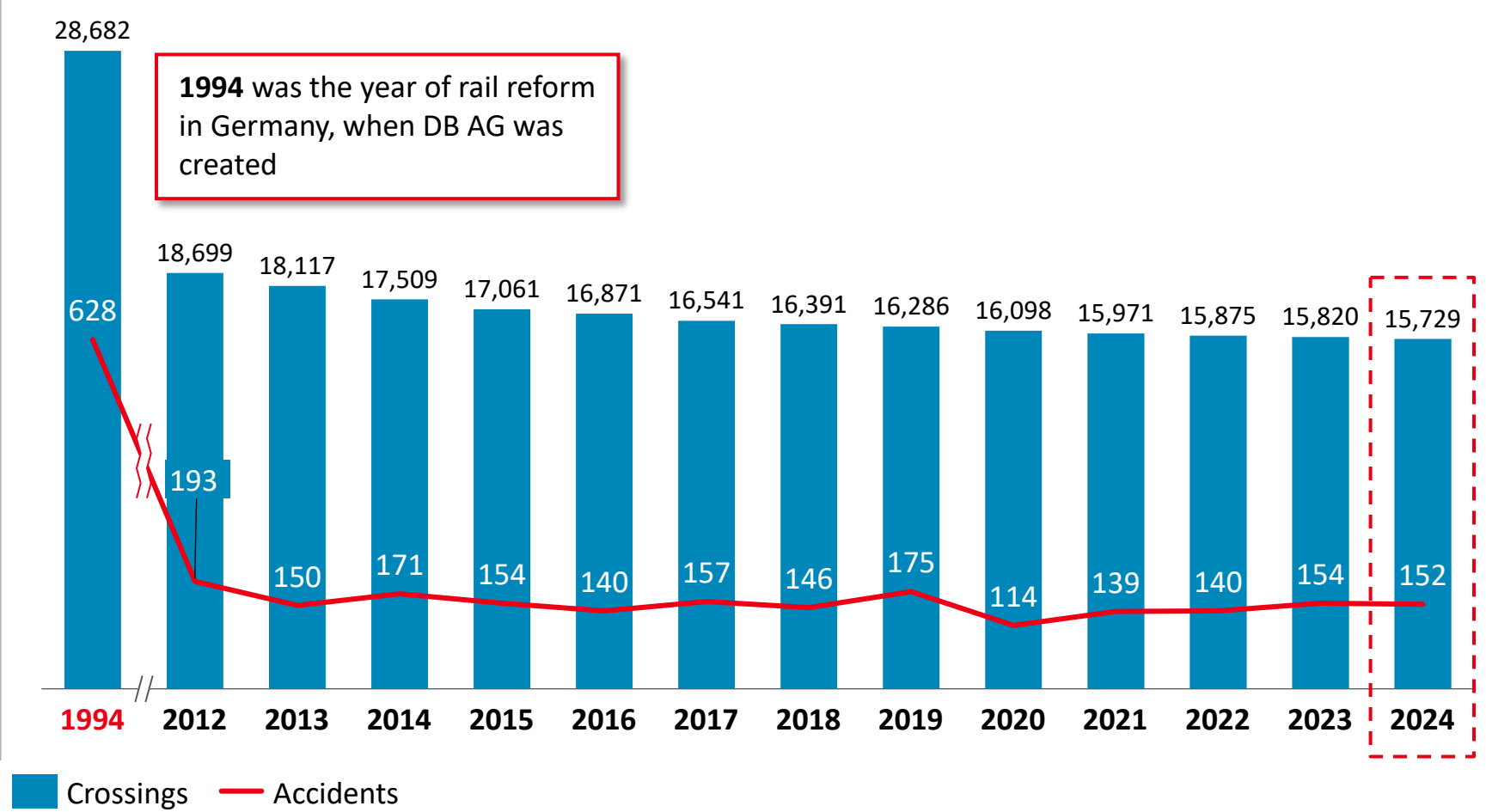
In the last three decades, the German network saw a decrease from almost 29,000 crossings to below 16,000, significantly lowering chances of accidents and incidents



Rail crossings per state



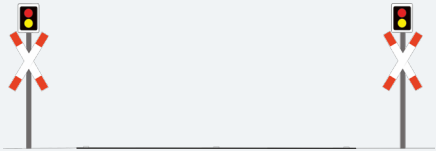
Rail crossings and annual accidents on the German Rail Network



DB's rail crossings are separated into two main categories, requiring different operational responses to ensure safety and reliability



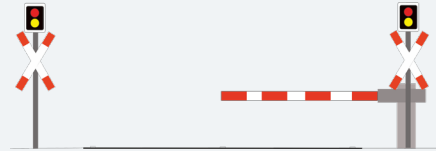
1. Level crossings technically secured



Traffic lights



Normal operations unless error detected



Traffic lights with half barriers



Protection is confirmed automatically



Call or Watched Barriers



Protection is verified by remote signal operator

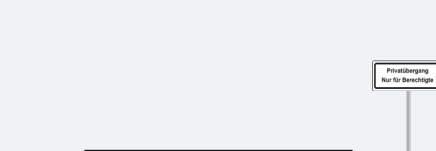


Traffic lights + full barriers



Requires cleared crossing supervision

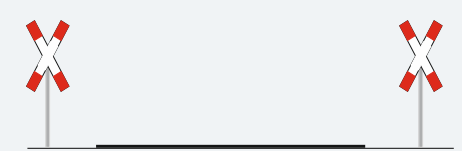
2. Level crossings non technically secured



Private level crossing



Restrictive ops rules based on case-by-case



Visual check



Engineer must exercise particular caution



Visual check + train horn



Mandatory train horn



Train horn + slow order



Mandatory train horn, permanent slow speed

Number of Crossings Percentage of Total Crossings Special Operations Requirements

Several factors impact the decision making for rail crossing technology, and help prioritize action while maximizing risk mitigation



Traffic intensity on the road



Light Traffic

≤ 100 vehicles / day

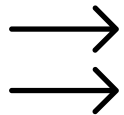
Typical crossing security



Visual check

Special Note

- Usual with an optional whistle or horn requirement
- Train speeds can not exceed 50 mph



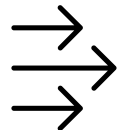
Moderate Traffic

100 - 2,500 vehicles / day



Traffic lights

- Utilizes flashing light signals to secure crossing
- Often combined with half barriers throughout the network



Heavy Traffic

> 2,500 vehicles / day



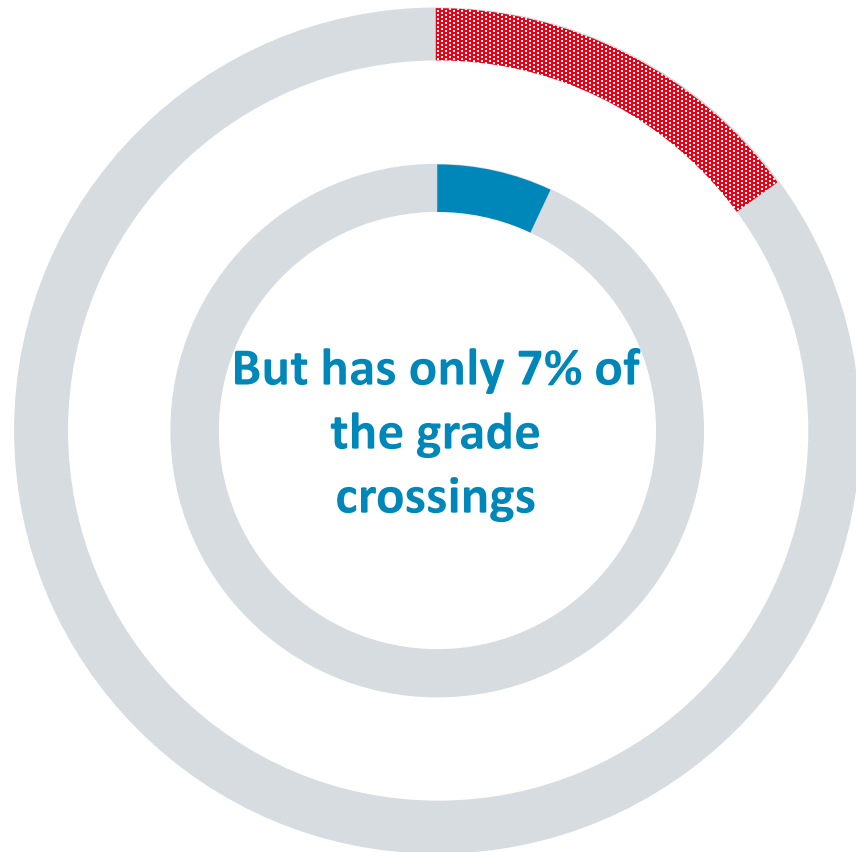
Traffic lights with barriers

- These crossings are typically targeted for grade separation projects due to the number of interactions between rail and road traffic
- Train speeds can no exceed 100 mph

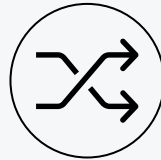
Beyond network size and grade crossing density, there are key differences between the U.S. and German crossing network management



Germany's network length is 15% of the U.S. network



In Germany, rail infrastructure is owned and maintained by DB InfraGO, part of the state-owned Deutsche Bahn Group



Most crossings are integrated into the signaling and interlocking systems, and assigned to a regional OCC



Crossings are usually secured by axel counters, remote cameras, or other points of contact



Manual checks are required for all full-barrier crossings



Crossings not technically secured are inspected three times annually, those technically secured are inspected twice annually, and private crossings once every two years

Federal German law discourages the construction of new railway crossings, viewing them as avoidable sources of risk and inefficiency



The federal railway crossing law codifies a three-part strategy:

Avoid



- The law forbids the construction of new level crossings
- New construction projects must consider alternative solutions, increasing the risk of limiting scope or budget

Secure



- DB is dedicated to making rail crossings as safe and reliable as possible
- Germany is currently investing to secure crossings or implement alternative solutions where possible

Remove



- Due to the operational and safety risk crossings pose, DB continuously conducts grade separation projects
- Removal cost is split equally among the federal government, DB, and the road owner



Beyond removing and avoiding new level crossings, DB has adopted multiple complementary measures to enhance safety and reliability.

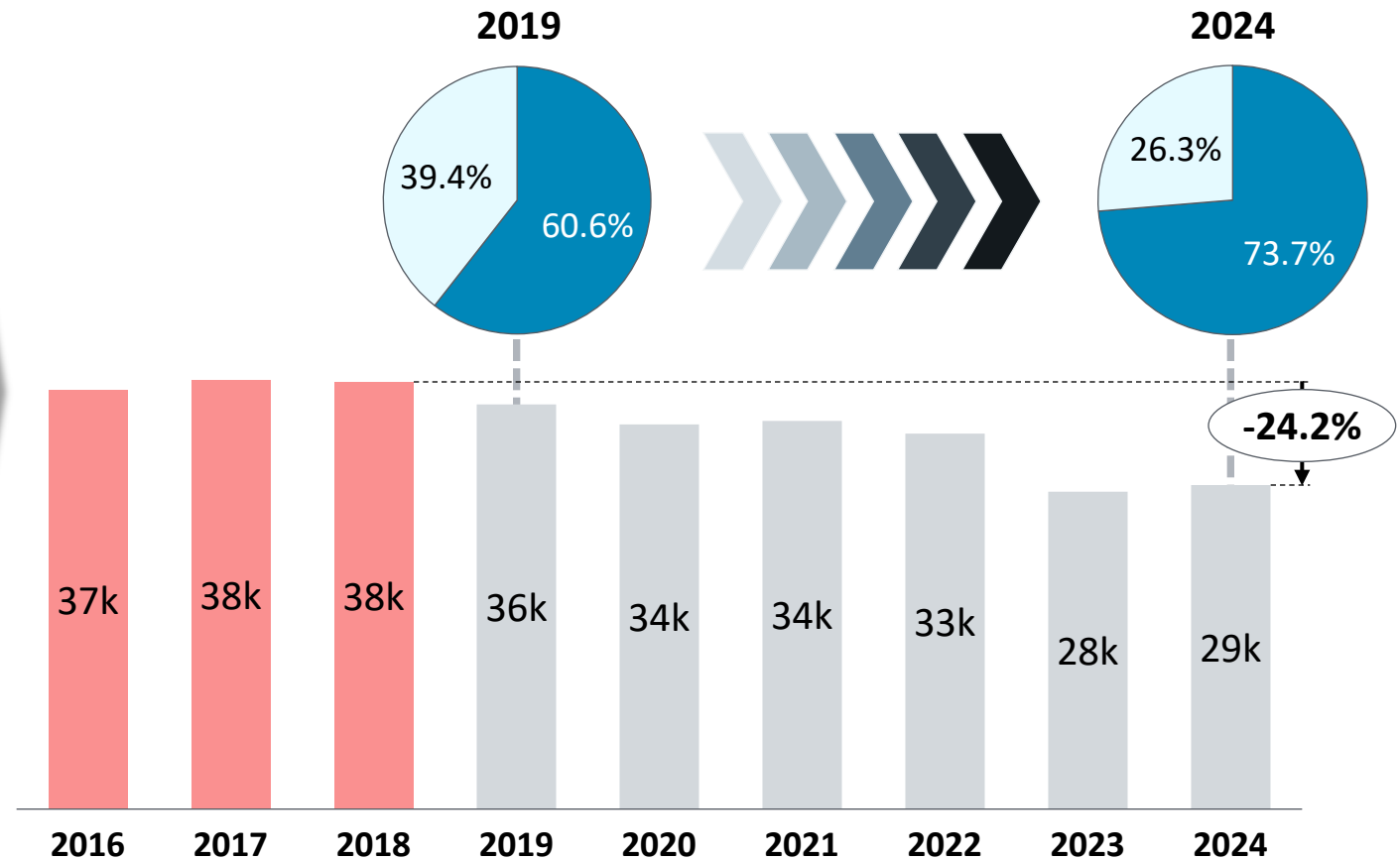
A lifecycle RAM model shifted maintenance from reactive to preventive, reducing both the number and severity of failures



Centralizing maintenance strategy

- DB's grade crossing portfolio includes multiple technology generations
- Maintenance was reactive – failure based
- DB first analyzed 100 crossings with the highest failure volume and components driving operational impact
- DB introduced a lifecycle RAM model with preventive maintenance regimes
- Prioritization was based on:
 1. operational impact in the prior year (lost units / delays),
 2. number of trains per day,
 3. technology type and age of the crossing system.

Annual grade crossing failures and their priority level



■ Priority 3 & 4
 ■ Priority 1 & 2
 ■ Failure messages before RAM model
 ■ Failure messages after RAM model

Providing better system oversight through technologies that detect blocked crossings is critical to keeping both passengers and pedestrians safe



DB has trialed level crossing clearance detection systems using multiple technologies and manufacturers



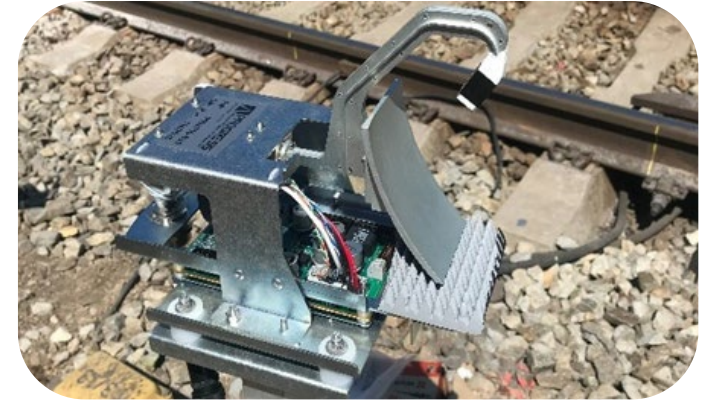
Rotating Radar

- Utilizes a rotating radar system with 4 reflection posts creating a detection zone over the crossing
- 450 of these systems were built and installed on the German network
- The installation phase lasted between 2000-2019



2-D Infrared

- Utilizes 2-D infrared LiDAR system and reflection posts to detect anomalies within the level crossings
- System used in the UK and currently undergoing safety testing in Germany



Stationary Radar

- Uses a two stationary radar system combined with a sensor camera to detect crossing clearance
- Currently undergoing testing and requesting federal approval

Crossing safety depends not only on protection measures, but also on reliable, consistent system operation backed by continuous monitoring and oversight

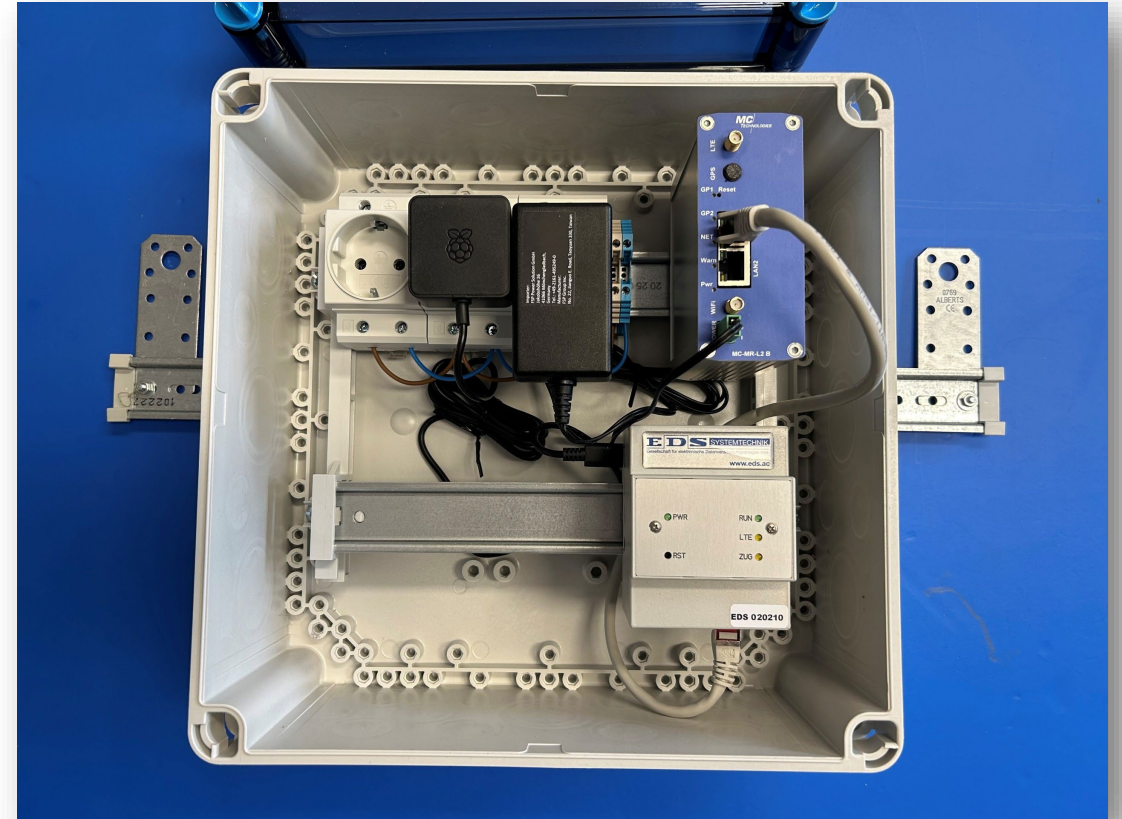
Implementing system oversight with aging infrastructure

In recent decades, DB InfraGO has focused on data-driven maintenance to target spending more effectively and improve overall network health.

Many German grade crossings use the EBÜT 80 system, which is failure-prone and too old for direct integration into modern analytics platforms.

DB developed an in-house digital adapter that reads internal electronic signals and enables remote fault detection and analysis.

Nearly 500 adapters have been installed, allowing remote condition visibility and supporting preventive maintenance.

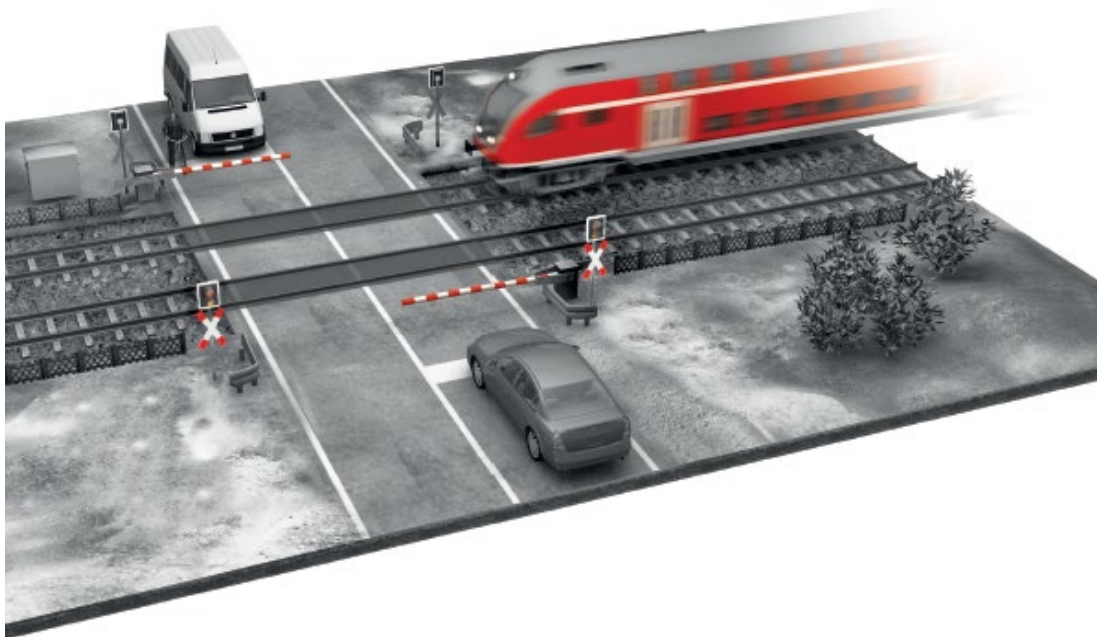


Adapter for EBÜT 80 crossing models

DB improves crossing safety and reliability through a combination of removal, modernization, preventive maintenance, and standardization



Together, these measures show how DB is optimizing the crossing network through coordinated actions



Remove and avoid

- Eliminate crossings through early planning and grade separation
- Prohibit new crossings to reduce long-term risk

Modernize protection

- Retrofit warning systems and barriers
- Deploy and test blocked-crossing detection technologies

Utilize Preventive Maintenance

- Implement RAM-based preventive maintenance regimes
- Use adapters for remote monitoring and early diagnostics

Standardize the system

- Assign maintenance programs by asset priority class
- Build standard interfaces and reduce obsolescence risk