Mid-term Conference

SAFER-LC

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

WP3 - Smarter LC: development and Integration of technical solutions

WP Leader: NTNU

Cerema, CERTH, Commsignia, Ifsttar, NeoGLS, NTNU, RWTH, SNCF, UIC, UTBM, ….

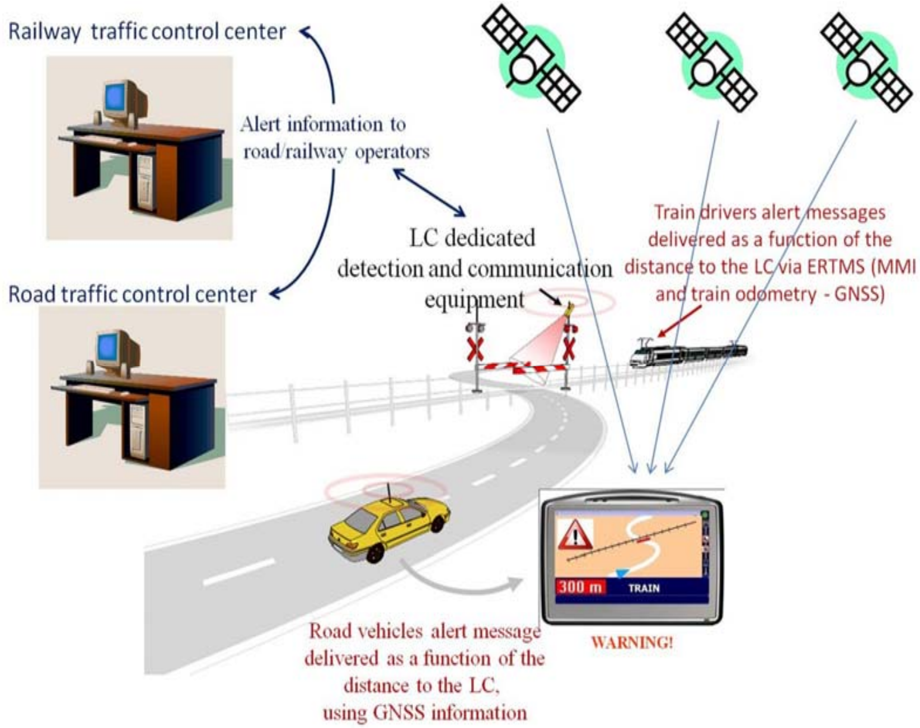
Elias Kassa, Professor

Norwegian University of Science and Technology (NTNU)

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 723205

Objectives

To develop **technological solutions** to **improve safety** at level crossings as well as at working zones through ***sharing information*** and ***giving warnings*** to trains/vehicles approaching/arriving to level crossings and to workers at or near train passing zones



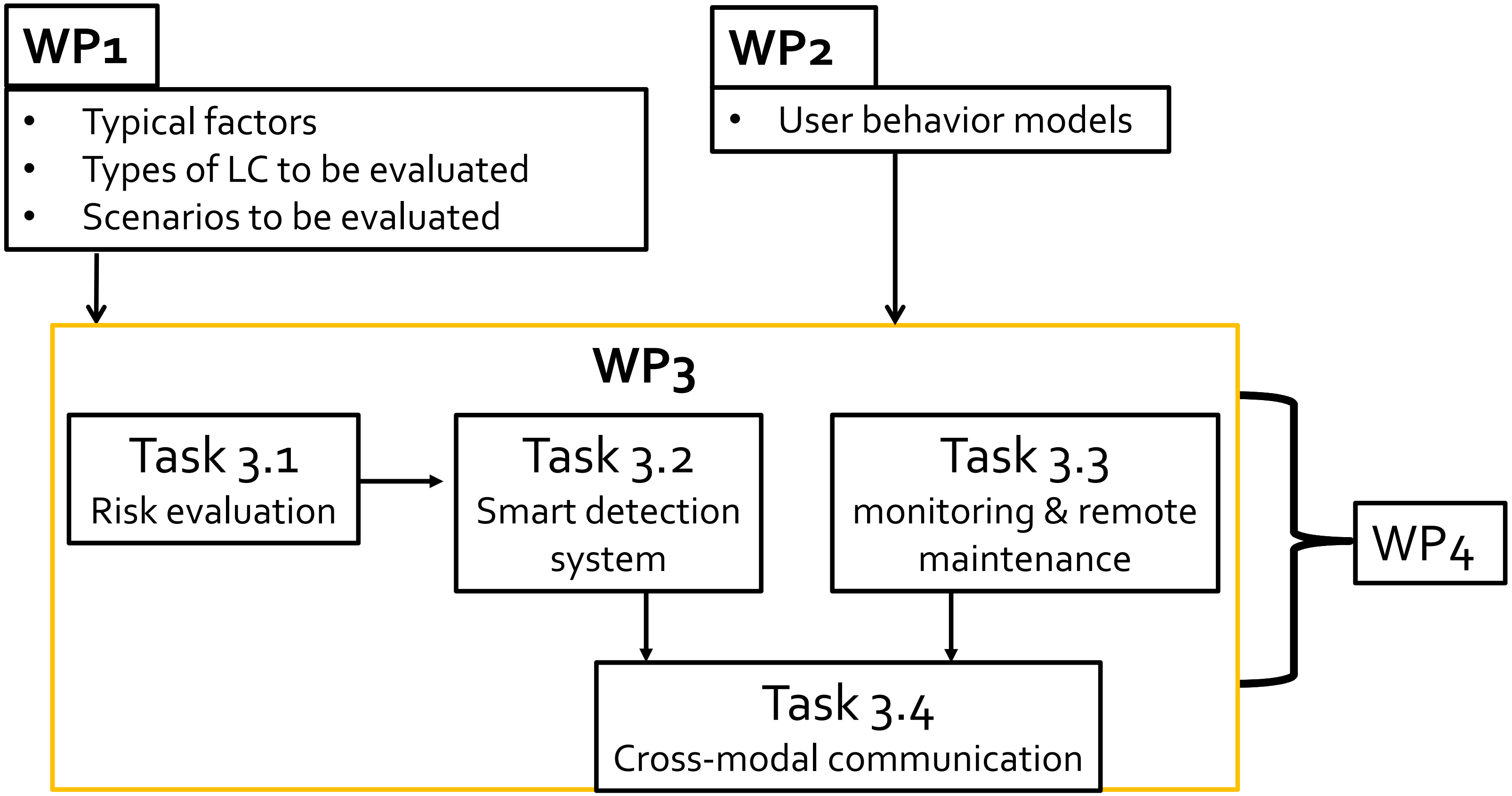
Specific objectives

- Advanced video surveillance system for modeling and analyzing LC users' behaviour
- Evaluate various safety enhancement techniques
- Develop Optimized Automatic/Smart Incident Detection (AID) system
- Develop smart sensor technologies for monitoring of LC infrastructure
- Develop systems to transmit and share the risks and hazard information detected at LCs
- V2X-based sensing, actuation and information sharing techniques to detect and forecast train arrivals and broadcast
- Automatic closure of level crossing triggered by the train geolocalisation

Tasks and Involved Partners

Task	Leader	Partners	Duration
Task 3.1 – Risk evaluation	**UTBM**	**CEREMA**, DLR, NTNU, CERTH, COMM, UIC, INTADER	M5-M30
Task 3.2 – Smart detection system	**CEREMA**	**UTBM**, COMM, VTT, NTNU, **IFSTTAR**, CERTH, UIC, SNCF, **NeoGLS**, INTADER	M5-M30
Task 3.3 – Monitoring and remote maintenance	**NTNU**	**CEREMA**, IFSTTAR, UTBM, CERTH, NeoGLS, COMM	M7-M28
Task 3.4 – Communication systems for cross-modal information sharing	**IFSTTAR**	VTT, **COMM, NeoGLS**, NTNU, CEREMA, CERTH, SNCF, TRAINOSE	M5-M24

Interaction within & with other WPs



Task 3.1 – Risk evaluation

Task leader: ***UTBM***, *Cerema, ….*

Objective

Provide a component of SAFER-LC Toolkit with semi-automatic and fully-automatic risk assessment

- Identifying and understanding the dynamics of hazardous situations in LC environments
- Extraction and description of dangerous behaviour models of user-to-user and user-to-infrastructure (LC) interactions
- Extracting quantitative information (number of occurrences of each dangerous behavior or interaction and classification)

Task 3.1 – Risk evaluation

Two main steps

1. Knowledge extraction from video data
   - Scene semantic segmentation (Machine learning /deep learning, background subtraction techniques)
     - Users detection and recognition
     - Infrastructure objects recognition
     - Barriers state recognition
   - Users trajectory extraction (objects tracking, matching, optical flow)

2. Abnormal situations classification and user behavioural modeling
   - Sequence segmentation (detection of state changing / important moment detection)
   - Analysis of the targets (vehicle, truck, pedestrian, etc.) involved in each detected subsequence
   - Classification of abnormal situations into different pre-defined models (zigzagging, obstacle, stopped vehicles line, etc.)

Generating data from simulation

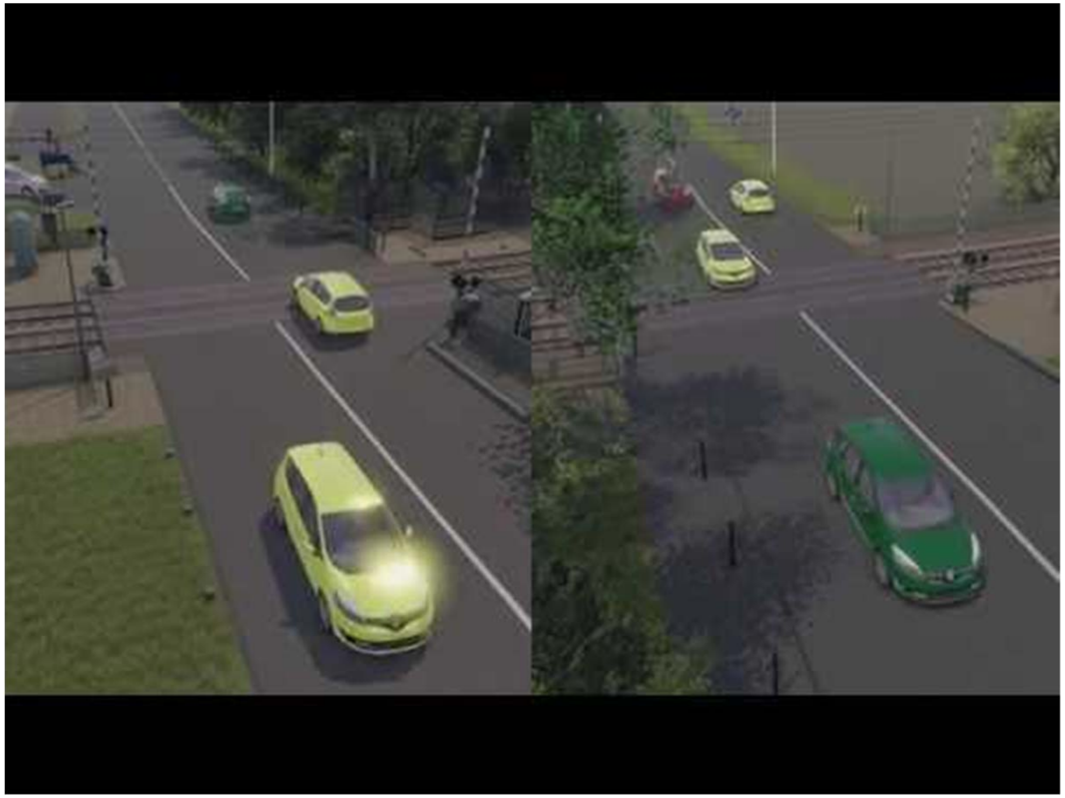
Motivation:

- Real life video capture may not contain dangerous behaviors
- It takes a long time before data are available
- Privacy and confidentiality issues

Solution: Generate realistic looking videos with/without dangerous events using simulation

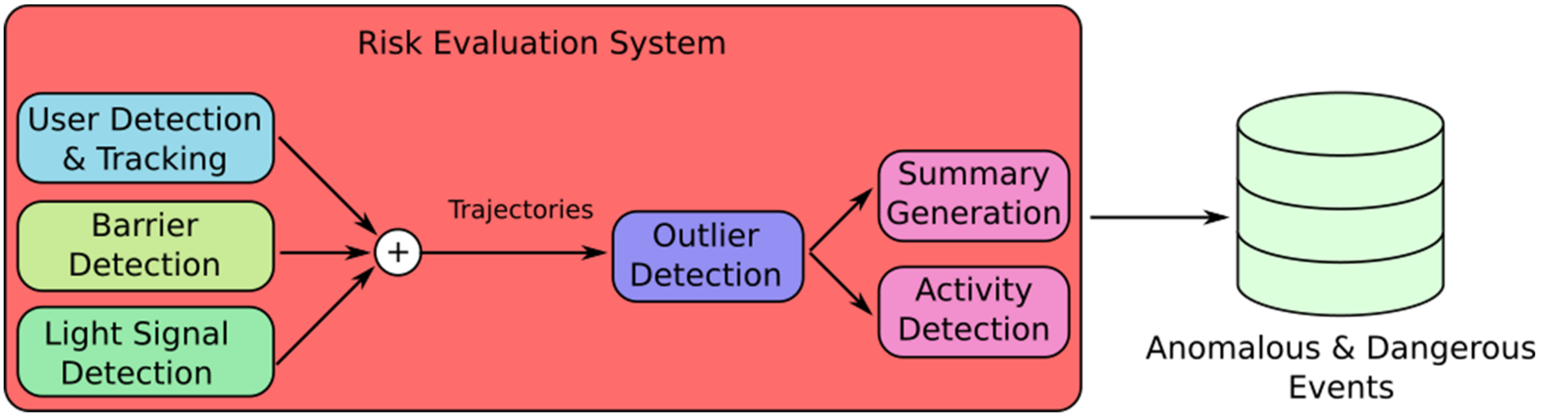
- Multi-agent based /behavioural simulation
- Vehicle dynamics simulation
- Weather and lighting simulation

Simulator



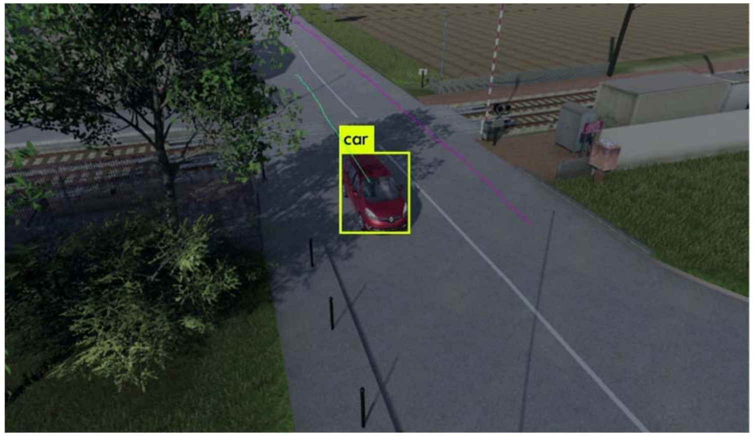
- New vehicle dynamics model
- Provides better stability at high speed (>60 kph)
- Better tire friction model

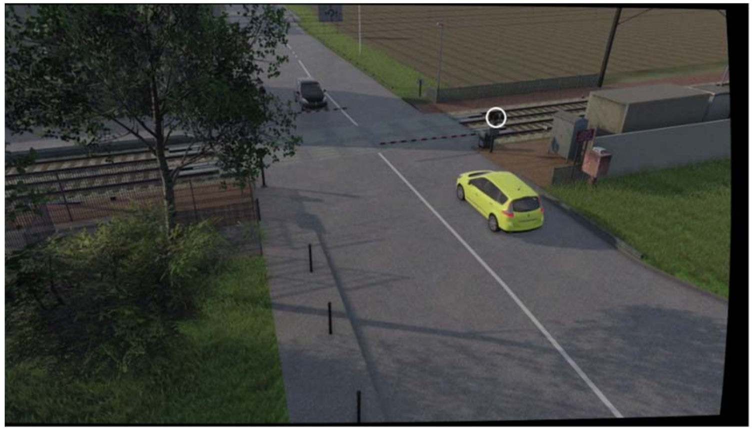
Risk Evaluation System architecture



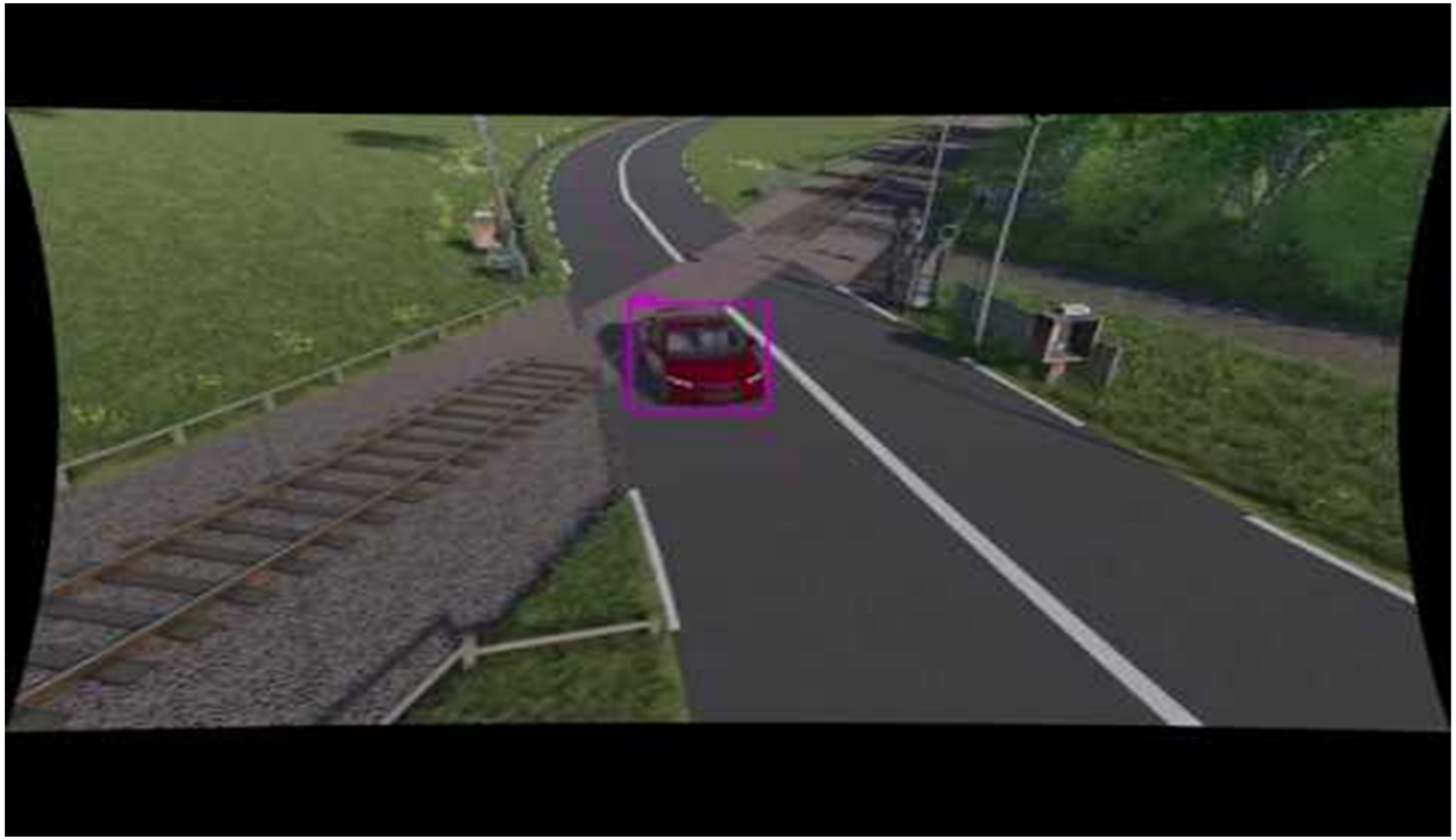
User detection

- Vehicle detection
- Light Signal state detection



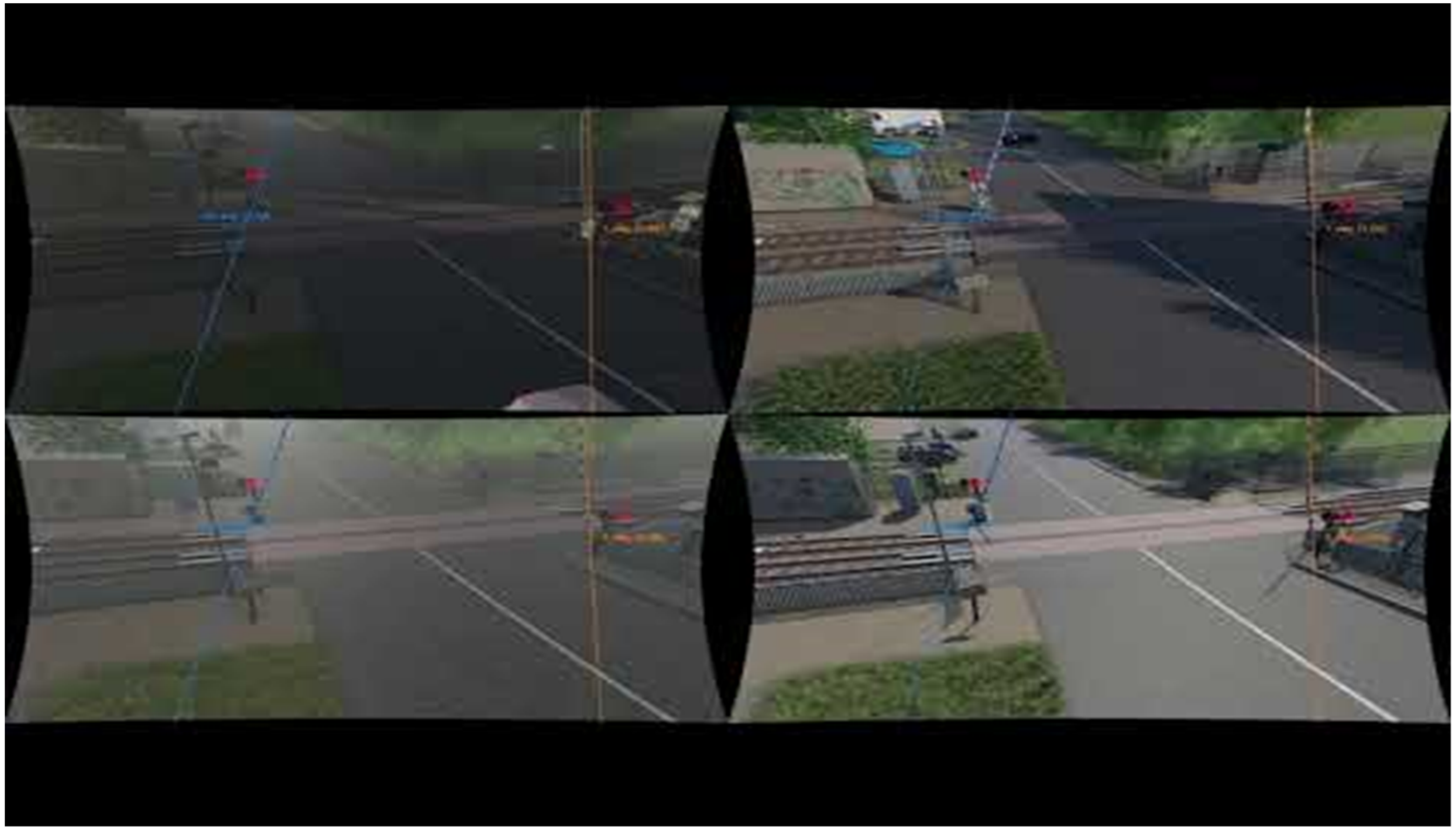


User detection and tracking



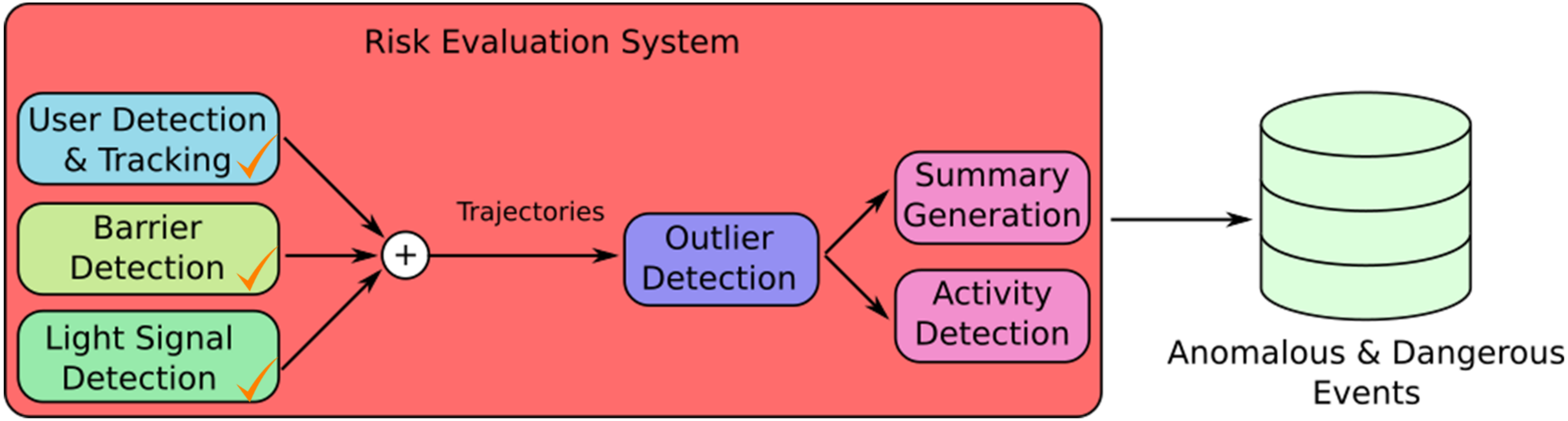
Barrier detection (Scene 1)

Barrier detection (Scene 2)



- Robust as long as lighting conditions are not too poor

Risk Evaluation System architecture



Task 3.2 Video sensing and communication

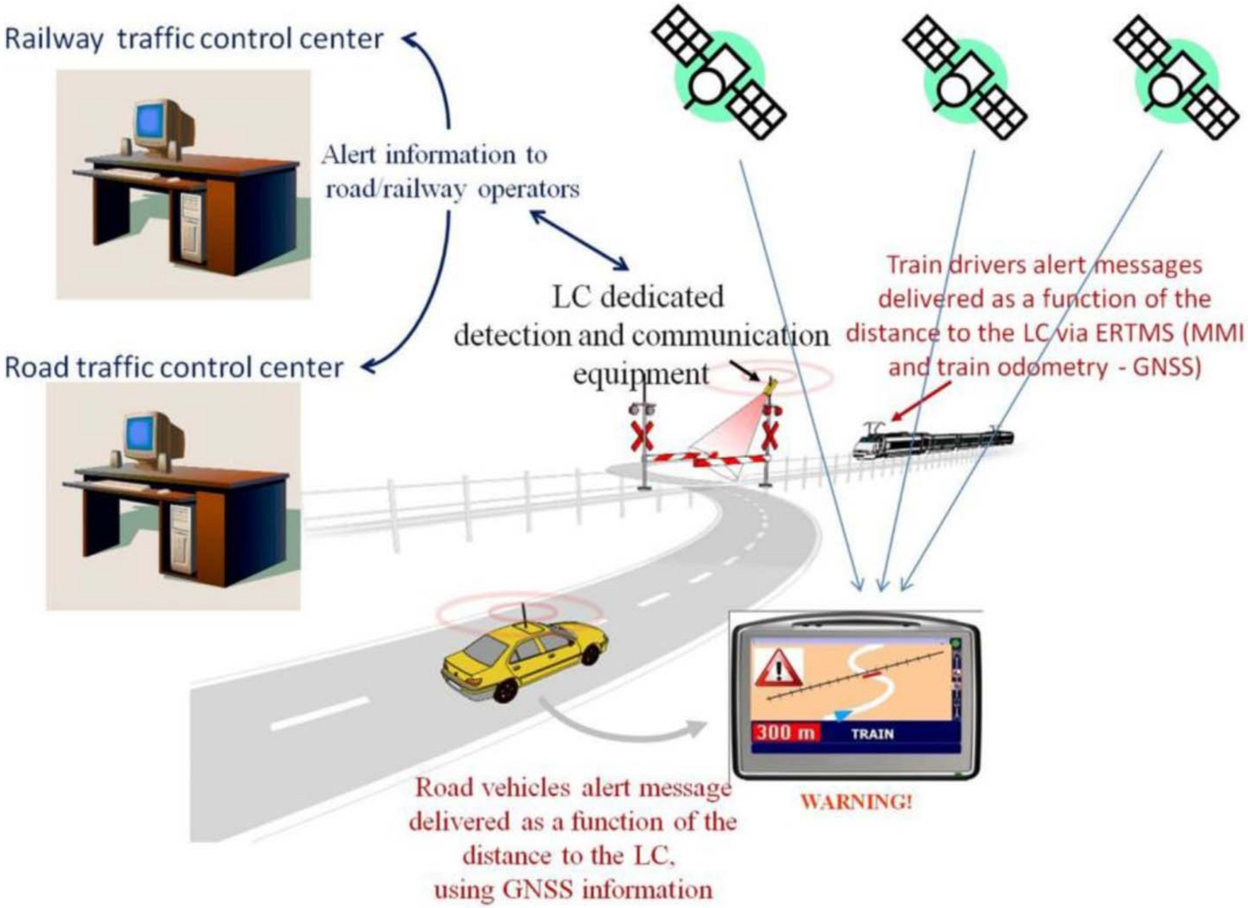
Mid term conference

Cerema, UTBM, NeoGLS, Ifsttar, RWTH, ….

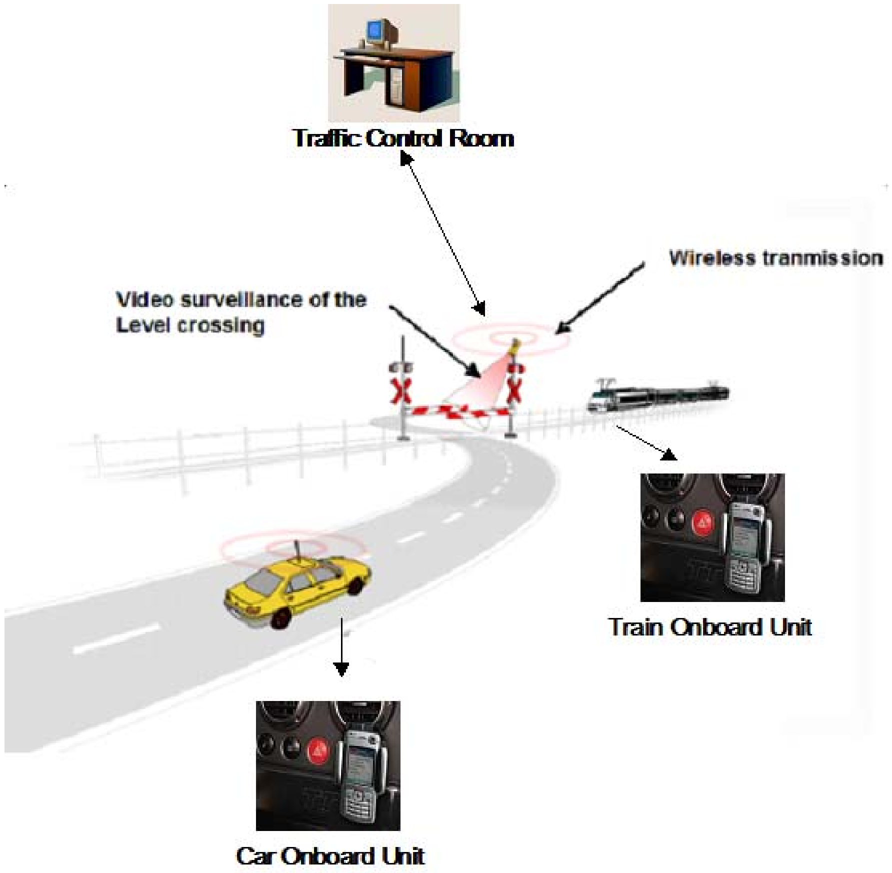
Objective

- Identification of principle factors of accident at LC
- Real time detection, recognition and evaluation of potentially dangerous situations at level crossing
- Sharing alert messages by a communication system
- Research and experimentation of technical solutions

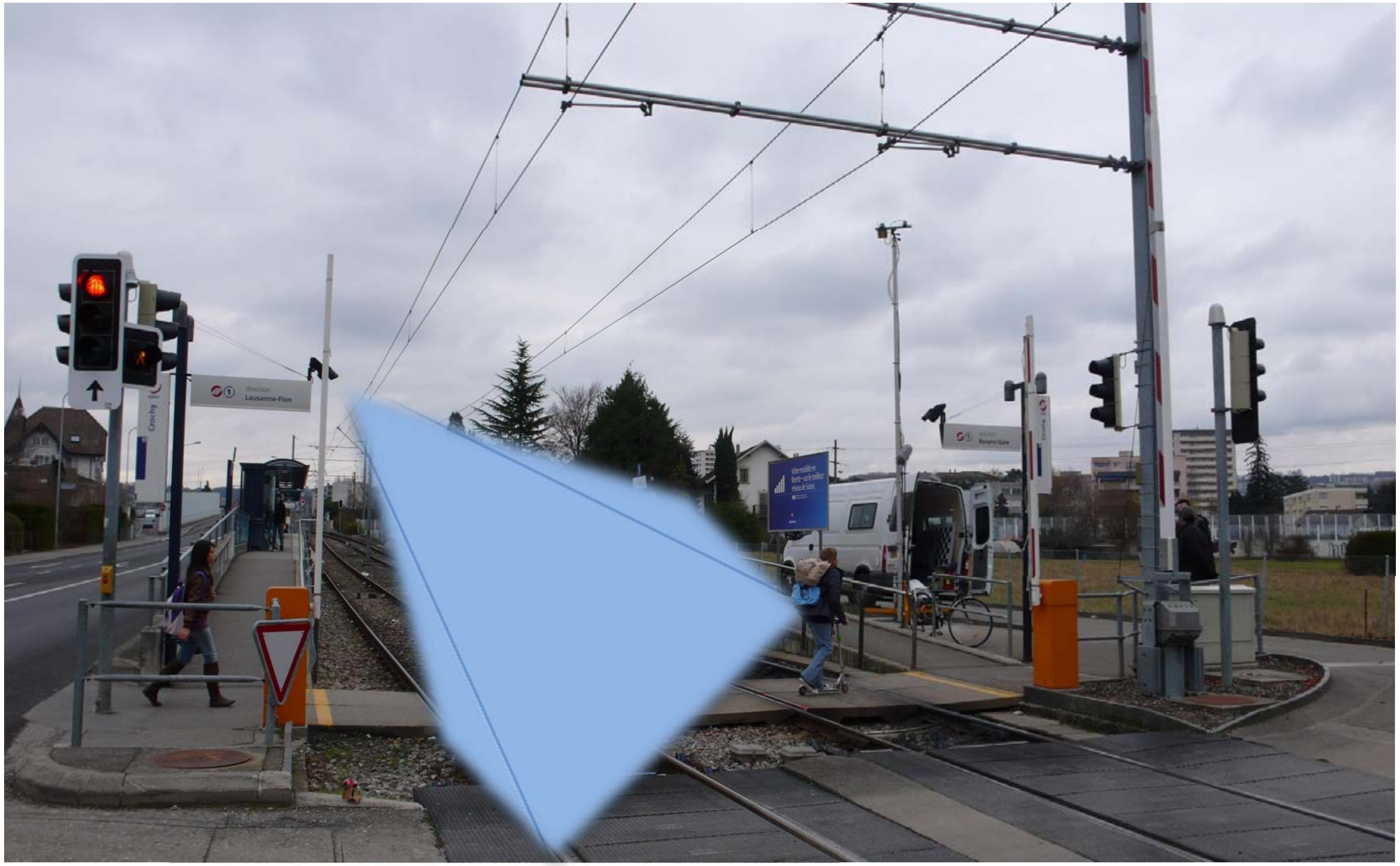
Initial idea



Global architecture

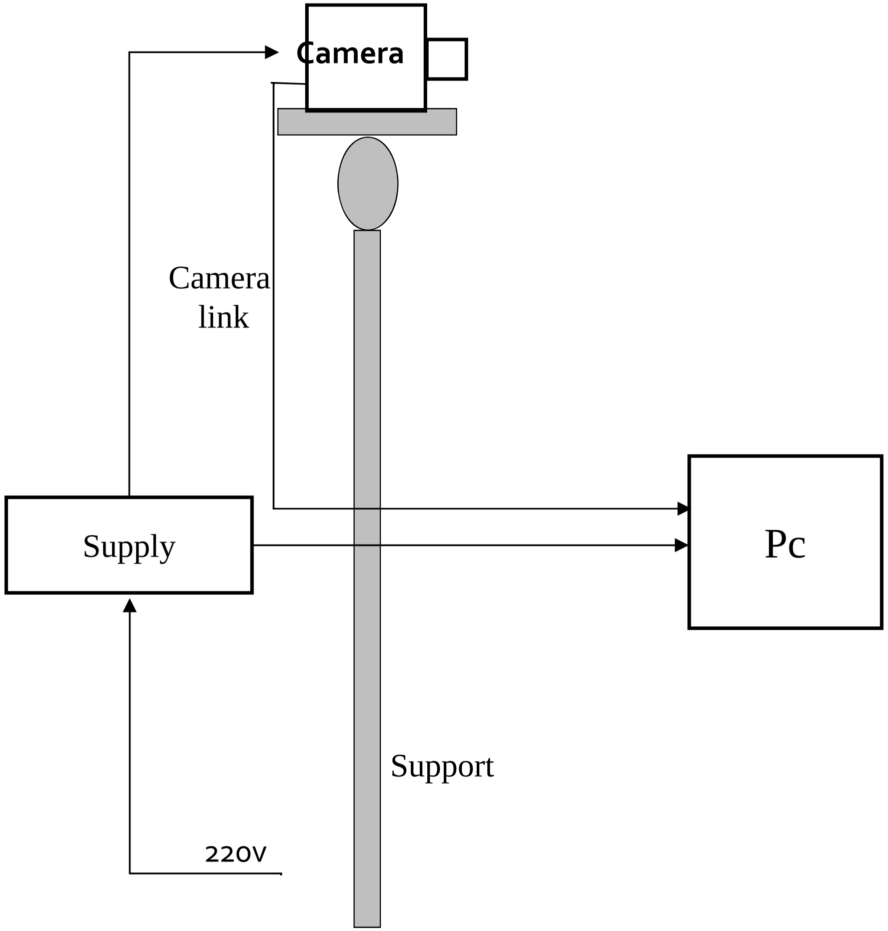


Sensors



Video architecture

Surveillance camera



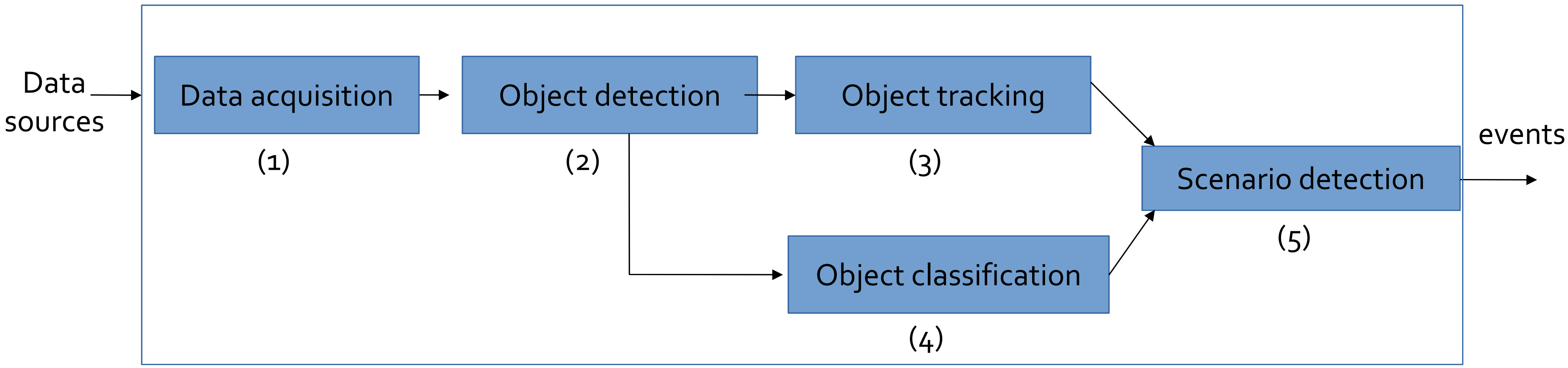
Datasets

- ♦ Cerema dataset 1

- ♦ Cerema dataset 2

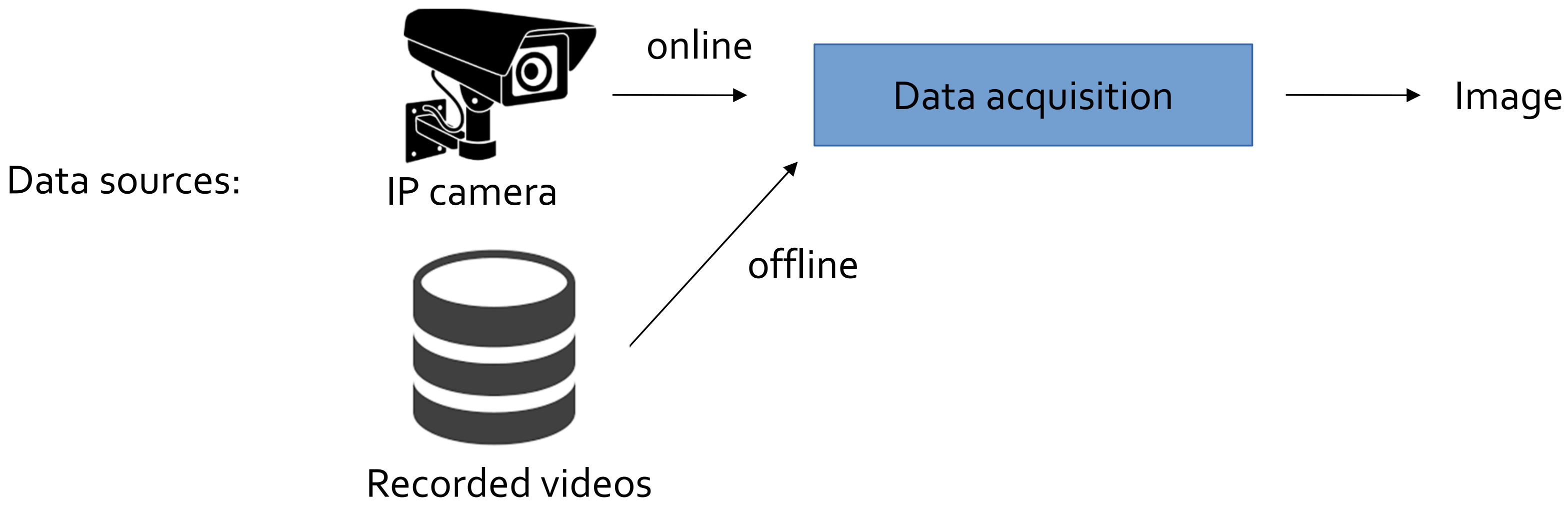
- ♦ Montaudran dataset

Smart detection system modules



Smart detection system

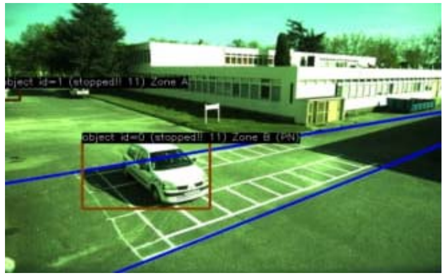
1) Data acquisition



2) Object detection

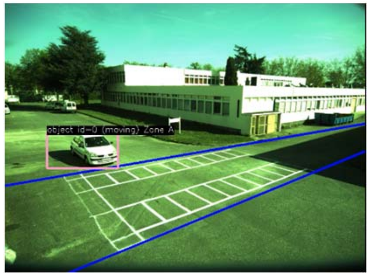
Image

Object detection module

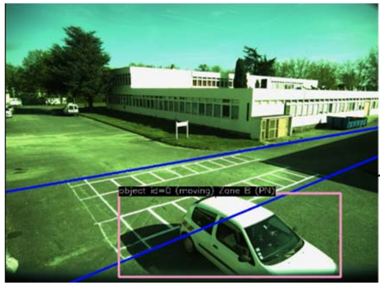


Object location

3) Object tracking



...



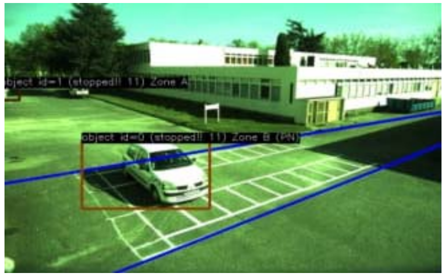
Object location
at time t

Object location
at time t+dt

Object tracking

Object trajectory

4) Object classification

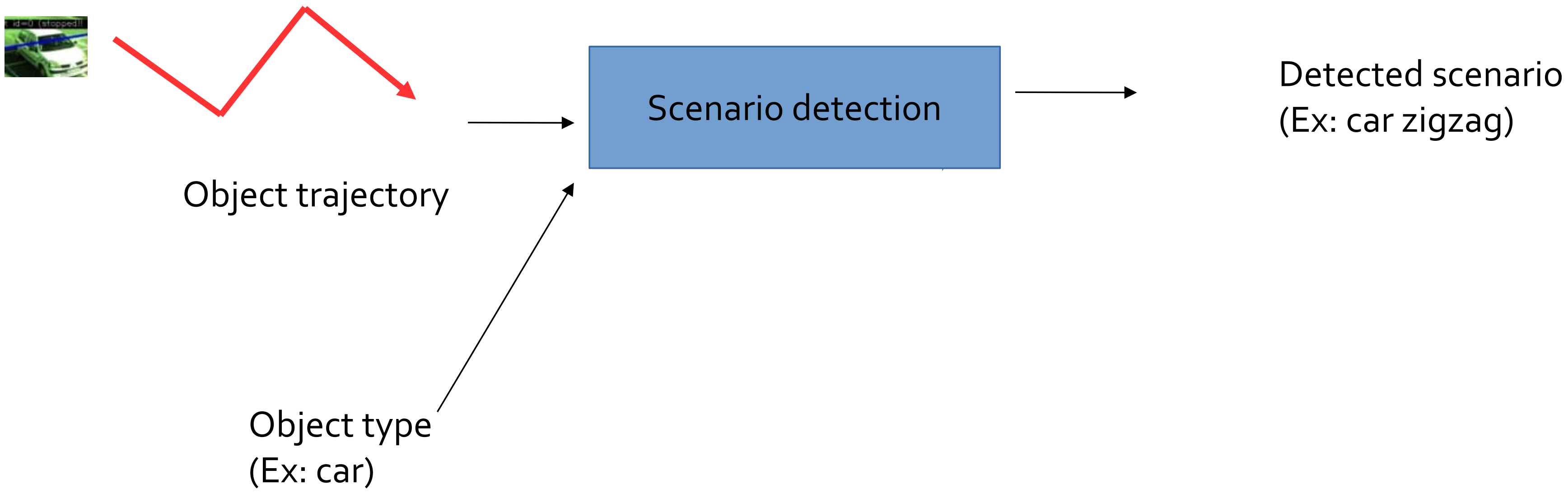


Object location

→ Object classification →

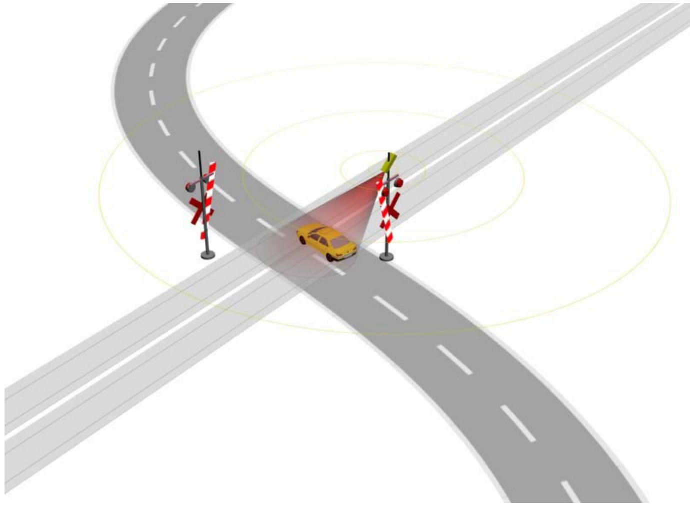
Object type
Ex: car

5) Scenario detection



Definition of possible scenarios to test

Open barriers



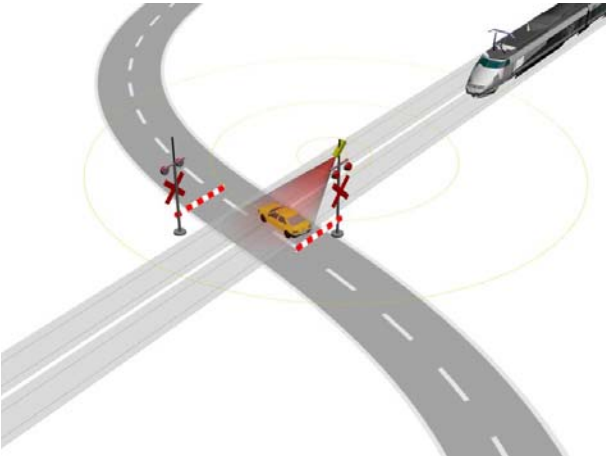
scenario 1: vehicle stopped at LC

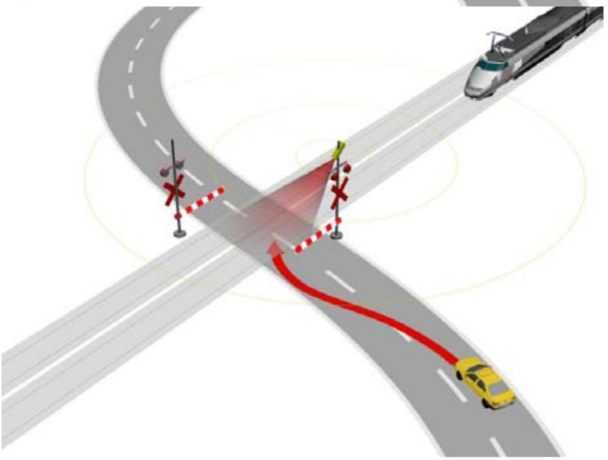
scenario 2: vehicles crossing the LC
(moving forward and backward)

scenario 3: pedestrians crossing the LC

scenario 4: pedestrians and vehicles crossing the LC

Definition of possible scenarios to test





Closed barriers

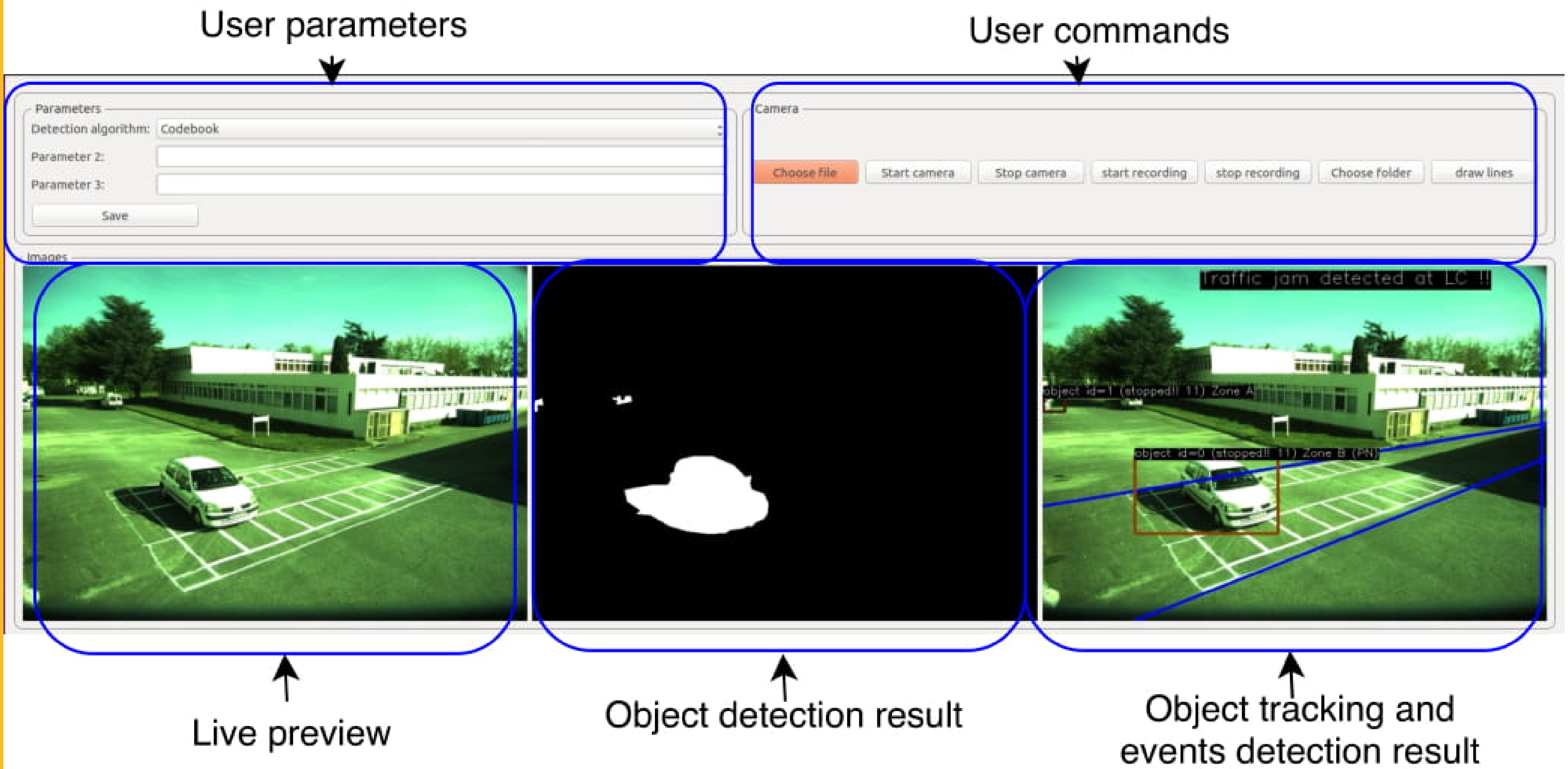
scenario 5: vehicle stopped at the LC
(emergency exit from the vehicle)

scenario 6: vehicles crossing the LC (zigzagging)

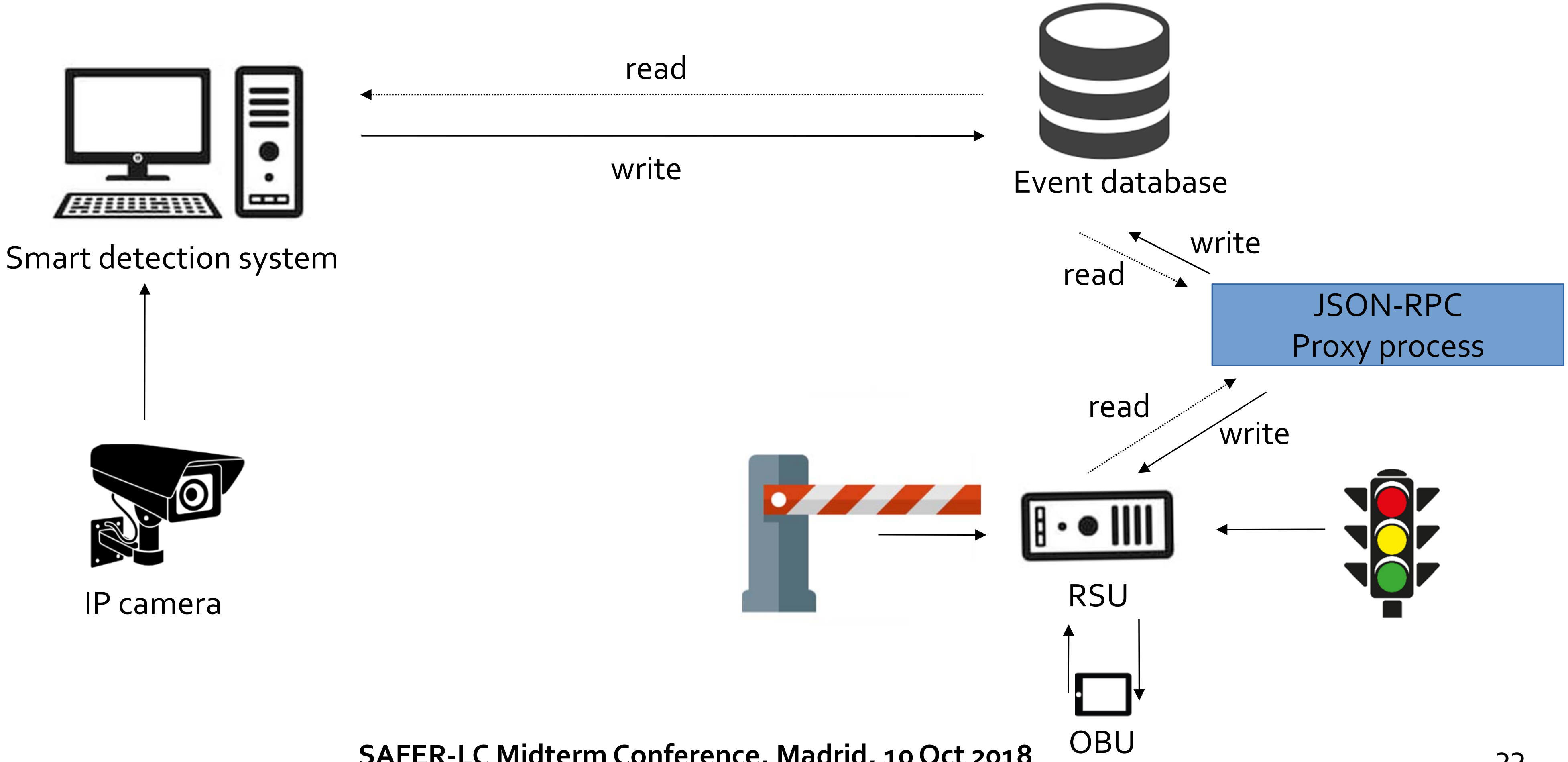
scenario 7: pedestrian crossing the LC

scenario 8: pedestrians and vehicles crossing the LC

Smart detection system interface



Interaction with RSU



Evaluation

Detection accuracy

Detection rate

Processing time

Sample size

Usability

Stability

Environment conditions for processing

Ability to work in hard conditions

Ability to transmit the information

Test site : Aachen

Aerial image of the test site

Road/rail intersection area at Aachen test site

WP3 and 4- Cerema NC Test Site

Tasks 3.3 Monitoring and remote maintenance
Mid-term conference
Madrid – 10 october 2018

Delphine Jacqueline, Carl Calmo
CEREMA France

Elias Kassa
NTNU Norway

Context

What's the problem ?

Conflict point with LC's longitudinal section
→ dramatic consequences
(blocked truck, multi-vehicle collisions…)

How is this situation possible ?
Topographic profil incomptible due to design or LC deterioriation

How is it possible to provide solution ?
Detect all points of conflict with better precision of the profile surveys

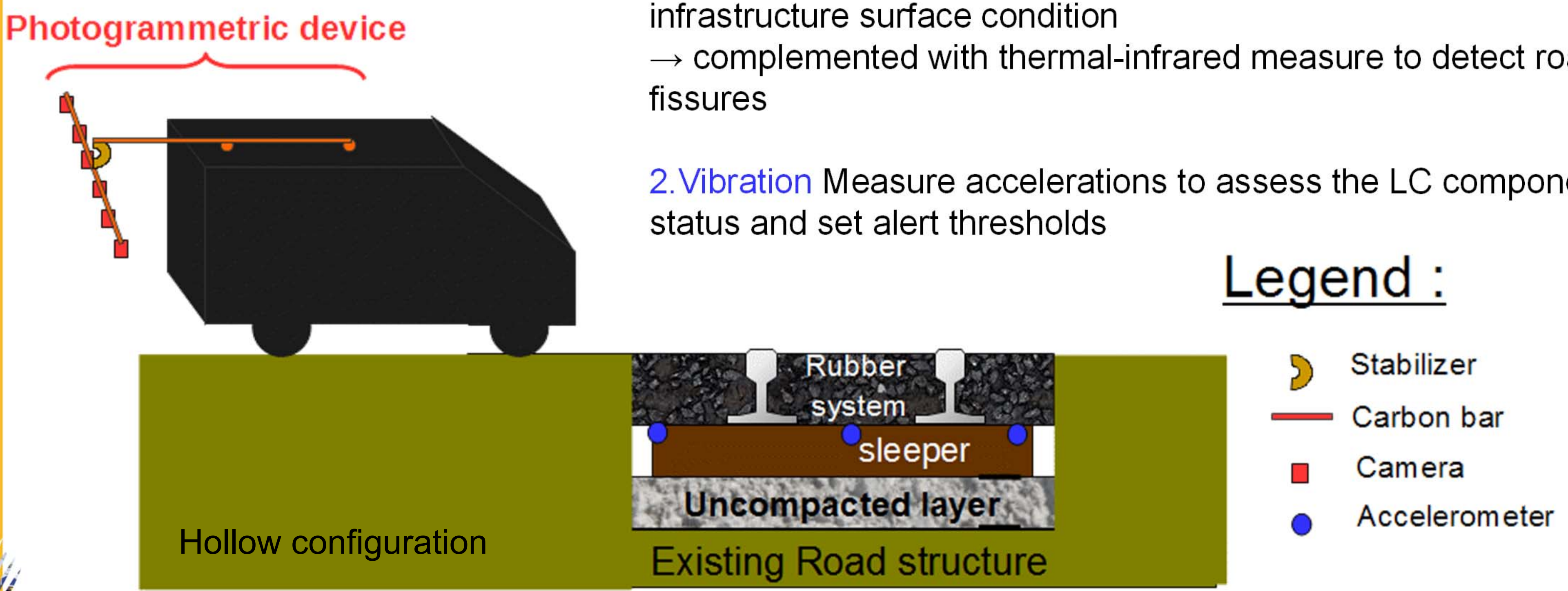
What's challenge for infrastructure managers :
→ to have a mobile, non-intrusive system that does not require intervention on the part of a road or rail agent, enabling acquisitions at 30-200 metres on either side of the level crossing
→ to have a solution developed for preventive maintenance (road/railway works or growth vegetation and snowfall)

Experimental level crossing - Cerema Rouen test site

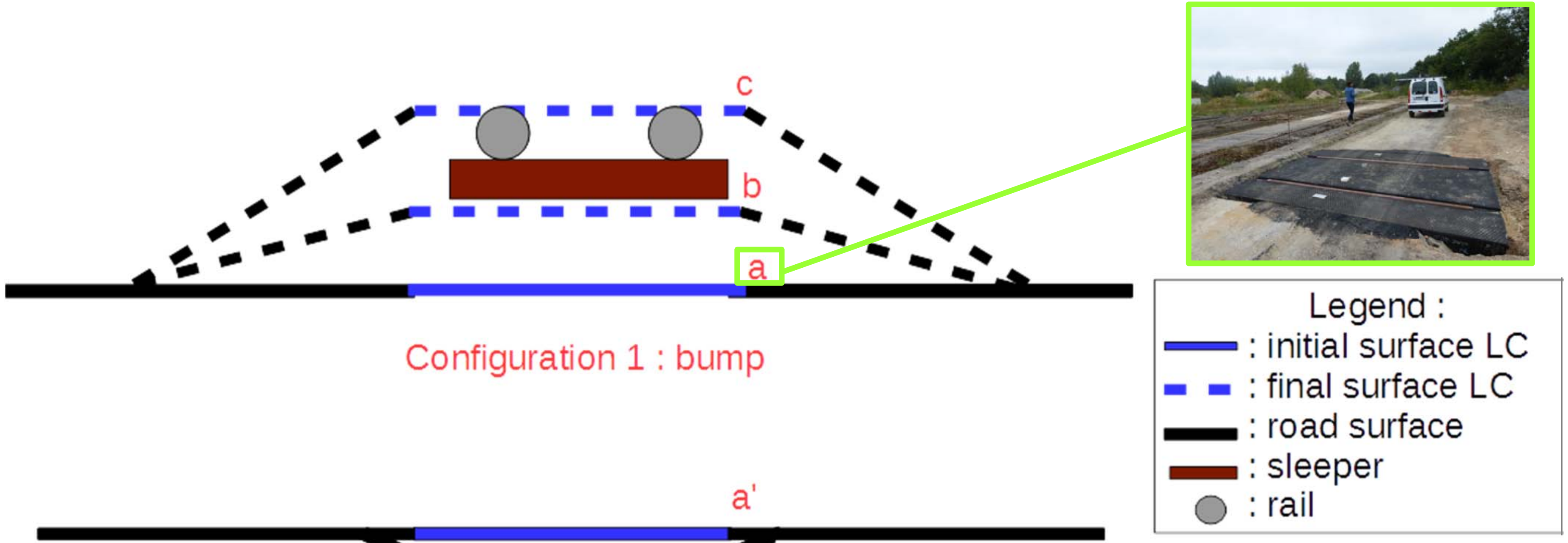
Two approaches will be followed for the real time monitoring :

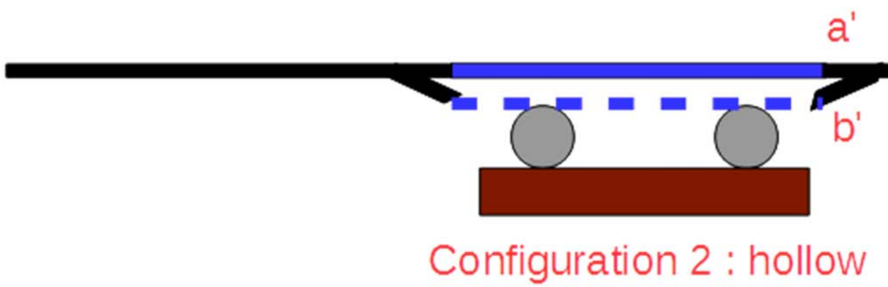
1. Photogrammetric method Measure displacements to monitor infrastructure surface condition
→ complemented with thermal-infrared measure to detect road fissures

2. Vibration Measure accelerations to assess the LC components status and set alert thresholds



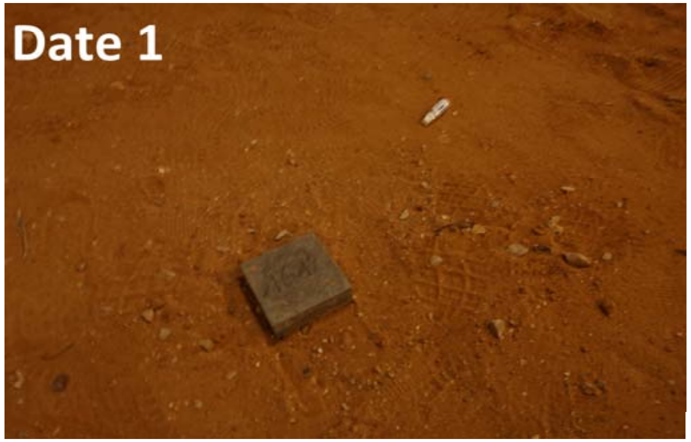
Test site configurations at Cerema Rouen

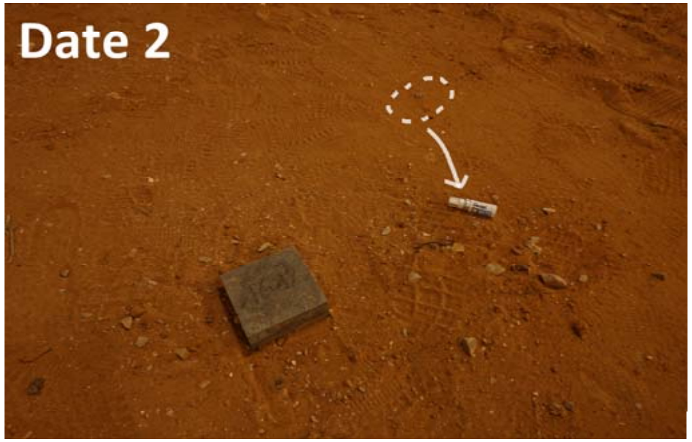


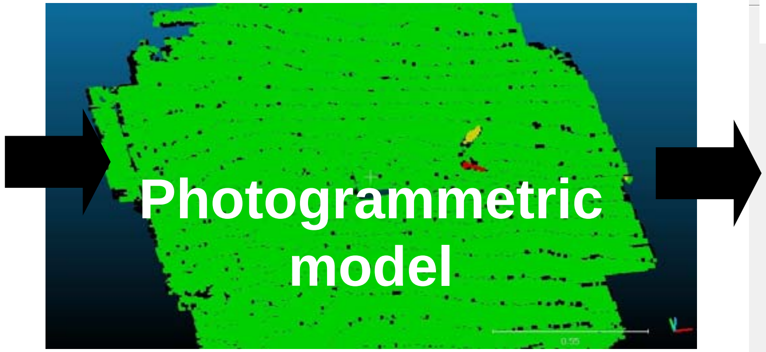


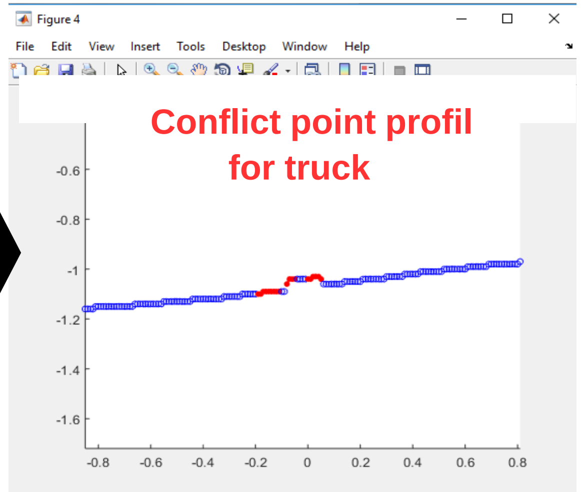
Configurations	Measures
Bump 1a, 1b, 1c	Vibration, photogrammetric
Hollow 2a', 2b'	Photogrammetric, thermoinfrared, Vibration

Current mock-up's examples









Thanks for your attention

Deliverables

Deliverable

- **D3.1. Proof-of-concept on data acquisition platform for the AID system (CEREMA) July 2018**
- D3.2. Report on communication and warning system (IFSTTAR) - April 2019
- D3.3. Guidelines for installation of smart sensors for monitoring of LC infrastructure (NTNU) April 2019
- D3.4. Report on risk evaluation system and use cases for pilot test (UTBM) - October 2019
- D3.5. Report on smart detection system (CEREMA) - October 2019