HARMONISED EUROPEAN SOLUTIONS FOR TESTING AUTOMATED ROAD TRANSPORT

THE HEADSTART approach
Virtual, 9 -10 September

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Applus IDIADA
Outline

• Safety assurance state-of-the-art
• The HEADSTART methodology
• The HEADSTART procedure
• Conclusions and next steps
Research projects that include CAV testing and safety assurance topics

- Cooperative driving at traffic intersections
- Grand Cooperative Driving Challenge
- Coordination of CAVs over 5G
- ADAS & me
- Verification and Validation
- SAFE-UP

Other projects:

- HoliSec
- MuCCA
- PROSPECT
- ESCAPE
- SetLevel4to5
- SAM

Program (SAFER)
Initiatives involving safety assurance

- CAD initiatives of interest for HEADSTART
- 22 relevant initiatives found
- Classification into several topics:
  - Manufacturers associations
    - Japan Automobile Manufacturers Association, Inc.
    - European Automobile Manufacturers Association
  - Public authorities
    - National Transport Commission
    - UNECE
  - KETs
    - 5GAA
    - CAR 2 CAR Communication Consortium
  - Consumer testing
    - Euro NCAP
  - Other relevant initiatives
    - Nouvelle France Industrielle (NFI)
The HEADSTART project

HEADSTART will define testing and validation procedures of CAD functions including:

- its key enabling technologies (i.e. communication, cyber-security, positioning)
- by cross-linking of all test instances such as simulation, proving ground and real world field tests
- to validate safety and security performance according to the needs of key user groups (technology developers, consumer testing and type approval)
HEADSTART Consortium

✓ 7 research centres
✓ 2 Technical services
✓ 3 Euro NCAP laboratories
✓ 4 OEMs
✓ 2 Tier-1s
✓ 3 coordinators of H2020 ART calls

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Technical Results up to M18

List of Deliverables M1 – M18

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<td>State of innovation of existing initiatives and gap analysis</td>
<td>IKA</td>
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<td>D1.2</td>
<td>Stakeholders and user group needs</td>
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<td>Technical and functional requirements for KETs</td>
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<td>Extension of the common methodology for the HEADSTART KETs</td>
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All finished deliverables available in www.headstart-project.eu
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HEADSTART Methodology approach

Where does the HEADSTART Methodology come from?

- State of the art analysis of international and national projects
- **Harmonization** of present and past projects
- Utilizing **common databases** to analyse data
- Testing of selected **relevant scenarios**

- **Inputs from:** PEGASUS, MOOVE, SAKURA, STREETWISE, ENABLE-S3 and many other projects…
  - Can be found in D1.1, D1.2, D1.3 and D1.4
  - [www.headstart-project.eu](http://www.headstart-project.eu)
**Overall Methodology**

### Input Data
- Source FOT
- Source Test drives
- Source xy
- Source Accident data

### Data Collection
- 2. Storage in database
- 3. Generation of complete scenario space

### Testing
- 4. Output generation & test concept
  - Usage testing ground
  - Usage XiL
  - Usage simulation

### Evaluation
- 5. Evaluation of the test

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**HEADSTART project SCOPE**

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Field Data
Aerial Data
Accident Data
Simulator Studies
Database + Mechanics

Input Data → Pre-Processing → Scenario Extraction → Post-Processing/Extraction of Parameters → Scenario DB

6-Layer Model

Field Data → Aerial Data → Accident Data → Simulator Studies

Injected Scenarios → Expert Knowledge → Completeness

Exposure → Logical Scenarios → Query

Parameter Distribution
Input Data
Pre-Processing
Scenario Extraction
Post-Processing / Extraction of Parameters
6-Layer Model
Scenario Database + Mechanics
Selection of Relevant Scenarios and Stochastic Variations
Allocation of Scenarios
Field Test
Virtual Simulation Testing
XIL based Testing
Proving Ground Testing
Use Case
Expert Knowledge
Completeness
Driving function
- ODD
- KETs involved
- Minimum Risk Maneuver
- Tactical maneuver behaviour
- Functional requirements
- Abstract scenario description
- Requirements for KETs
Use Case
Selection of Relevant Scenarios and Stochastic Variations
Allocation of Scenarios
Field Test
Virtual Simulation Testing
XIL based Testing
Proving Ground Testing
Existing Infrastructure
Expert Knowledge
Completeness
Driving function
- ODD
- KETs involved
- Minimum Risk Maneuver
- Tactical maneuver behaviour
- Functional requirements
- Abstract scenario description
- Requirements for KETs
Input Data Pre-Processing Scenario Extraction Post-Processing / Extraction of Parameter Scenario DB

Expert Knowledge

• ODD
• KETs involved
• Minimum Risk Maneuver
• Tactical maneuver behaviour

Completeness

Selection of Relevant Scenarios and Stochastic Variations

Driving function

Use Case

• Functional requirements
• Abstract scenario description
• Requirements for KETs

Concrete Scenario

Evaluation

Pass/Fail Criteria

Human Capabilities

Results

Allocation of Scenarios

Scenario Creation on KET Layer

Existing Infrastructure

Field Test

Virtual Simulation Testing

XIL based Testing

Proving Ground Testing

Selection of Relevant Scenarios and Stochastic Variations

Injected Scenarios

Parameter Distribution

Logical Scenarios

Query

Exposure

Database + Mechanics

Field Data

Aerial Data

Accident Data

Simulator Studies

6-Layer Model
Open Scenario – Open Drive

Digital information
e.g. V2X information on traffic signals, digital map data

Environmental conditions
e.g. Light situation, weather (rain, snow, fog)

Moving Objects (4a ➔ Ego ; 4b ➔ Others)
e.g. Vehicles, pedestrians, other moving objects

Temporal modifications and events
e.g. Road construction, traffic cones, fallen trees

Road furniture and Rules
e.g. Traffic signs, railguards, lane rules, bot dots

Road layer
e.g. Road geometry, road unevenness, lane logic

Layer 6

Layer 5

Layer 4

Layer 3

Layer 2

Layer 1
KETs within the methodology

• New information channels
  • V2X communication
  • Positioning dependent on other Layers

• Adding new parameters to be tested
  • Top-Level parameters to be arbitrary from the used hardware
  • Use V2X as “Sensor”

• Cyber-Security needs to be treated in a special way
  • Special treatment for in-depth analysis
KETs within the methodology
KETs within the methodology
Outline

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Process vs. Procedure

✓ **A process** is a set of interrelated or interacting activities which transforms inputs into outputs. It’s about **what to do**.

✓ **A procedure** is a specified way to carry out an activity or a process. It’s about **how to do it**.
High-Level Process

- Scenario Selection
- Scenario Allocation
- Testing Method Coordination
- Field Testing
- Virtual Testing
- XiL Testing
- Proving Ground Testing
- Cyber Security
- Evaluation
High-Level Process

Selected Example

✓ Scenario Selection

- Define a query
- Extract scenarios from database
- Include additional scenarios if ODD/functionalities are not sufficiently covered
- Assess relevance of parameters
- Make feasibility checks
High-Level Process

**Scenario Allocation**

- Define capabilities of the testing methods
- Compare capabilities of testing methods with requirements of scenarios
- Allocate scenarios to testing methods
- If additional requirements available
  - add them to available scenarios if possible
  - or create separate scenarios
High-Level Process

Selected Example

✓ Field Testing

- Define route
- Prepare testing strategy, equipment and infrastructure
- Conduct field tests
- Compare test data with KPI requirements
High-Level Process

✓ Cybersecurity

- Optional side branch
- Based on common criteria
- Linked to the scenario allocation phase for additional requirements that can be allocated to testing methods
High-Level Process

Selected Example

- **Evaluation**
  - Define key performance indicators (KPIs)
  - Define KPI verification
  - Compare test data with KPI requirements (for each testing method)
  - Combine test results for evaluation
Methodology and procedure in a nutshell
Outline

• The HEADSTART
• The HEADSTART methodology
• The HEADSTART procedures
• Conclusions and next steps
Conclusions

✓ The HEADSTART Methodology is a living process
   ▪ Need for expert input to refine the methodology is welcomed
   ▪ KETs have been considered in the whole process
   ▪ Keep the Methodology harmonized and applicable for different databases

✓ Harmonization necessary for current and future technologies
   ▪ Some KETS are naturally integrated (V2X + positioning)
   ▪ Some require specific paths (cybersecurity)
   ▪ Include other technologies in the process: e.g. human factors

✓ Standardisation efforts
   ▪ Cooperation on Open Scenario extension/enhancement is ongoing
   ▪ ODD description, scenario DBs queries still require standardisation
Cooperate with HEADSTART

EXPERT GROUP PARTICIPATION

• Join as associated partner and our expert group
• Join the discussion group of your interest:
  • Cyber-security
  • Communications (V2X)
  • Positioning
  • Scenario selection
  • Consumer testing (NCAP)
  • Type approval
• Provide needs and requirements and evaluate

JOINT TESTING ACTION

✓ Joint cooperation between both projects for testing validation and certification purposes
✓ Align your project with the harmonized methodology and tools developed within HEADSTART
✓ Become one of our use cases!

Please let us know about your interest and join our distribution list.
Website: www.headstart-project.eu
Contact: info@headstart-project.eu
Thank you for your kind attention.

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Colours

Primary colours

- R 0
  - G 158
  - B 255

- R 109
  - G 207
  - B 246

- R 199
  - G 234
  - B 251

Secondary colours

- R 0
  - G 105
  - B 145

- R 198
  - G 63
  - B 57

Occasion of presentation