Customized techniques and operational rules to improve level crossings by means of imaging methods

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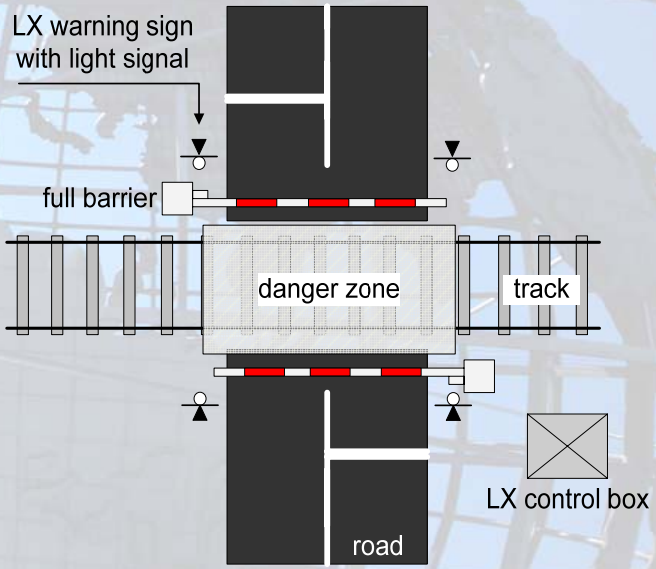
Content

- Motivation & target
- Current state
- Operational requirements
- Example of application
- Summary



About myself

- Dipl.-Ing. Markus Pelz
  - Studies at TU Dresden,
    at Chair of Railway Signalling and Transport Safety Technology
  - Research assistant at DLR since 2005
- German Aerospace Center (DLR)
  - Institute of Transportation Systems
    - Division Railway Systems
- Main Focus
  - Level crossing operation and technology
  - New ideas, low cost technology, safety systems
- Co-authors of the paper
  - Dipl.-Ing. Matthias Grimm
  - Dr.-Ing. Michael Meyer zu Hörste
  - Prof. Dr.-Ing. Karsten Lemmer

About the Institute

German Aerospace Center
Institute of Transportation Systems

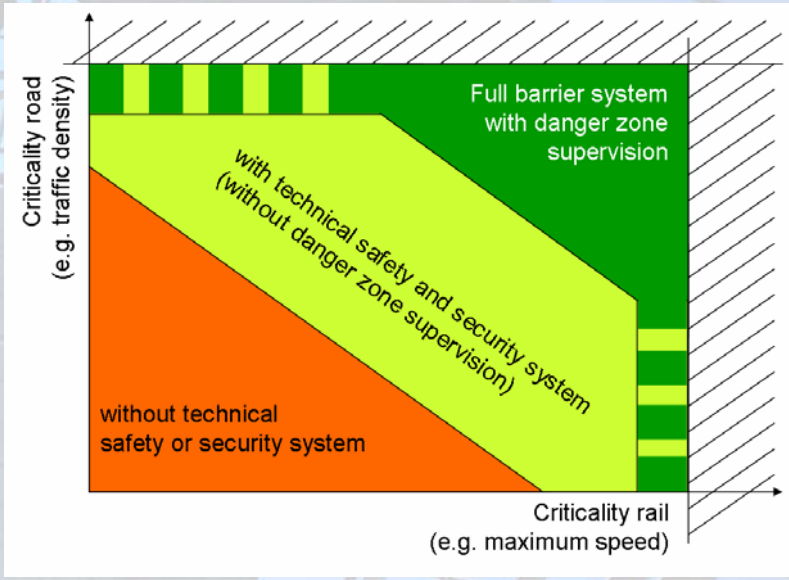
Residence:	Braunschweig and Berlin
Since:	March 2001
Director:	Prof. Dr.-Ing. Karsten Lemmer
Employees:	Presently 100 employees from various scientific disciplines

- **Fields of research**
  - Automotive
  - Railway systems
  - Traffic management

- **Range of tasks**
  - Basic research
  - Creating concepts and strategies
  - Prototype development

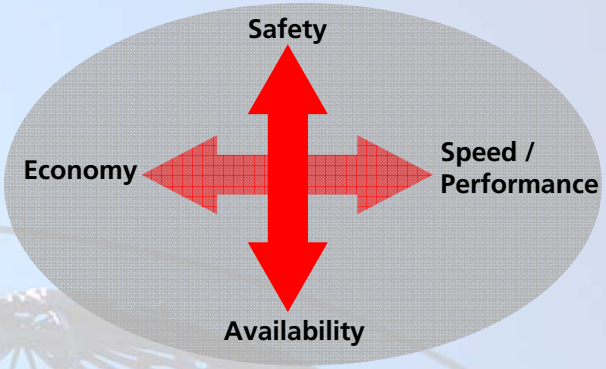
Motivation

- There are many level crossings (LX) all over the world
- Their equipment with technical or non-technical security systems depends on the criticality of the local operational conditions
- There are numerous incidents at LX with high damages to material and fatalities
- E.g. in Germany there is no danger zone supervision at LX that have only flash lights or half-barriers
- Most accidents occur due to mistakes in noticing or obeying the warning signs



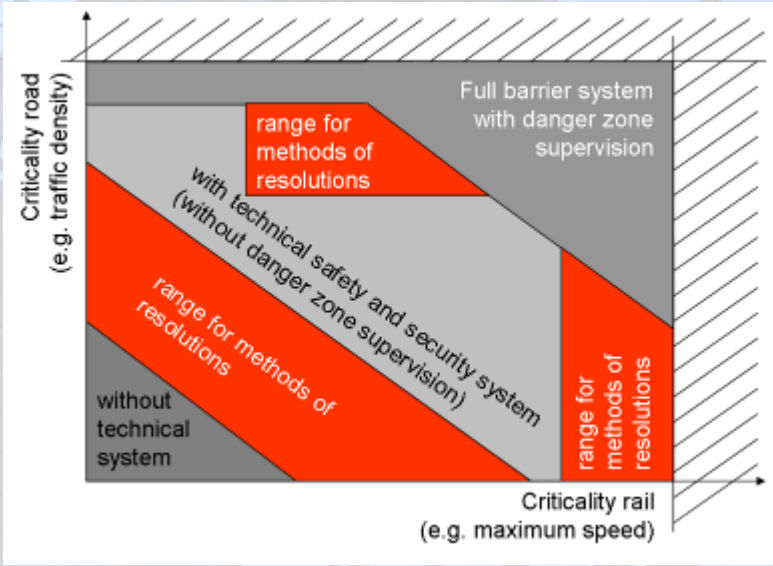
Target

- Identifying a LX safety system which is included in the European way of harmonized development
  - For a higher level of safety where needed
  - For a simpler way of approval where needed
  - For better operative conditions
  - For more cost-efficient solutions



- Development of new LX technology based on customized technique
  - To close gaps in the safety systems
  - To reduce the costs through accidents
  - To observe the danger zone at half-barrier LX
  - To automate “Call for Open” LX

- **Solution:** Optical systems?



Applications by optical sensors – current state

State of the art

- Train departure is dispatched by the driver
- Monitoring of LX danger zone

All these applications are only supporting tools without safety relevance.

There is no image processing, only optical sensors (video).

Potential applications to support LX systems

Support existing LX systems by using optical sensors

- At automatic half barrier systems (AHB) and systems with flash lights
  - Automatic obstacle detection between barriers
  - Obstacle detection to inform, to warn, to brake the train
  - Detection of the closing barriers (availability)

- At full barrier
  - Closed full barrier system within an “Call for Open” function to open barrier automatically
  - Observe closing barriers
  - Road Traffic tailback detection
  - Automatic danger zone supervision (high safety relevance)

All these applications will use optical sensors with image processing ➔ optical systems

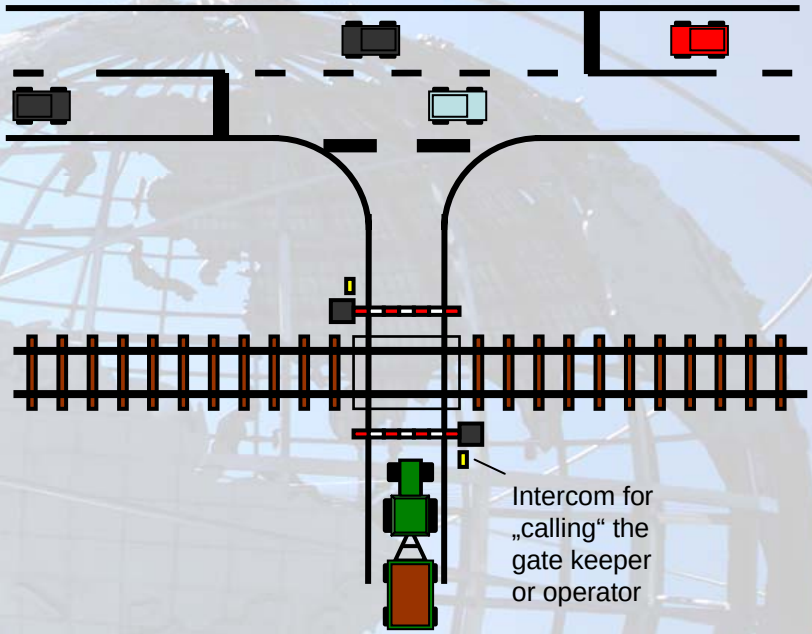
Realization Strategy: “Call for Open” LX

Aim

- Integration of an “Call for Open” LX system into central operation mode
- Reduction of costs for obstacle detection at danger zone

Method of resolution

- “Call for Open” LX system has to be automated
- Danger zone supervision through customized techniques

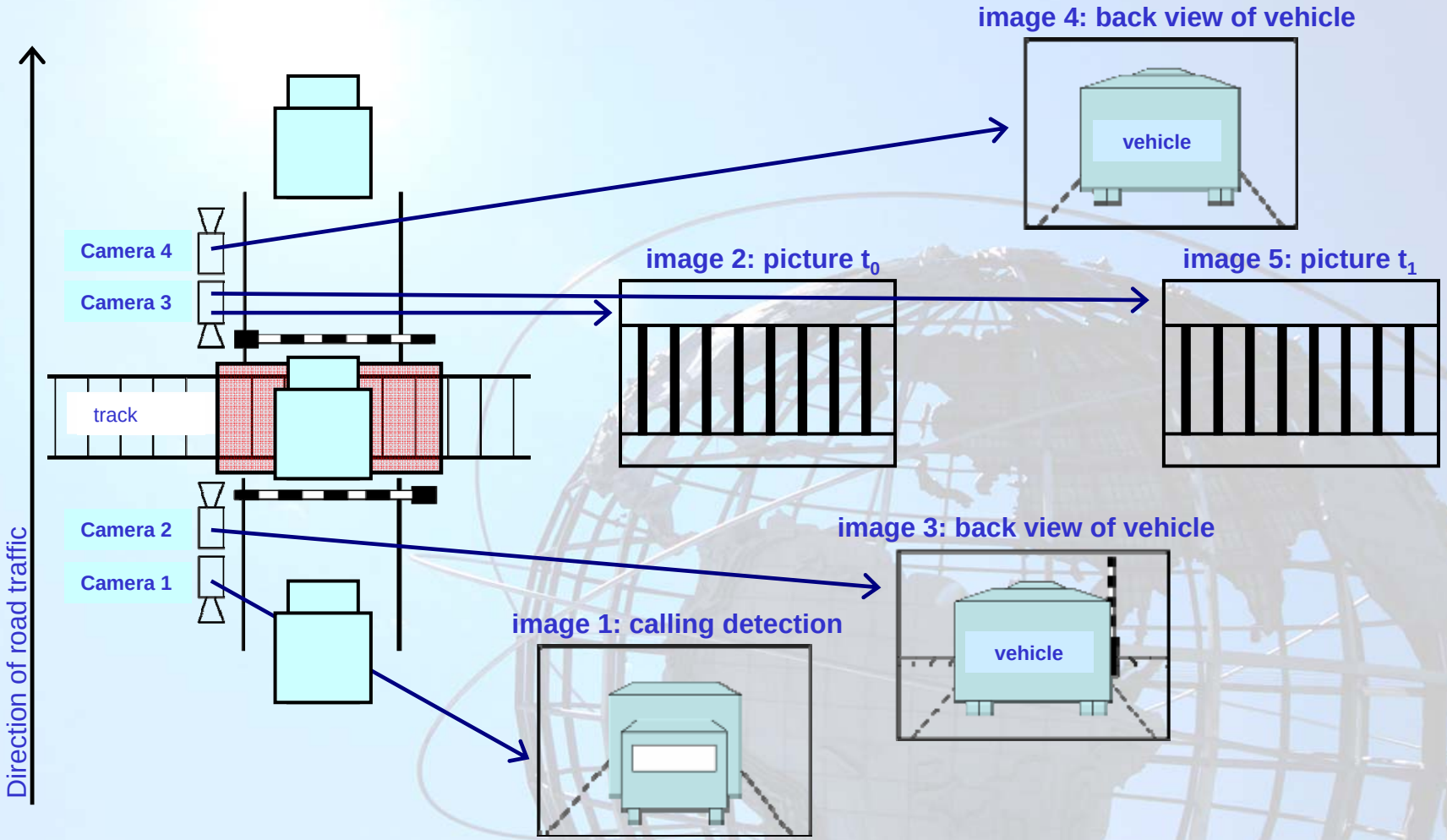


Step by step tests of operational requirements

- **“Call for Open” function to open barriers automatically**
  - Observe closing barriers
  - Detection of the closing barriers
  - Road Traffic tailback detection
  - Obstacle detection between half barriers
- **Automatic danger zone supervision**

Operation of the automatic «Call for Open»

Example: precise test at full barrier with “Call for Open” functionality



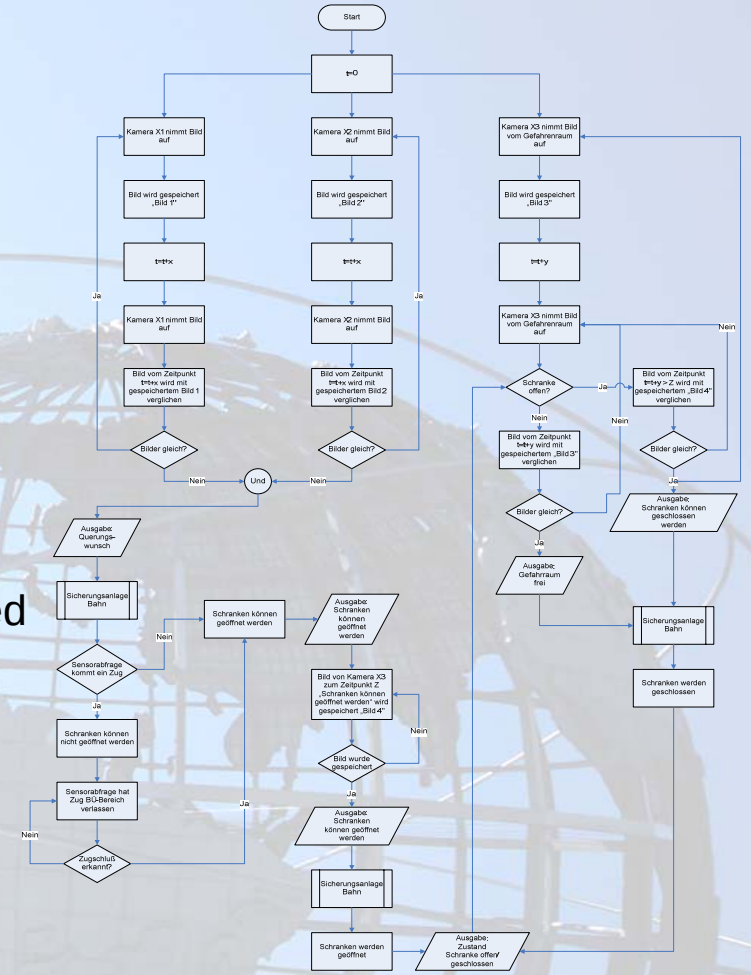
Algorithm of the automatic «Call for Open»

Algorithm is needed to

- Find out the gaps in the safety system
- Identify all operational requirements
- Describe the operational rules
- Describe the requirements for a fall-back system

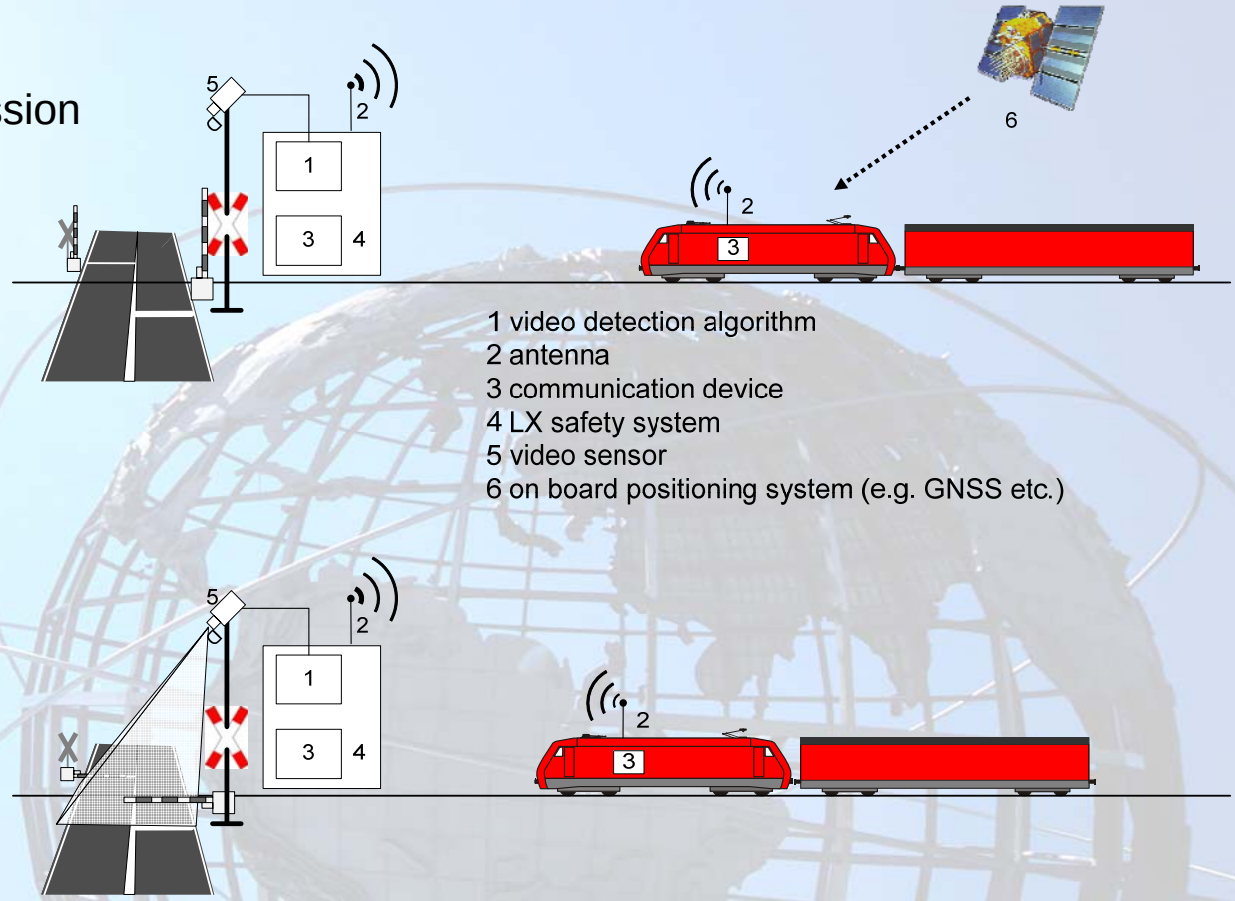
- Identify further applications while development
  → e.g. obstacle detection system at AHB was identified

→ **The basic technical solution of the project:**



Scenario for obstacle detection at AHB (#1)

- Activation by wireless transmission
  → minimization of cable
- Train localization by GNSS (or/and DemoOrt)
  → no track side sensors
- Reduced waiting time for road traffic users
  → optimized activation time
  → human factor (acceptance)
- Detection of road traffic users between the barriers

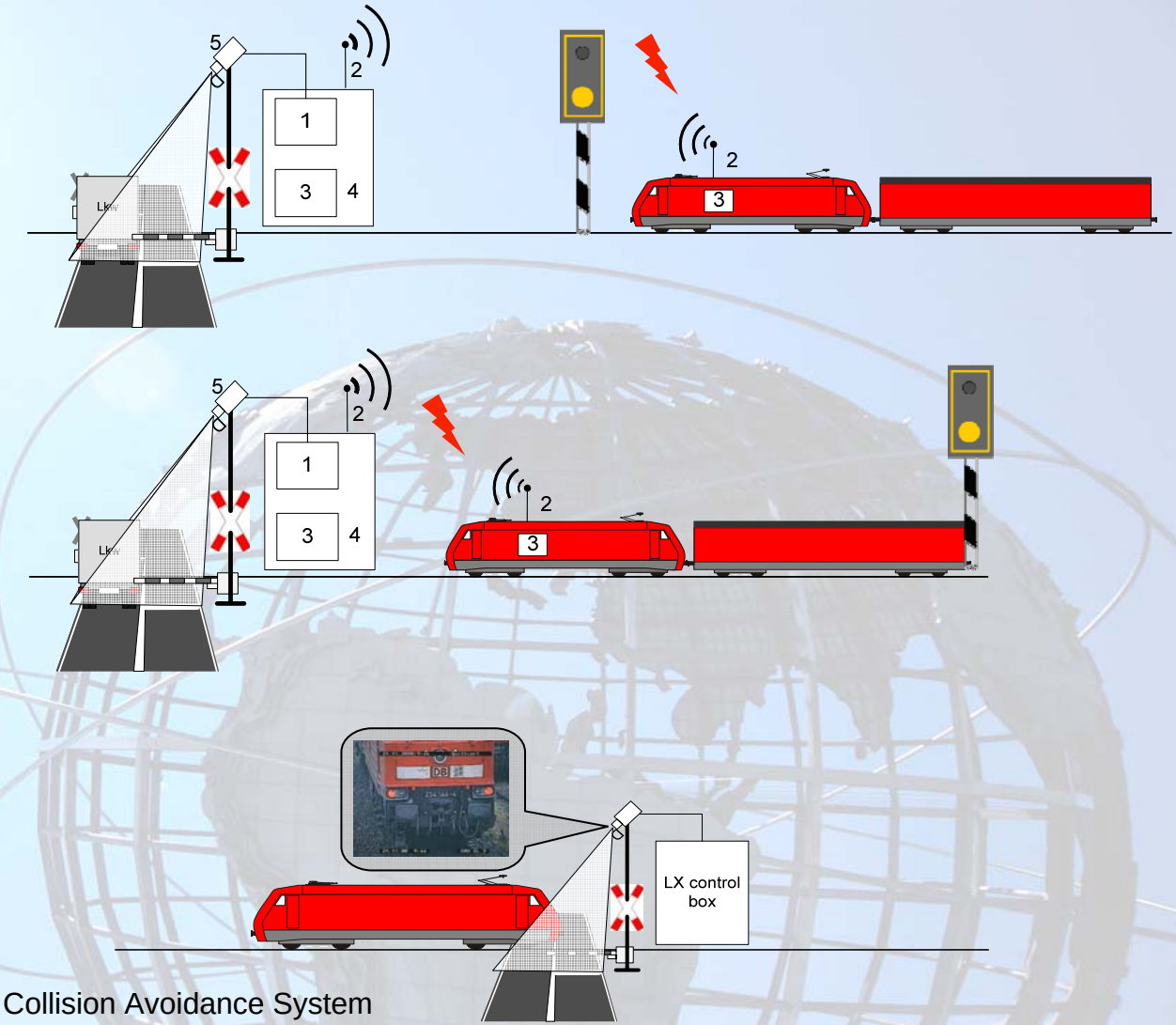


1 video detection algorithm
2 antenna
3 communication device
4 LX safety system
5 video sensor
6 on board positioning system (e.g. GNSS etc.)

GNSS: Global Navigation Satellite System
DemoOrt: Demonstration unit for train side localization

Scenario for obstacle detection at AHB (#2)

- Warning the train driver through the signal in braking distance
- Behind the signal automatic braking in case of danger (e.g. with RCAS)
  → minimization of severity of accident
- End of train detection
  → de-activating LX



RCAS: Railway Collision Avoidance System

Outlook

- More different test campaigns for early validation

- Upgrading the algorithm to find out all the operational requirements

- Build up a demonstration unit at an existing level crossing for evaluation

- Combination of LX System with RCAS
- Cost-benefit analysis

Summary

- The implementation of imaging methods can help to increase the safety at level crossings.
- Innovative level crossings using optical systems can be an economical alternative.
- The Institute of Transportation Systems of the DLR is developing an imaging based system for LX and will evaluate it in several field tests.

- Important facts for the impact of a new LX system
  - Describing the rules for a fall-back system (operational or/and technical)
  - Do not forget the transmission
  - *Do not forget the human factors…*

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