PRE-DRIVE C2X
Preparing an European FOT on Car-2-X Communication

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PRE-DRIVE C2X objectives

• Establish a **pan European architecture framework for cooperative systems** ensuring interoperability of all different applications of vehicle to vehicle and to infrastructure communications for safety and mobility

• Perform **consistent a priori estimations** of the impact on traffic safety and mobility of cooperative systems for road safety and traffic efficiency

• **Pave the road for the forthcoming field operational tests** on cooperative systems

• **identify the key enabling and disabling factors** to plan the future market introduction of vehicular communication systems.
Requirements for a Pan-European FOT

- **Functional system related requirements**
  - Standardized system architecture
  - Validated and robust hardware prototypes

- **Test system related requirements**
  - *Methodology*
  - Selection of *use-cases*
  - *Test management system* and tools
  - *Pre-assessment* of use-cases and overall system
  - Selection of possible test sites
Methodology Outline FOTs

Planning
- Scenario Creation
- Scenario Validation

Execution
- Test Campaigns
- Log Data
- Analysis Results

Analysis
- Technical Analysis
- Non-Technical Analysis

Pre-assessment
Segmentation
Methodology Outline F0Ts

Use Case Descriptions

Test Campaigns

Test Management System

Test Bench

Planning

Test Campaigns

Execution

Analysis

Analysis Results

Scenario Creation

Scenario Validation

Test Execution

Test Validation

Integrated Simulation Tool Set

Pre-assessment

Segmentation

Technical Analysis

Non-Technical Analysis

Pre-assessment

Use Case Descriptions

Test Campaigns

Testing

Analysis

Analysis Results

Scenario Creation

Scenario Validation

Test Execution

Test Validation

Integrated Simulation Tool Set

Pre-assessment

Segmentation

Technical Analysis

Non-Technical Analysis
Use Case Selection Process

- Collection of potential use cases (57)
- Harmonized description and collection of initial requirements with template
- Two-step selection mechanism (ranking and balancing)
  - Survey of experts with weighted selection criteria
- 16 use cases have been selected for elaboration
- Validation of selection in 1st Stakeholder Workshop

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<thead>
<tr>
<th>No.</th>
<th>Selected Use Cases</th>
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<tr>
<td>1</td>
<td>SW Provisioning</td>
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Favorite Use Cases

What are your most favorite use cases?

Traffic Information and recommended itinerary
Enhanced Route Guidance and Navigation
Decentralized floating car data
Intersection management
Green-light optimal speed advisory
V2I traffic optimization
In-Vehicle Signage
Cooperative vehicle-highway automation system
Cooperative flexible lane allocation
Regulatory and Contextual Speed Limit
Cooperative adaptive cruise control
Adaptive drive train management
Limited Access Warning

Traffic Efficiency

0 2 4 6 8 10 12
Integrated Simulation Tool Set

- Create and apply an integrated tool set for communications networks, C2X applications and vehicular traffic including environmental issues.
- Pre-evaluation of selected use cases
- Input for test case specification according to simulation results

![Diagram of vehicles and communication]
Evaluation of Available Tools

• Long list of available simulation tools:
  • Communication: 13
  • Traffic: 9 within Project (+34 others)
  • Application: 4
  • Environment: 4
  • Driving Simulators: 5
  • „Coupling“: 6
"Coupled" Simulation Environment: VSimRTI

- VSimRTI for coupling and management of the simulation tools

- Traffic simulators utilized
  - VISSIM, SUMO

- Communication simulators
  - JiST/SWANS
  - OMNeT++
  - OPNET
  - ns-2

- Application simulation
  - VSimRTI_App
Example Use Case - Traffic Information and Recommended Itinerary (TIRI)

- Vehicles transmit information such as their current speed, position, and direction (CAM)

- Received information used for local in-vehicle estimations about current traffic situation in vicinity

- Routes to circumnavigate traffic congestions calculated locally
Simulation Scenario - TIRI

- Excerpt of the city of Cologne (Germany)

- Most vehicles drive on the main street Luxemburger Straße from the southwest to the northeast (green line)

- Vehicle flow of 2880 vehicles per hour
  - Overall simulation time: one hour
  - To create congestion, two traffic light systems are used
Initial Results - TIRI

Vehicle Benefit

V2X Penetration Rate

- Regular
- V2X Equipped
- Polynomisch (Regular)
- Polynomisch (V2X Equipped)
Overview Test Management System

- **ITS Vehicle Station**
- **ITS Central Station**
- **ITS Roadside Station**
  - **OBTU**
  - **CSTU**
  - **RSTU**

**Test Bench**
- **Virtual Data Injector**
- **Packet Sniffer / Spectrum Analyzer**
- **Distributed test components at partners’ sites**

**Symbols**
- **Test System**
- **Test System in Test Bench Environment only**
- **Operational System**
- **Test Data Flows**
- **Use Case related data flow**
- **Test Data Flows in Test Bench Environment only**

**Dates**
- **Project Start Date: 01.07.2008**
- **End Date: 30.06.2010**

**Website**
- [www.pre-drive-c2x.eu](http://www.pre-drive-c2x.eu)
Test Management Center

Test components at partners’ sites
- Various Test Data Analysis Tools

Test Management Center
- Test Data DB
- Test Monitoring
- Data Acquisition System
- Deployment-server
- Test Control System

ITS Station and Testing Unit
- Logging
- Use Case Logic

http://www.pre-drive-c2x.eu
Test Bench for HIL Testing

Test components at partners’ sites

Various Test Data Analysis Tools

Test Bench

Test Data DB

Test Monitoring

Data Acquisition System

Deployment-server

Test Control System

Virtual Data Provider

Virtual Data Player

Virtual Data Connector

ITS Station and Testing Unit

Logging

Use Case Logic

Vehicle data provider or LDM

Testing Unit

Test Bench

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Summary
Lessons from PRE-DRIVE C2X

• **Time is precious!** Therefore,
  • Careful preparation of controlled test campaigns
  • Sophisticated segmentation of logged data for naturalistic campaigns
  • In-depth lab and HIL testing of communication hardware

• Integrated simulation tool set for test preparation and pre-assessment

• Continuous test management system crucial for pan-European field operational testing on several test sites
Thank you

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