SAFER-LC

SAFER LEVEL CROSSING BY INTEGRATING AND OPTIMIZING ROAD-RAIL INFRASTRUCTURE MANAGEMENT AND DESIGN

WP4: Lab tests, field implementation and evaluation

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Objective

- To **evaluate** the **positive** and **negative** impacts of **lab test** and **field implementations** executed within the SAFER-LC project
- WP4 was **finalized** in December 2019, and has produced **the following outputs**:
  I. Guidelines for the implementation of pilot tests
  II. Definition of evaluation framework to monitor and evaluate the pilot tests
  III. Pilot operation report
  IV. Results of the evaluation of the pilot tests

Implementation guidelines and evaluation framework

For each pilot site:

- General introduction and technical description
- Examples of safety measures that can be evaluated
- Description of data and indicators that can be assessed
- Technical details of tools to be used for data collection
- Guidelines to pilot implementation, operation and monitoring
- Prerequisites and boundary conditions of test site use
- Identification of relevant parameters and the feasibility of their collection

Description of KPIs:
- Technical
- Traffic
- Safety
- Business
- Human Behaviour

→ Identification of required data (with different alternatives) → Comparison of required data with capabilities of test sites

Piloted safety measures

- 17 measures were piloted
- Effect mechanisms:
  - Measures with mostly indirect safety effects
  - Passive LC signs, promoting correct behaviour and the dangers of LCs
  - Speed reduction measures
  - Active warnings, associated either with LC proximity, approching trains or both
  - Measures improving detectability of train

SAFER-LC test sites

Simulation

Field tests

- **Driving simulators** (DLR, SNCF)
- **Two simulation environments** (VTT)
- **Test-track pilot activities** (RWTH, CEREMA)
- **Self-driving vehicles** (VTT)
- **Test track under real rail environment** (VTT)
- **Real-world pilot activities** (DLR, TRAINOSE, CERTH)







SAFER-LC test sites

Finland (2)

Tampere

Sääksjärvi

Aachen

Integration of multiple measures

Braunschweig

Germany (3)

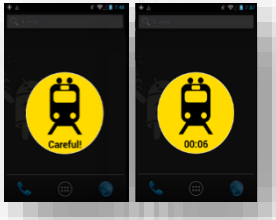
Rouen

France (2)

Thessaloniki

Greece (1)

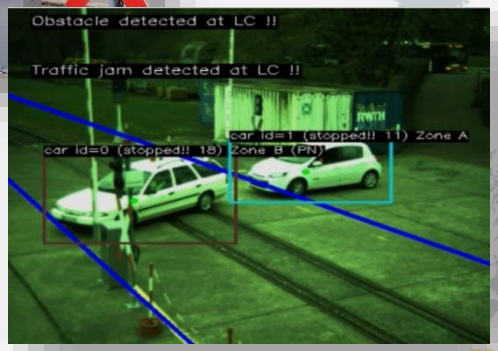
Chalon-sur-Saône



Activity Type
- Simulation
- Test-track
- Real-world pilot

Germany

Aachen test site – Integration of multiple measures



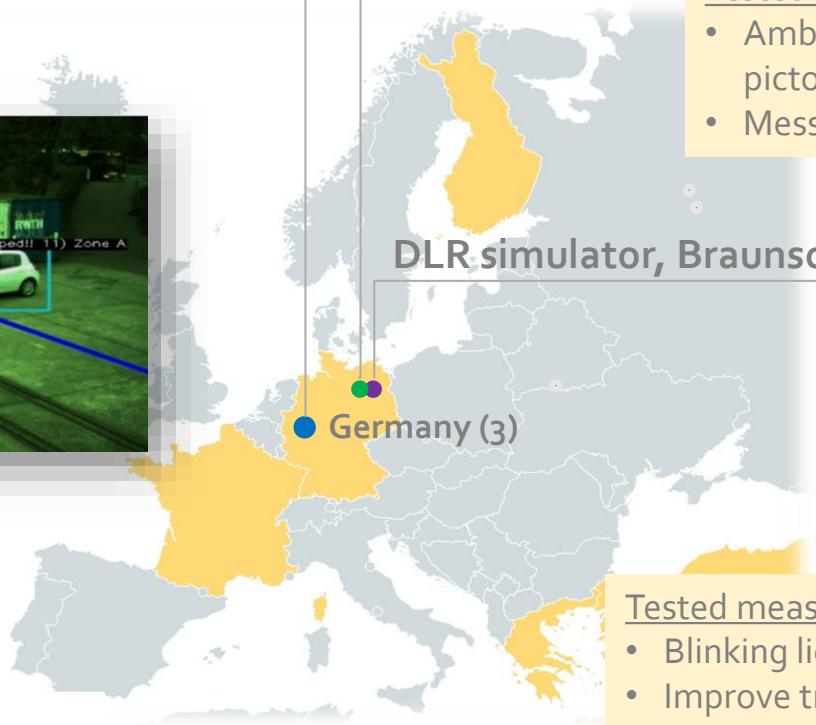
Tested measures (test-track)
- Smart Detection System
- Smart Communication System
- Alert to equipped vehicles
- Early train detection and hazard information

Braunschweig test site

Tested measures (real-world)
- Amber blinking light with train pictogram (electronic sign)
- Message written on the road

DLR simulator, Braunschweig

Tested measures (simulation)
- Blinking lights drawing driver attention
- Improve train visibility using lights
- Noise-producing pavement
- Sign look for train

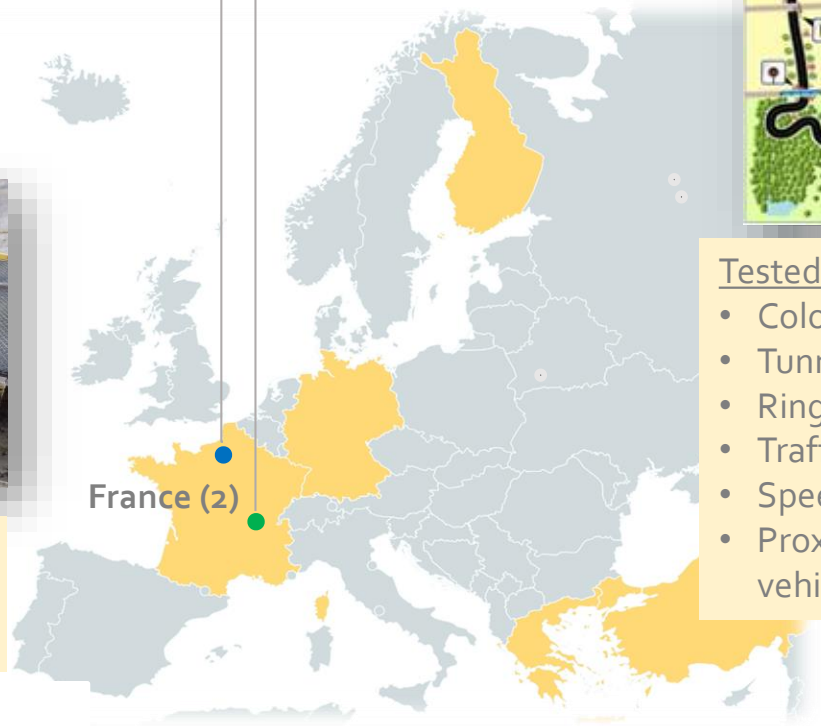


Activity Type
- Simulation
- Test-track
- Real-world pilot

France

SNCF simulator, Chalon-sur-Saône

Rouen test site



Tested measure (test-track)
- Monitoring and remote maintenance

Tested measures (simulator)
- Colored road markings
- Tunnel effect stick
- Rings
- Traffic lights
- Speed bump and flashing sticks
- Proximity message via in-vehicle device

Activity Type
- Simulation
- Test-track
- Real-world pilot

Finland

Sääksjärvi test site

Tampere test site

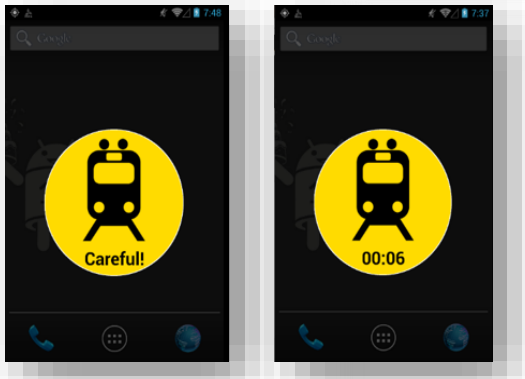
Tested measure (simulation & test site)
- V2X messaging between automated vehicle and passive level crossings

Tested measure (test track)
- Additional warning light system at front of the locomotive

Activity Type
- Simulation
- Test-track
- Real-world pilot

Greece

Thessaloniki test site



Tested measure (real-world)
- In- vehicle train and LC proximity alert

Implementation and evaluation of pilots

- The aim was to pilot human-centered low-cost safety measures characterized as promising in previous WP
- The status of each pilot was followed via Periodic Progress Report; updated every three months
  - Overview of piloted measure
  - Evaluation data and methodology
  - Evaluation results
  - Discussion (lessons learned, recommendations, applicability to different circumstances, conclusions)

Estimation of safety potential: Definition of targeted LC accidents

Variable	Details
Type of LC	▪ Active LC with automatic user-side warning ▪ Active LC with automatic user-side protection (and warning) ▪ Active LC with automatic user-side protection and warning, and rail-side protection ▪ Active LC with manual user-side protection and/or warning ▪ Passive LC
Type of victim	▪ Car drivers & passengers ▪ Moped riders & motorcyclists ▪ Pedestrians & cyclists ▪ Other
Type of behaviour	▪ Situation awareness error ▪ Vehicle handling error ▪ Other human risk factor ▪ Vehicle risk factor ▪ Other

Potentially prevented LC accidents

Safety measure	Type of LC		Type of victim		Type of behaviour		Total	
	Low (%)	High (%)	Low (%)	High (%)	Low (%)	High (%)	Low (%)	High (%)
Smart detection and communication system	56.1	56.1	97.4	100.0	64.3	99.2	**35.1**	**55.6**
V2X messaging system between AVs and passive LCs	39.8	39.8	53.4	53.4	96.3	100.0	**20.5**	**21.3**
Monitoring and remote maintenance	No information available							
Sign 'Look for train'	39.8	39.8	100.0	100.0	93.5	96.3	**37.3**	**38.4**
Road markings	39.8	39.8	46.6	100.0	93.5	96.3	**17.4**	**38.4**
Coloured road markings	25.5	25.5	53.4	97.4	53.5	53.5	**7.3**	**13.3**
Speed bumps and flashing posts	25.5	25.5	53.4	60.2	53.5	53.5	**7.3**	**8.2**
Funnel effect pylons	25.5	25.5	53.4	60.2	53.5	53.5	**7.3**	**8.2**
Noise-producing pavement	39.8	70.5	53.4	60.2	93.5	96.3	**19.9**	**40.8**
Proximity message via in-vehicle device	25.5	25.5	53.4	60.2	53.5	53.5	**7.3**	**8.2**
Blinking amber light with train symbol	39.8	39.8	100.0	100.0	93.5	96.3	**37.3**	**38.4**
Blinking lights drawing driver attention (Perilight)	39.8	39.8	100.0	100.0	93.5	96.3	**37.3**	**38.4**
Traffic lights	25.5	25.5	53.4	97.4	53.5	53.5	**7.3**	**13.3**
In-vehicle train and LC proximity warning	43.9	100.0	53.4	60.2	93.5	96.3	**21.9**	**57.9**
Rings	25.5	25.5	53.4	60.2	53.5	53.5	**7.3**	**8.2**
Additional warning light system at front of the locomotive	39.8	39.8	53.4	97.4	93.5	93.5	**19.9**	**36.3**
Improved visibility using lights	39.8	100.0	100.0	100.0	93.5	96.3	**37.3**	**96.3**

Effectiveness estimates

Safety measure	Accident Reduction
Sign 'Look for train'	<5%
Road markings	<5%
Coloured road markings	<5%
Speed bumps and flashing posts	5–20%
Funnel effect pylons	0.5–2%
Noise-producing pavement	2.5–10%
Proximity message via in-vehicle device	<5%
Blinking amber light with train symbol	5–10%
Blinking lights drawing driver attention (Perilight)	5–20%
Traffic lights	<5%
In-vehicle train and LC proximity warning	10–15%
Rings	2.5–10%
Additional warning light system at front of the locomotive	15–30%

Effectiveness estimates discussion

- An attempt was made to draw **numerical estimates of safety effects** (some uncertainties exist)
- The estimates include the following **assumptions**:
  - **100% implementation coverage**, meaning that all relevant LCs, trains and/or road users are equipped with the system
  - The functionality and reliability of the system is **100% fail safe** and all the **road users obey to** the provided information and/or warnings
- The assumptions used in the calculations are **clearly documented**
  - The safety estimates can be easily updated if new information become available
- **Detailed methodology is documented in the project's Deliverable D4.4**

Conclusions and recommendations

- The results of the safety effects of piloted measures are **promising**
- Measures with **highest estimated safety benefits** are:
  - **Additional lights at the train front**. Prevention of 15–30% of relevant LC accidents and target rather large share of LC accidents (20–96% depending on the approach).
  - **In-vehicle train and LC proximity warning**. Prevention of 10–15% of relevant LC accidents and targets 22–58% of LC accidents (depending on the approach).
  - **Speed bumps and flashing posts**. Prevention of 5–20% of relevant LC accidents and targets 7–8% of LC accidents (depending on the approach).
  - **Blinking lights drawing driver attention (Perilight)** (targeted to passive LCs). Prevention of 5–20% of relevant LC accidents and targets 37–38% of LC accidents.
- Some of the most promising measures should be tested in **larger scale, real-world** experiments with well-planned research design
  - To obtain more information on their effects on road user behavior and thus on road safety, also on long term
  - To support the numerical estimation of safety effects of the piloted measures

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Thank you

Questions?

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