SAFER-LC

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

WP3 : *development and Integration of technical solutions*

WP Leader: NTNU

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

Objectives

- The aim of this work package is 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.

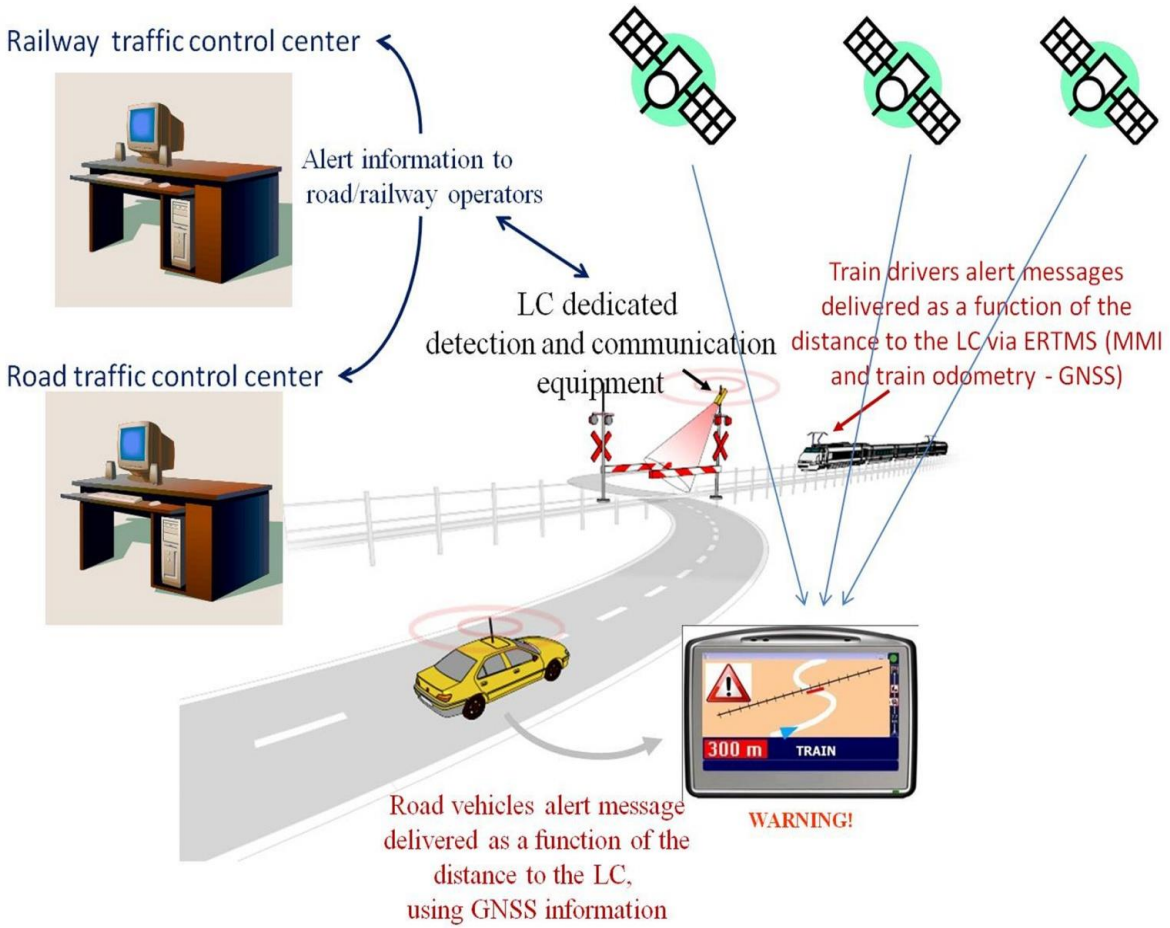
Objectives

- A lot of existing technologies in terms of detection, recognition, data exchange and communication

- Idea is to test already existing technologies to demonstrate the feasability and the usefulness of technological bricks

Architecture

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*



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

Risk evaluation (UTBM)

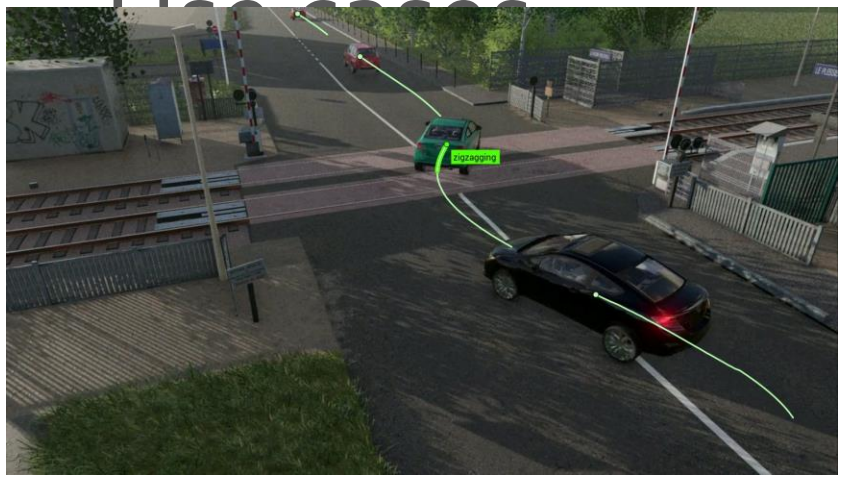
- Provide a component of SAFER-LC Toolkit with off-line semi-automatic and fully-automatic risk assessment
  - Identifying and understanding the dynamics of hazardous situations in LC environments
  - Extraction and description of dangerous behaviour models of user-to-user and user-to-infrastructure (LC) interactions
  - Extracting quantitative information (number of occurrences of each dangerous behavior or interaction and classification)

Methodology

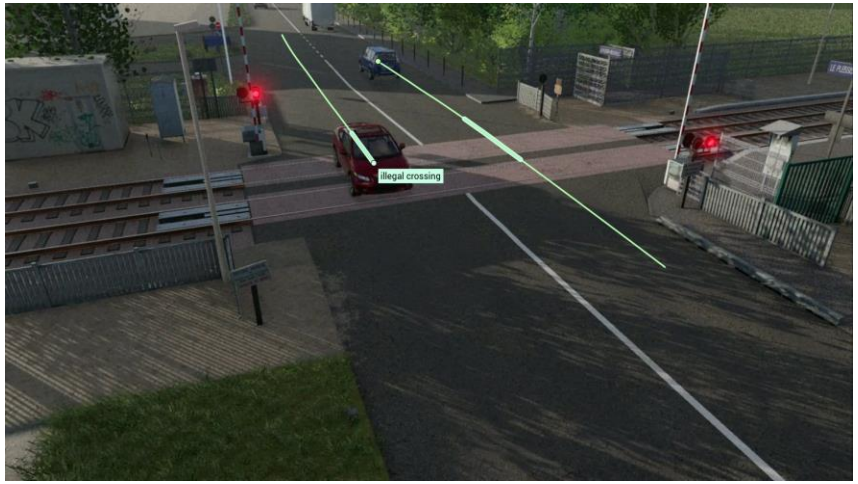
Two main steps

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.)

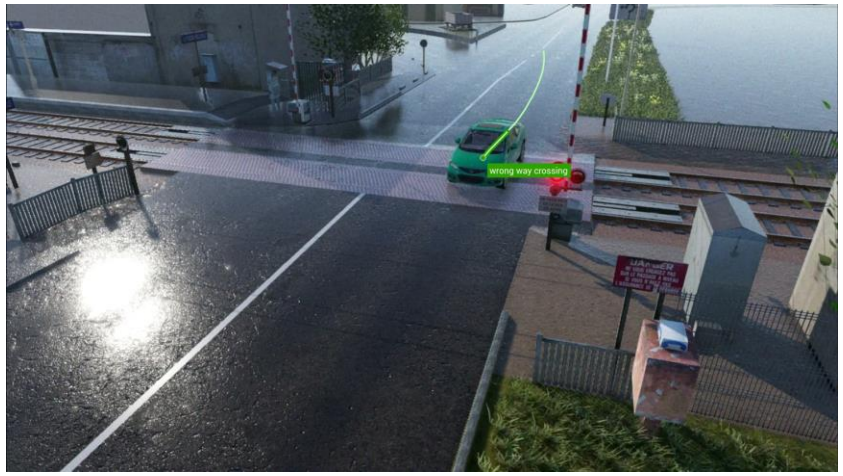
Use cases



Zigzagging



Illegal intersection crossing



Wrong way crossing detection

Stop detection

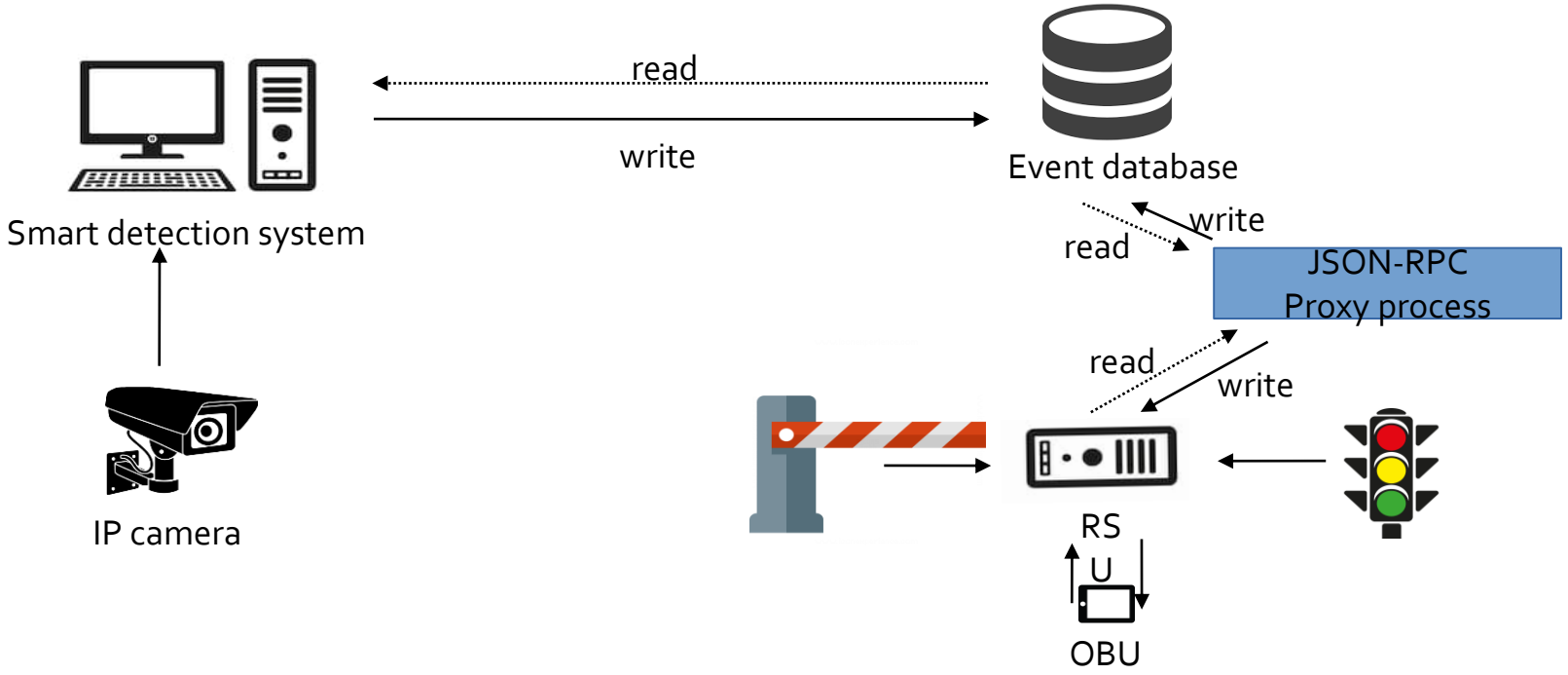
Work done and Results achieved

- A simulator is developed to generate realistic looking videos
- High resolution video rendering framework is complete
  - It will allow vehicle detection and tracking, barrier angle detection, and traffic light signal detection
- The simulator has been improved
  - with new vehicle dynamics model enables to simulate trucks
  - improved tire friction model to simulate different scene

Smart detection system (Cerema)

- Dynamically detect any abnormal behaviour of road/vulnerable users and detect/identify obstacles (e.g. stopping vehicles) that may be the potential source of an incident at a LC, by monitoring the LC environment and its surroundings,

to reduce the risk of collisions and near misses at LCs.



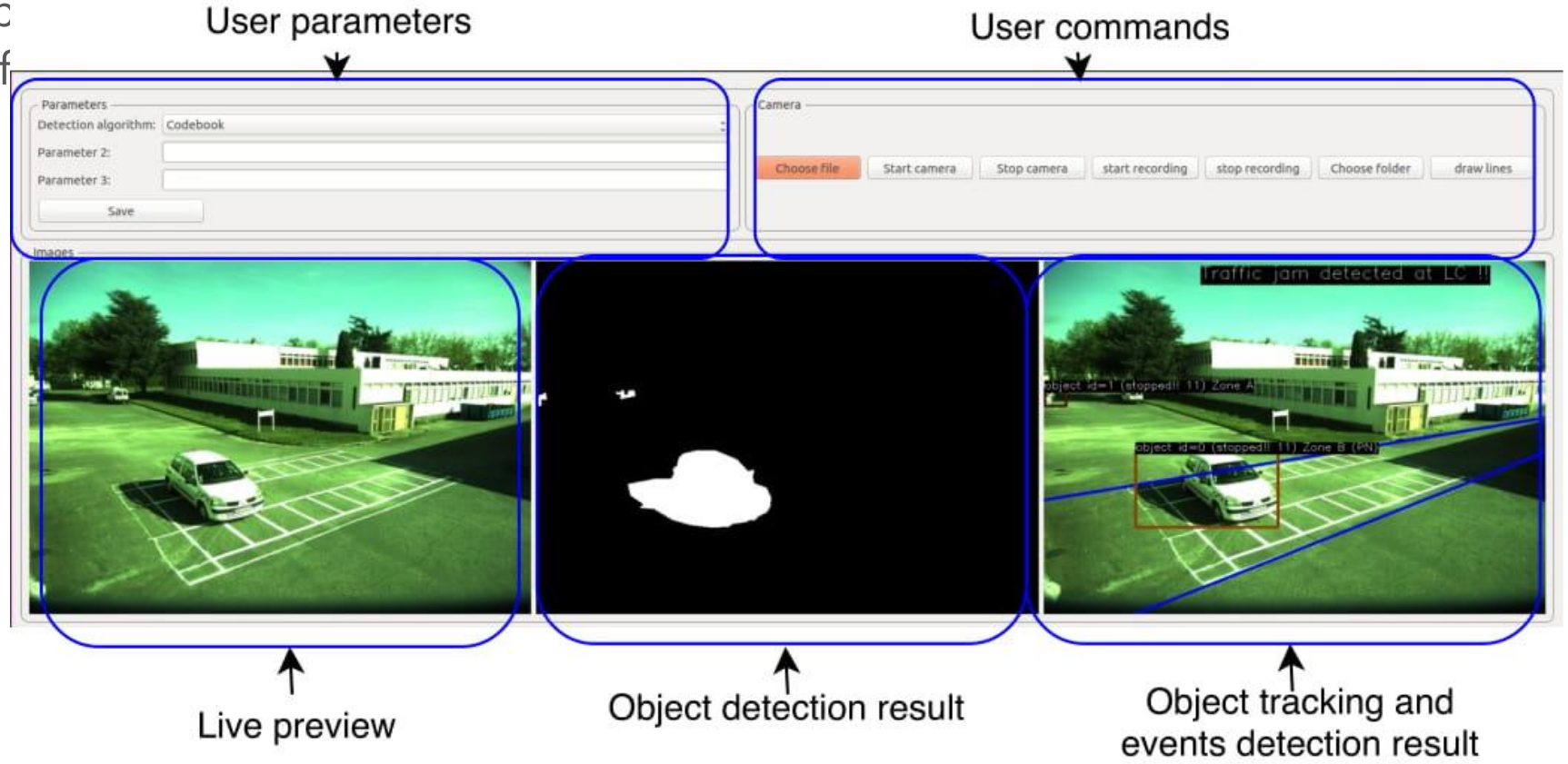
Use cases

-Cars stopped processing time

Indicators : detection performance, recognition performance,

84% of good detection

- Pedestrians
- Atyp
- Traff



Smart detection system interface

3.4 : Communication systems for cross-modal information sharing (Ifsttar)

Specific objectives

- 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

Work done and results achieved

- Definition of evaluation method
- Definition of evaluation indicators: Packet Delivery Ratio PDR, Effective Communication Range, Transmission delay
- Three scenarios were studied:
  - traffic jams occur at the level crossing with barriers open
  - slow crossing of an old pedestrian with barriers closed
  - case where a car is blocked between the barriers

Range : 300 m in Aachen test site

Packet discard rate, Network authentification Request

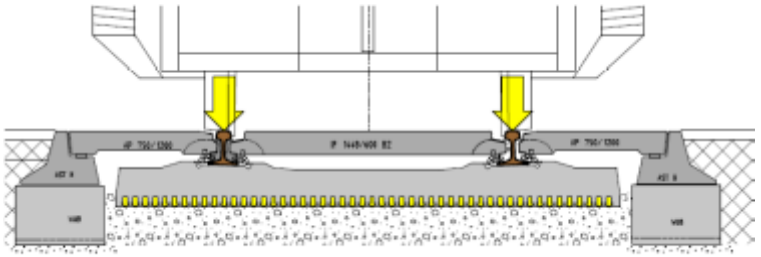
3.3 Infrastructure Monitoring and remote maintenance

I. To develop a real-time monitoring system of LCs using vibration sensors

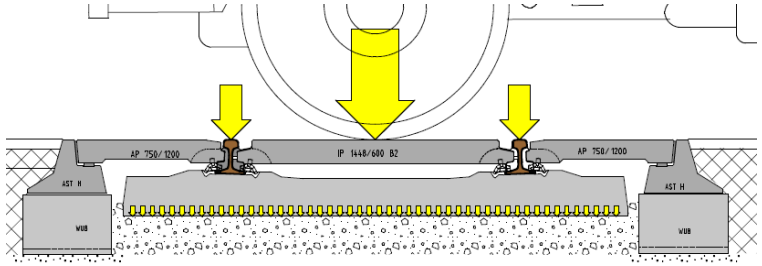
- To monitor the vibration on track/road components due to dynamic loading
- To set an alert threshold to assess the status of the LC components
- To send alerts to LC owners and maintainers of possible safety risks

II. To monitor and assess the condition of LC infrastructure to ensure the safety performance of the LC

- To identify and predict the potential failures at LC boom barrier
- To send alerts of possible safety risks due to LC infrastructure faulty operations



Train loading



Car tyre loading

Methodology

- Two approaches will be followed for the real time monitoring

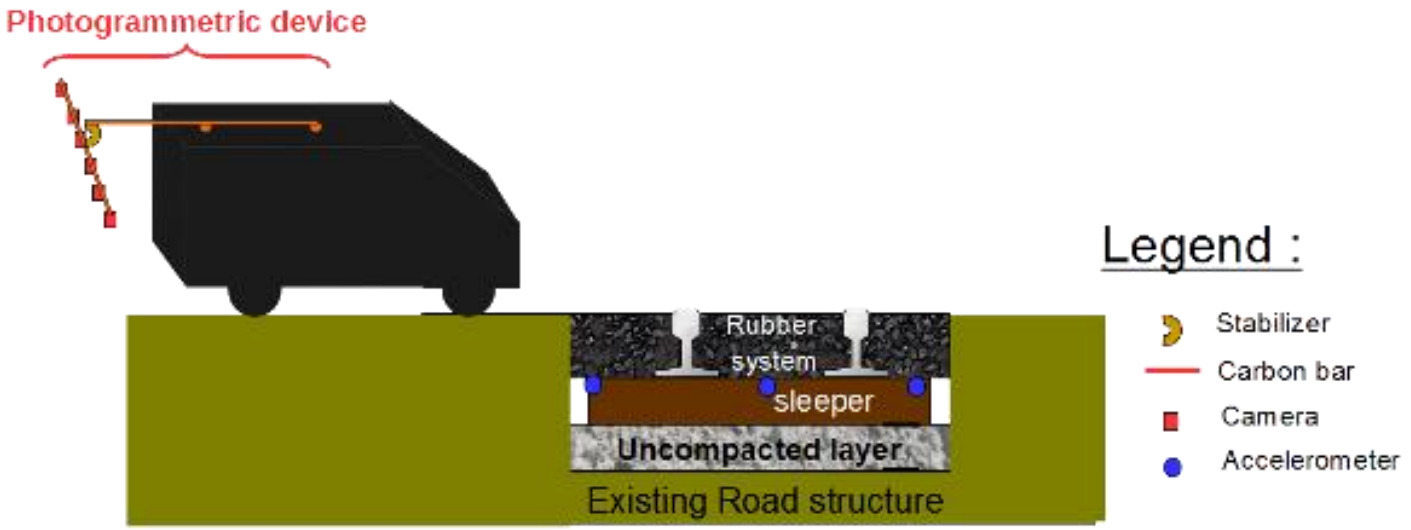
1. Photogrammetric method: Measure displacements to monitor infrastructure surface condition

- → complemented with thermal-infrared measure to detect road fissures

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

Work done and results achieved

- A test site and test configuration is developed
- Mock tests of the photogrammetric method is conducted to to detect the movement and displacement of elements



Status of WP3

-Completed end of october 2019
- Deliverables :

D3.1 **Proof-of-concept on data acquisition platform for risk evaluation and AID systems** **M15**

D3.2 **Report on communication and warning system** **M24**

D3.3 **Guidelines for installation of smart sensors for monitoring of LC infrastructure** **M24**

D3.4 **Report on risk evaluation system and use cases for pilot test** **M30**

D3.5 **Report on smart detection system** **M30**

Global recommendations

WP3

- is a technical workpackage
- Demonstrators are small scales ones and in protected areas
- The datasets collected are quite reduced

Results on the different demonstrators are quite promising

- Risk evaluation is a very good tool to generate many use cases
- Smart detection system shows the technical feasability of a video-based sytem
- Communication tools shows also the complementarity between detection and communication
- Infra monitoring and remote maintenance is a good predictive system for failures

Recommendations

- Test the implemented measures in a larger scale real world experiments with well-planned research design to obtain more information on their effects
- Analysis of user behaviour and on road safety

Thank you for your attention