COOPERATIVE SYSTEMS FOR PREVENTIVE TRAFFIC SAFETY

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Airbag 2010 - December 8th 2010

Cooperative systems for preventive traffic safety
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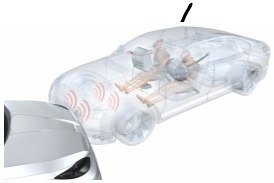
- Introduction to the world of cooperative technologies
- Cooperative technologies in the national research initiative Ko-FAS
- Cooperative transponders – an excellent localization tool
  - Functional principle
  - Unique features
  - Status of realization and system performance
  - Interaction with related technologies
- Cooperative perception with sensor networks based on
  - ADAS sensors in the vehicles and C2C communication
  - Environmental sensors in the infrastructure and information broadcast
- Perspectives

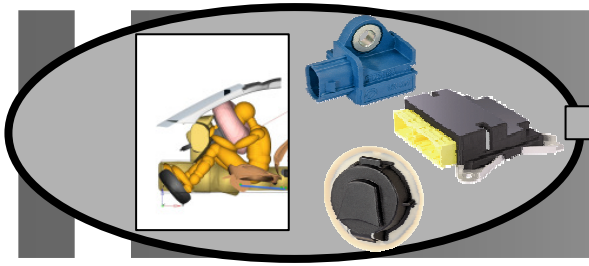
Cooperative systems for preventive traffic safety
Cooperative technologies

MITIGATION → **PREVENTION**

2010

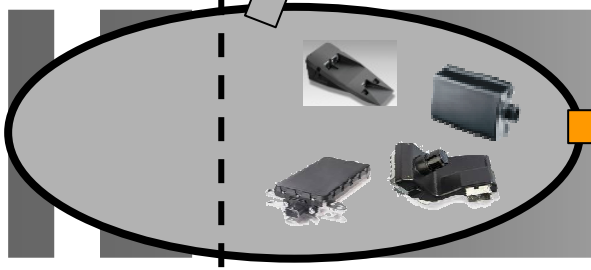
CONTACT





Integrated Occupant Protection

PREDICTIVE



Cooperative Perception

CONNECTED

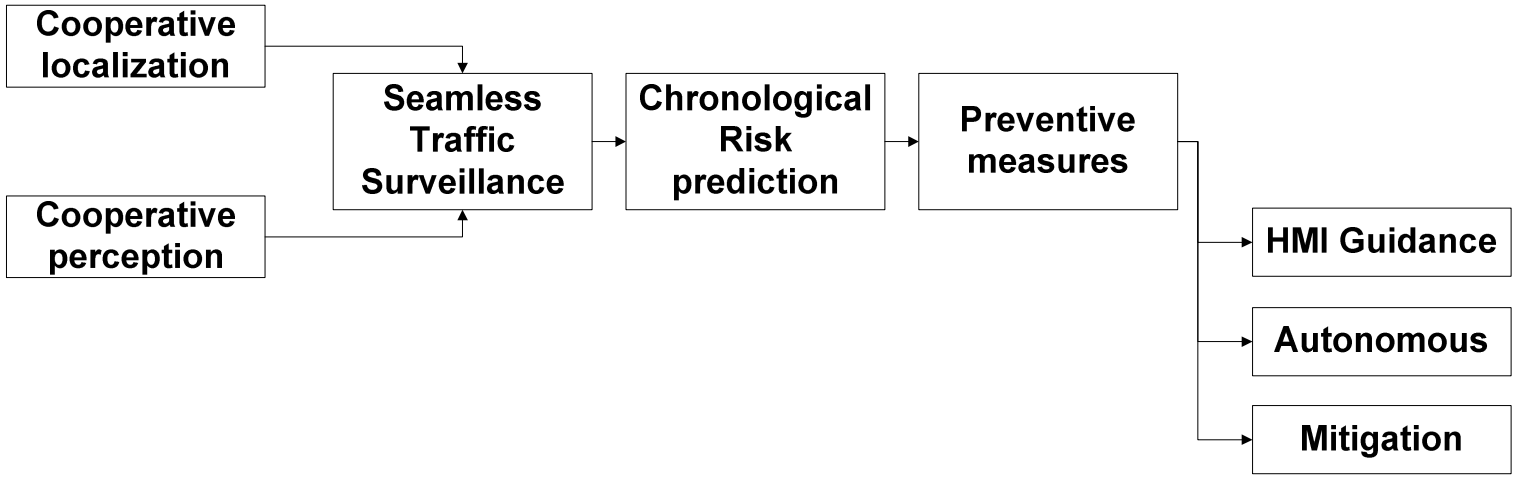
Cooperative Localization (transponder)

Cooperative systems for preventive traffic safety
Research Initiative Ko-FAS – Goals and partners

Ko-FAS: Cooperative sensors and cooperative perception for the predictive traffic safety

Goal: Significant reduction of severe accidents and fatalities

Realization:

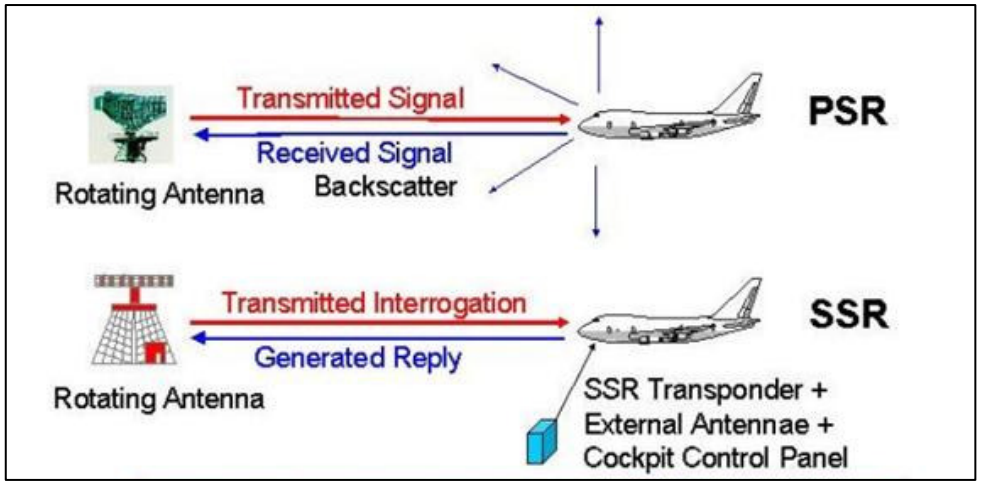


Partner:

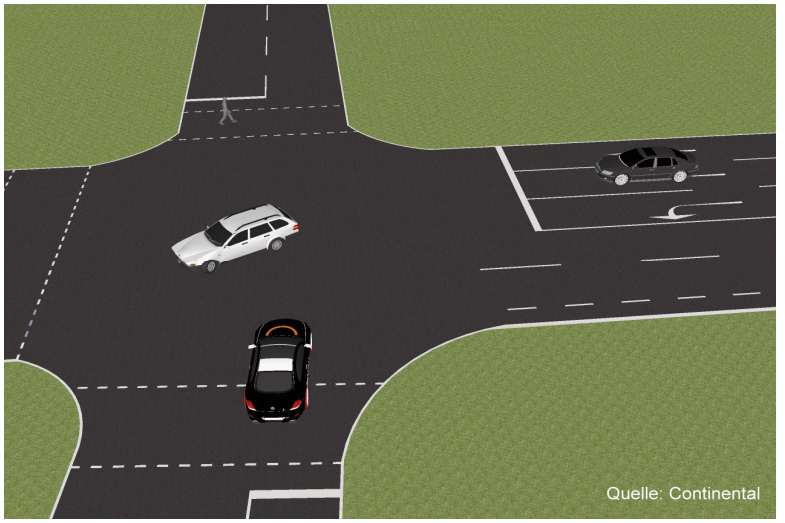
BMW Group Forschung und Technik, Continental, DAIMLER, SICK Sensor Intelligence., DELPHI, MAGNA ELECTRONICS, Fraunhofer IIS, Fraunhofer Heinrich-Hertz-Institut, UNIVERSITÄT PASSAU, IZVW, ITE, hochschule aschaffenburg, Steinbeis Transferzentrum Embedded Design und Networking, Steinbeis Innovationszentrum Embedded Design und Networking, Duale Hochschule Lörrach

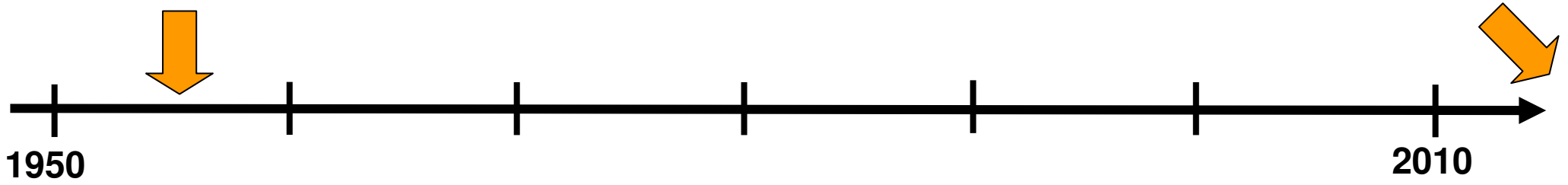
Cooperative systems for preventive traffic safety
Well established cooperative technologies

Secondary surveillance radar –
In the civil aviation
since 1955

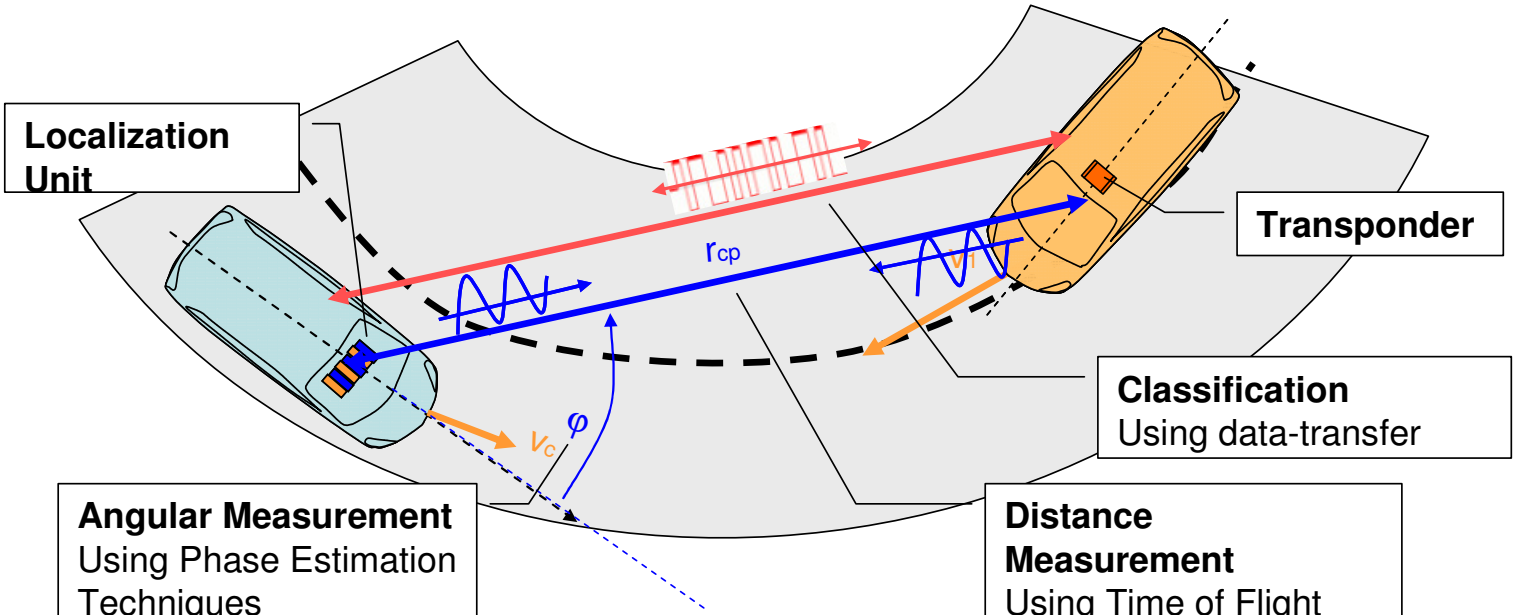


Cooperative transponder –
Transfer to road traffic in 20XX



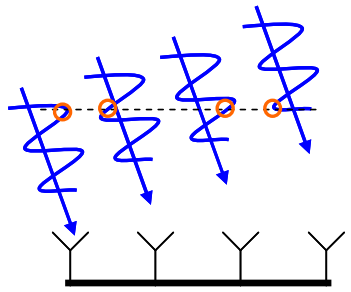


Cooperative systems for preventive traffic safety
Cooperative transponders – functional principle

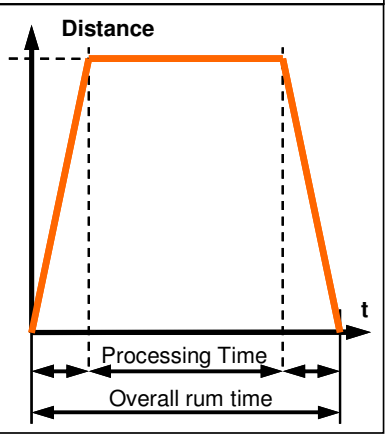


Classification
Using data-transfer

Angular Measurement
Using Phase Estimation Techniques

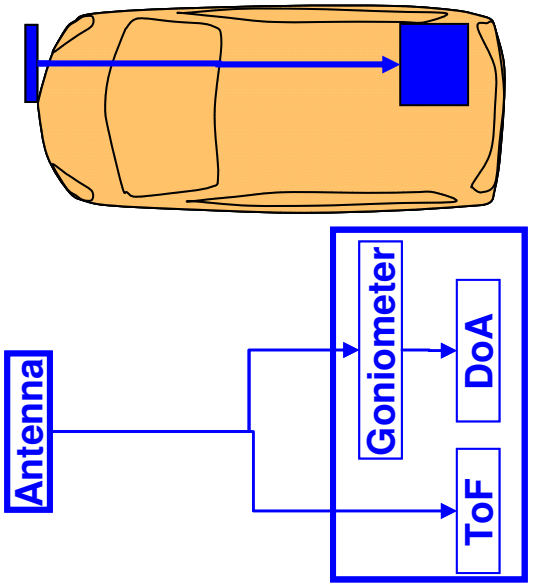


Distance Measurement
Using Time of Flight

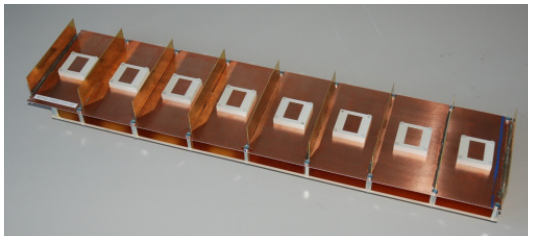


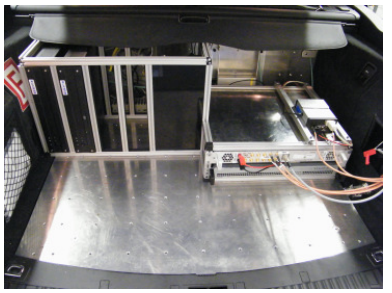
Cooperative systems for preventive traffic safety
Cooperative transponder: Prototypical realization

Vehicle Set-up



Antenna & Localization-Unit





Performance Data:

Version: Ko-TAG 1.0

Frequency: 2.4 GHz (ISM Band)

Range: > 200 m

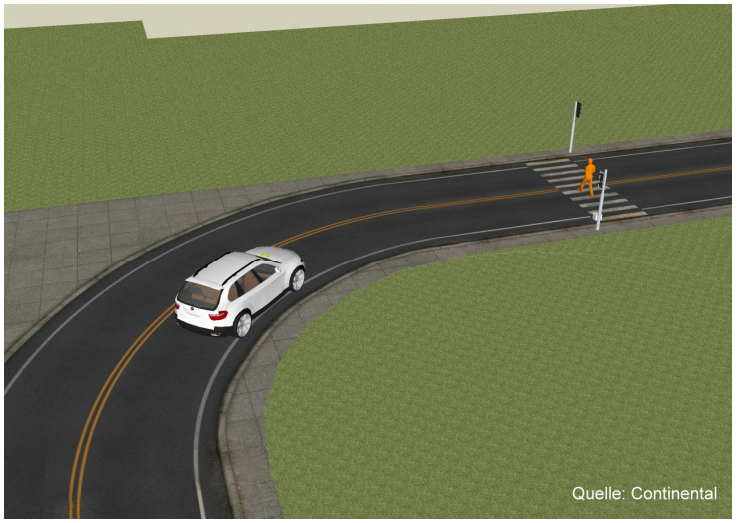
Accuracy: +/- 10 cm

Transponder-Unit:

Cooperative systems for preventive traffic safety
Cooperative transponders – unique applications

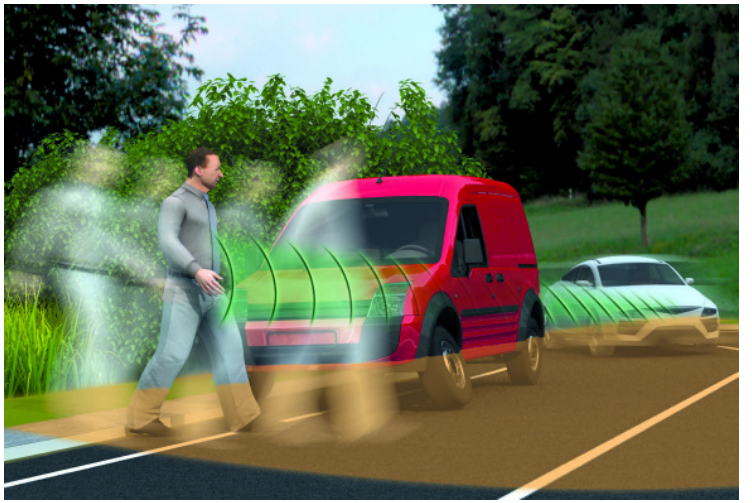
Predictive pedestrian protection

- Pedestrian accident statistics:
  20 % occur combined with occulation
  33 % occur at night or twilight



Cooperative transponder can

- **Classify objects by ID**
- **Locate pedestrians without line-of-sight**
- **Track objects chronologically**
- **Resolve individual pedestrians in groups**



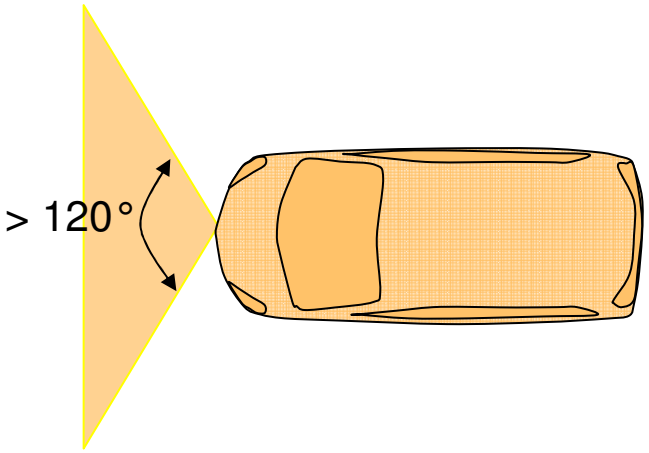
Cooperative systems for preventive traffic safety
Cooperative transponders – unique applications

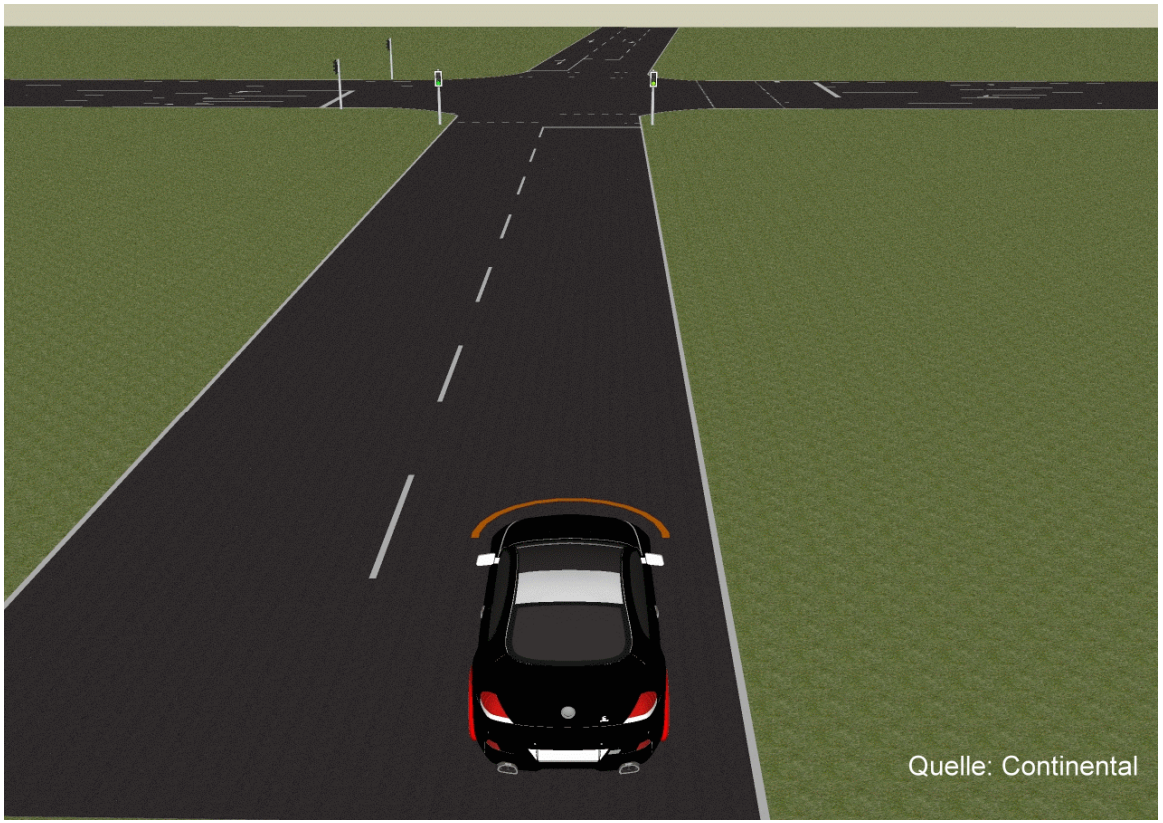
Omnidirectional safety

- Accident statistics:
  35 % of all severe accidents occur at crossings

Cooperative transponder can

- **Recognize objects with significant lateral offset due to large aperture angle**

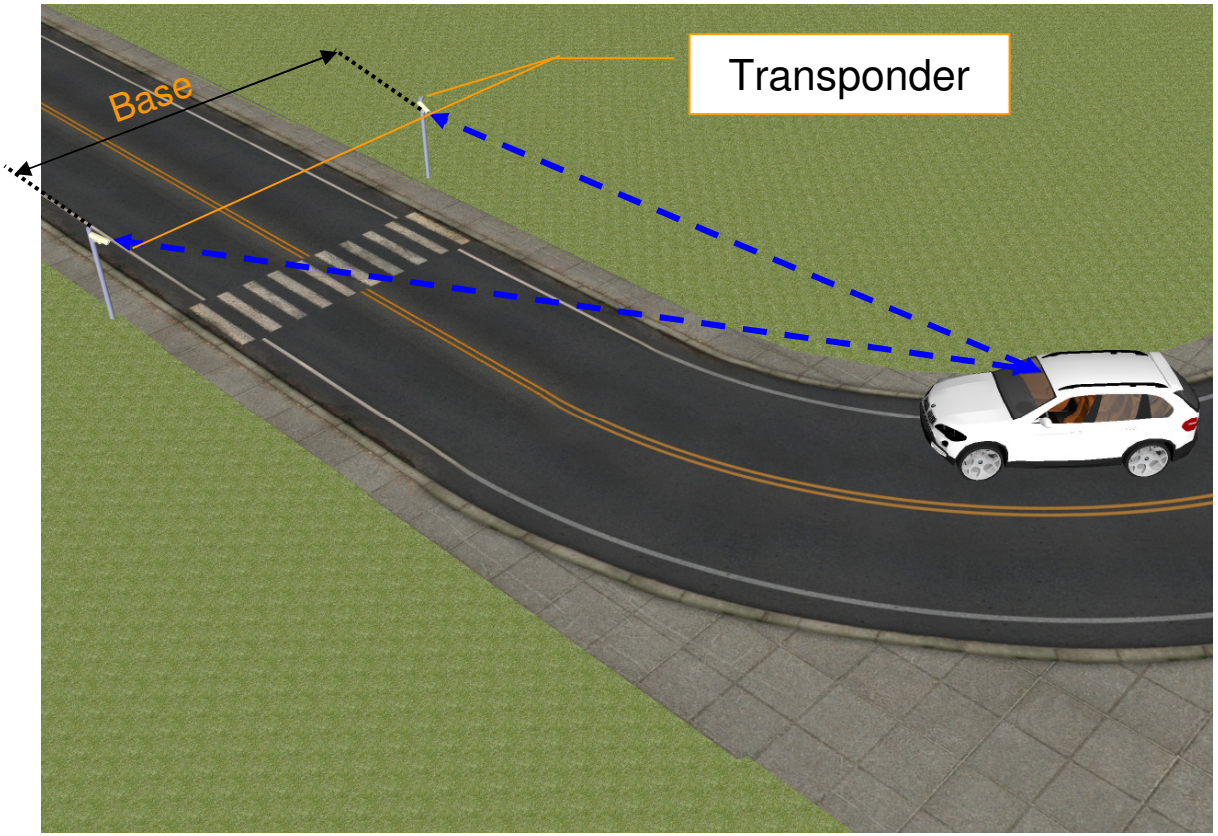




Cooperative systems for preventive traffic safety
Cooperative transponders – unique applications

Self-localization

- Precise self localization in urban environment

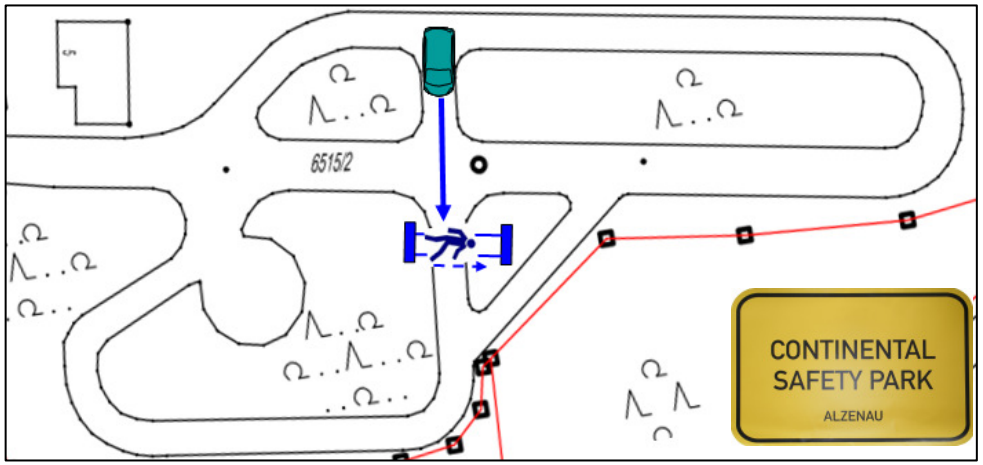


Cooperative transponder can

- **Find the own position and orientation using infrastructure transponder**
- **Support guidance through difficult routings**

Cooperative systems for preventive traffic safety
Cooperative transponders – Current test results

Pedestrian crossing scenario

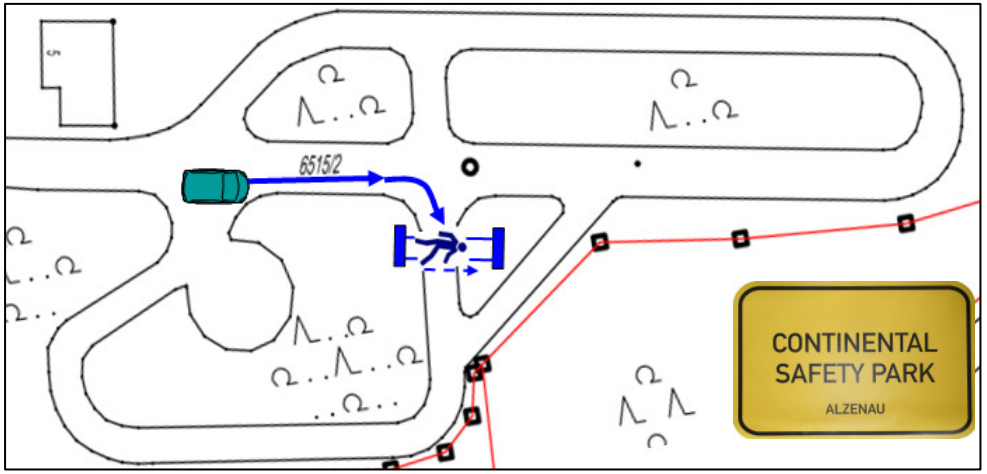


Collision test

Near-miss test

Cooperative transponders – Current test results

Vehicle turns in while pedestrian crossing scenario



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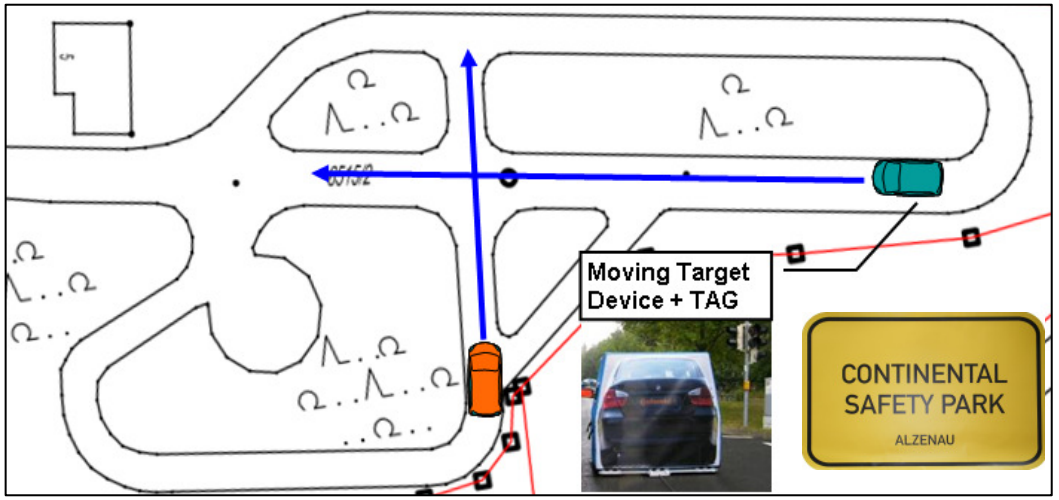
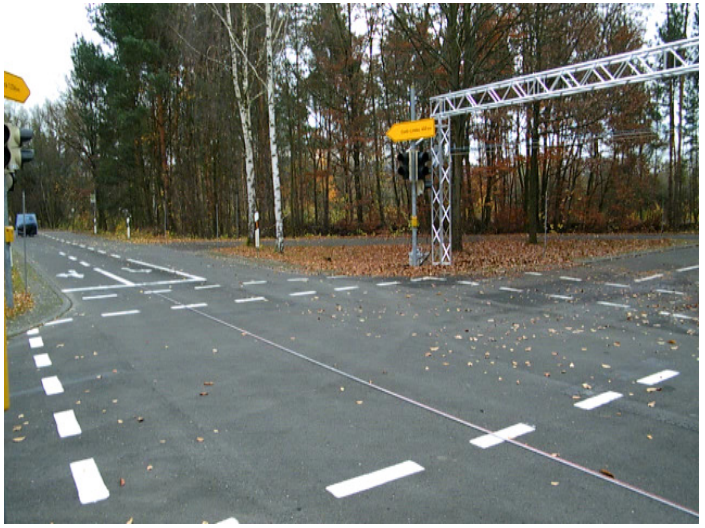
Cooperative systems for preventive traffic safety
Cooperative transponders – Current test results

Cross-Road application





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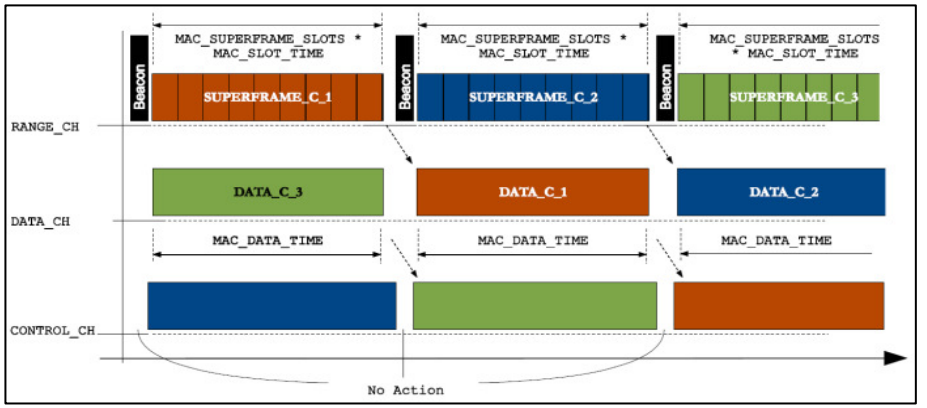
Cooperative systems for preventive traffic safety
Alignment possibilities with related technologies

Approximation of latest C2C standard by:

- Usage of frequency bandwidth close to C2C standard (5.9 GHz)
- Implementation of 802.11p communication protocol

Segmentation in 3 Sub-channels

- Management channel for TAG handling
- DoA Channel for angle measurement
- TOF channel for distance measurement
- Dynamic communication topology
- Temporally separation of angle and distance measurement



Advantages for C2C and C2I

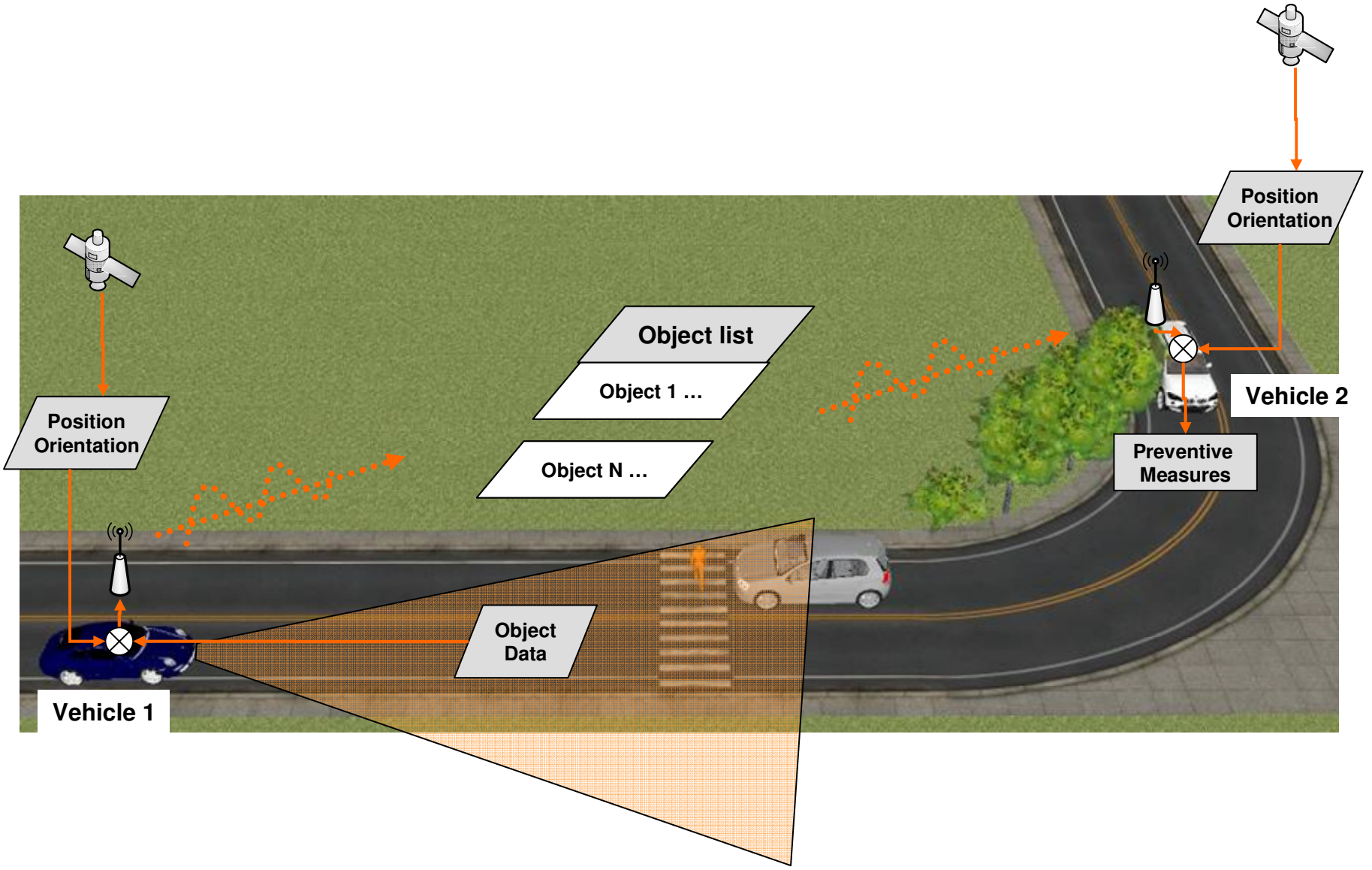
- Availability of precise relative position measurement in urban environment
- Communication link of C2C could be “physically” linked to position measurement (significant security advantage)

Possible realization

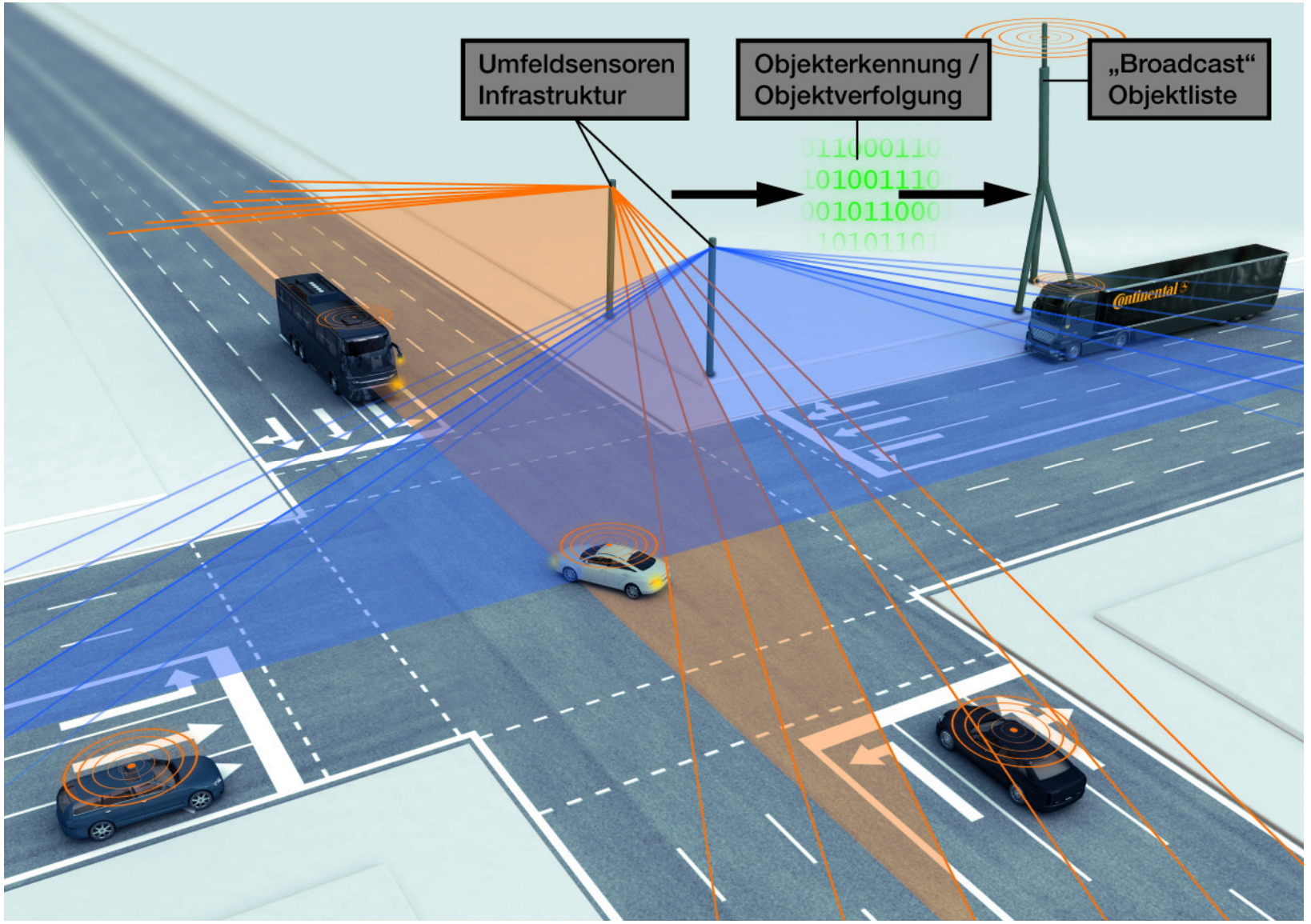
Integrated communication and localization unit

Source: Ko-TAG

Cooperative systems for preventive traffic safety
Interconnected sensors for cooperative perception

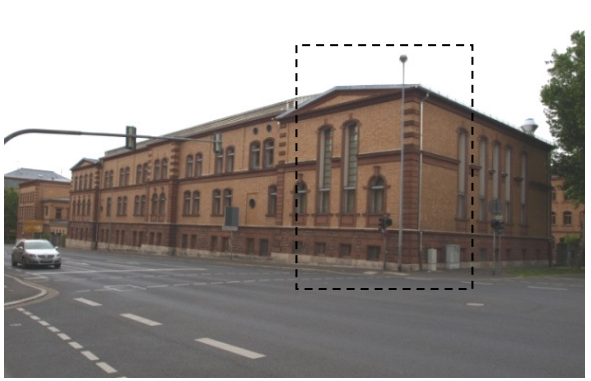


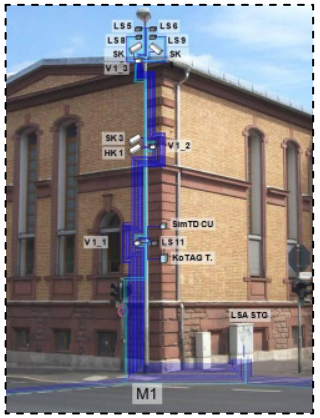
Cooperative systems for preventive traffic safety
Interconnected sensors for seamless observation of cross-roads



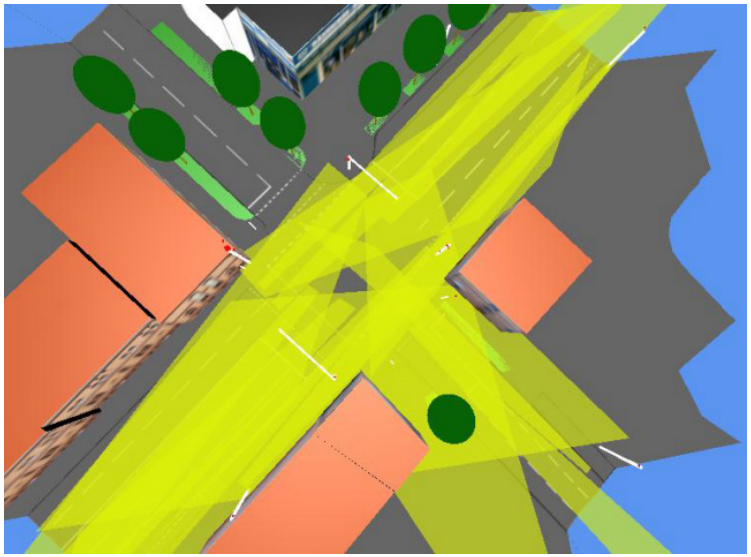
Cooperative systems for preventive traffic safety
Interconnected sensors for seamless observation of cross-roads

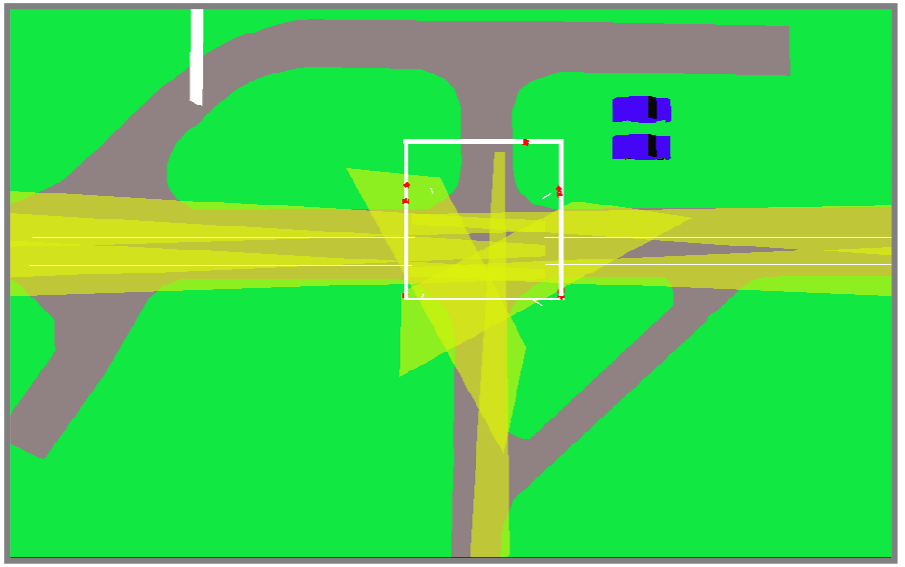
Public cross road:





Generic cross road:





Cooperative systems for preventive traffic safety
Unique features and perspectives

Unique Features:

- Clear classification of traffic partners
- Recognition and chronological tracking of hidden objects
- Big aperture angle (beyond 120 °): Cross-road sensor
- Physical replacement of security key required for C2C and C2X
- Precise localization in urban environment

Next steps:

- Proof of system performance at prototype stage
- Find possibilities for interweaving with related technologies (e.g.: C2C)
- Internationalization & standardization


Thank you for your attention !
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