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Automated Driving Applications and Technologies for Intelligent Vehicles

Álvaro Arrúe
Applus IDIADA

Technical Workshop

Athens, Greece
21-22 APRIL 2016

Certification and standardization needs tailored to the needs of automated driving

//Content

- **Standardisation and certification activities in FP7 Call 10 projects**
  - VRA
    - **Standardisation and certification activities**
    - **Concertation meeting**
  - Standardisation in C-ACC and platooning
    - **AutoNET2030 – COMPANION – iGAME**

- **Testing and validation: iGAME & PROSPECT projects**

- **Other standardisation & certification activities**

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//VRA in Short

VRA – Vehicle and Road Automation is a support action funded by the European Union to create a collaboration network of experts and stakeholders working on deployment of automated vehicles and its related infrastructure

This project is funded by the European Union

// Role of VRA as facilitator for collaboration between national and EU-funded activities
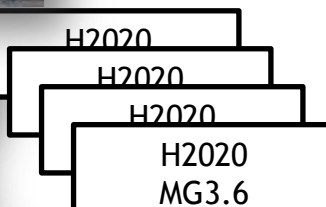
Mission
- Identify relevant activities
- Identify common partners
- Propose collaboration
  - What: topics, gaps
  - How: Level of collaboration
  - When: Timeline

//Objectives of VRA Support Action

Create an active European network of experts on Vehicle and Road Automation and foster cooperation within the Automation WG

Contribute to EU-US-JPN trilateral WG on road vehicle automation (EC – US DoT – MLIT)

Identify deployment needs for Vehicle and Road Automation

Deployment paths, Regulatory issues, Roadworthiness Testing, Connectivity, Human Factors, Digital Infrastructure, Evaluation of Benefits, Decision and Control Algorithms

VRA-net.eu/wiki

Promote the Research on Vehicle and Road Automation

//VRA: hot topics discussed in Sub-WGs of the iMF Automation WG

Deployment paths (VOLVO)
- Viable business models and deployment paths including socio-economic implications

Regulatory issues (ERTICO)
- Clarify current regulatory and liability issues among European countries

Road Worthiness Testing (IDIADA)
- Identify needs for standardisation, testing, compliance and certification

Connectivity (ICCS)
- Identify additional requirement on C-ITS

Digital infrastructure (HERE - ERTICO)
- Identify role of digital maps for automation

Human factors (DLR-TRL-LEEDS)
- Identify solutions for driver and other road user interactions

Evaluation of benefits (CTL)
- List potential direct and indirect benefits of automation

Controls and decisions (DLR)
- Identify gaps in current control and decision solutions

Reliability and CyberSecurity (→HTG6)
- Clarify reliability concerns and make recommendations

Deliverables available at VRA webpage: vra-net.eu

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//Standardisation and certification

- **Objectives**
  - Convene discussion group meetings to agree on the approach towards standardisation and certification
  - Lead and contribute to the European position on standardisation and certification of automation and automated vehicles in Europe
  - Contribute to the Tri-Lateral meetings US-EU-Japan
  - Promote cooperation between R&D projects through concertation
  - Issue a position or white paper on the topic at the end of the project
- **Outputs**
  - Topic list regarding standardisation and certification needs and main issues
  - Open and public deliverables on standardisation and certification
    - D3.3.1 and D3.3.2 published in VRA webpage: vra-net.eu
  - White paper on road automation (within the iMF AWG)

//VRA concertation meetings on standardisation and certification

- Organised annually
- Foster cooperation and harmonisation between FP7 call 10 projects
  - Experts from AdaptIVe, COMPANION, iGAME, AutoNET2030 and VRA
  - Invited guests i.e from DGs, GRRF and other EU projects on automation
  - Identify common topics that could support standardisation activities within SDOs
- First event June 2015
  - List of topics:
    - V2V Standardization (new messages set and interaction (com. protocol)) and Interoperability
    - ADAS/AD based systems
    - Standardization in terms of interaction, use cases, validation and evaluation methodologies
    - State of the art of Homologation → Feedback from UNECE ITS/AD informal group

//VRA concertation meetings on standardisation and certification

- First event June 2015
  - Conclusions:
    - EC big interest in connected automation and standardisation as a tool to foster European advantage
      - PROBLEM Long time for deployment → Roadmap for standardization
    - GRRF not comfortable with SAE levels → Focusing on functions
    - V2X message set & Comms: Ongoing cooperation and some different approaches
    - ADAS/AD: Several ISO activities to amend/create/extend existing standards
    - Need to define which topics should be addressed: Prioritize the topics, i.e. discard those that will be addressed by industry

- NEXT EVENT: Specific workshop in parallel to the iGAME project GCDC competition
  - Dates: 30-31 May 2016
  - Venue: Automotive Campus - Helmond

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// Standardisation in Europe – C-ACC & Platooning

- **ETSI TR 103 299 – C-ACC pre-standardization study**
  - Initiated by ETSI with support of C2C-CC.
  - International harmonization via collaboration with
    - SAE TC DSRC
    - ISO TC204 WG15
  - Scope: definition, use cases, requirements, recommendation on technical specification
  - Extend release 1 standards to support C-ACC: CAMs?

- Participant members from COMPANION, AutoNET2030 & iGAME

1	Start of work	Start of work			2014-10-16		
2	Early draft	Early draft			2015-06-19		
4	Stable draft	Stable draft			2016-06-17		
6	Final draft for approval	Final draft for approval			2017-02-01		
7	WG approval	WG approval			2017-02-01		
8	TB approval	TB approval			2017-02-01		
8 A	Draft receipt by ETSI Secretariat	Draft receipt by ETSI Secretariat			2017-02-15		
12	Publication	Publication	PU		2017-03-15		1.1.1

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- Definition:
  - An in-vehicle driving assistance system that adjusts the vehicle speed to keep a desired time gap with preceding vehicle (target vehicle) to improve driving comfort, reduce fuel consumption, improve road capacity, etc.
  - At least a level 1 automated system, and may participate to higher level automation
- Use Cases:
  - **Follow the target vehicle at configured target time gap**
  - **Follow the target vehicle at automatically adjusted target time gap**
  - **Single lane of C-ACC string with more than three C-ACC vehicles**
  - Co-operation of steering control and C-ACC

iGAME approach

- Message set extension for the iGAME scenarios →iCLCM consisting of 43 messages
    - Discussed with AutoNET2030
- These messages can be classified into the following categories:
    - State: including physical parameter, velocity and position of the vehicles.
    - Control: including parameters used for control purpose, i.e. measure the distance from one vehicle to an following object (safety distance)
    - Event-driven: including information about some events happen, such as road works or an emergency vehicle aproaching
- Due to very strict safety measures:
    - some messages are transmitted at a higher frequency of 25Hz.

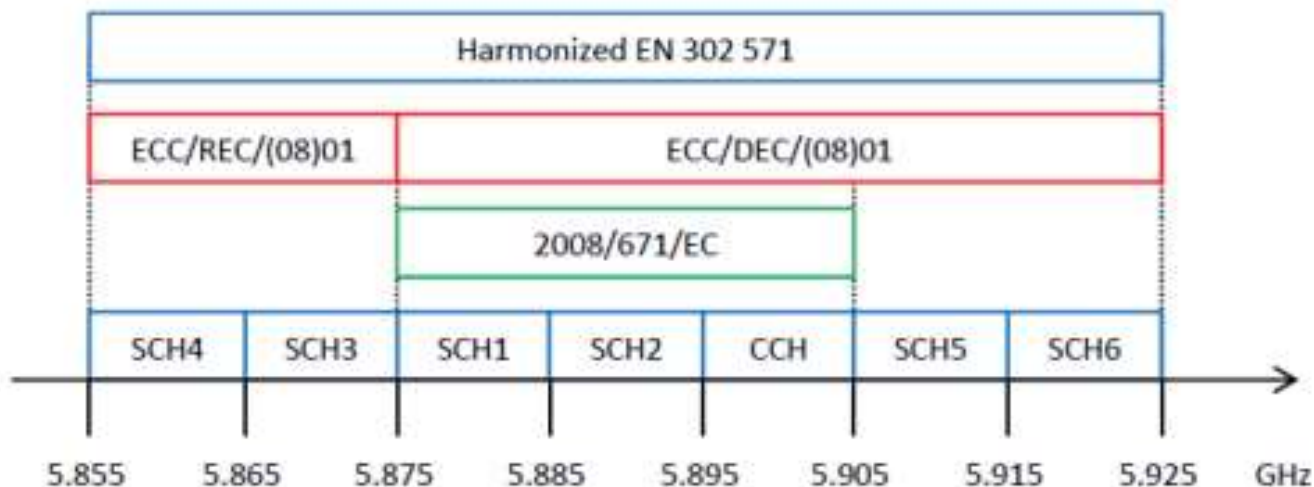|		
header	CAM/DENM/IGAME	-
GenerationDeltaTime	CAM	25Hz
Station ID	CAM/DENM/IGAME	25Hz
Station Type	CAM	25Hz
Vehicle Role	CAM	1Hz
Vehicle length	CAM	25Hz
Vehicle rear axle location	IGAME	25Hz
Vehicle width	CAM	1Hz
Controller type	IGAME	25Hz
Vehicle response time constant	IGAME	25Hz
Vehicle response time delay	IGAME	25Hz
referencePosition (latitude, longitude, confidence)	CAM	25Hz
Heading (Heading, confidence)	CAM	25Hz
Speed	CAM	25Hz
yawRate	CAM	25Hz
Longitudinal vehicle acceleration	CAM	25Hz
Desired longitudinal vehicle acceleration	IGAME	25Hz
MIO ID (measured by object vehicle)	IGAME	25Hz
MIO range (measured by object vehicle)	IGAME	25Hz
MIO bearing (measured by object vehicle)	IGAME	25Hz
MIO range rate (measured by object vehicle)	IGAME	25Hz
Time headway	IGAME	25Hz
Cruise speed	IGAME	25Hz
Merge request flag	IGAME	1Hz
Safe-to-merge (STOM) flag	IGAME	1Hz
Merging flag	IGAME	1Hz
ID of fwd pair partner	IGAME	1Hz
ID of bwd pair partner	IGAME	1Hz
Tail vehicle flag	IGAME	1Hz
Head vehicle flag	IGAME	1Hz
Platoon ID	IGAME	1Hz
Travelled distance inside the CZ	IGAME	25Hz
Intention (left, right, or straight)	IGAME	1Hz
Lane on which the vehicle enters the CZ	IGAME	1Hz
Intersection vehicle counter	IGAME	1Hz
Pair acknowledge flag	IGAME	1Hz
Reference Time	DENM (management container)	10 Hz
eventType (Roadworks, Stationary vehicle, Emergency vehicle approaching, Dangerous Situation (Emergency electronic brake light)	DENM (situation container)	10 Hz
closedLanes	DENM (alacarte container)	10Hz
lanePosition	DENM (alacarte container)	10Hz
Participants ready	IGAME	1 Hz
Start scenario	IGAME	1 Hz
EoS (End of Scenario)	IGAME	1Hz
Reserve/spare/future use	IGAME	-
Reserve/spare/future use	IGAME	-
Reserve/spare/future use	IGAME	-

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//Standardisation Worldwide

- SAE TC DSRC established "Cooperative Vehicle Task Force" for **C-ACC and platooning**
  - SAE J2945/6 – message sets for platooning and C-ACC
  - ISO TC204 WG14 - Vehicle/Roadway and Control Systems
    - PWI 20035 Intelligent Transport Systems – Cooperative Adaptive Cruise Control (C-ACC) – Performance Requirements and Test Procedures
      - Extends the already available "ISO 15622 Adaptive Cruise Control Systems"
      - Excerpt from scope: classification of the types of C-ACC, performance requirements, state transition diagrams, test procedures, etc.
      - C-ACC does **only longitudinal** vehicle speed control, uses time gap control strategy similar to ACC and has similar engagement criteria as ACC

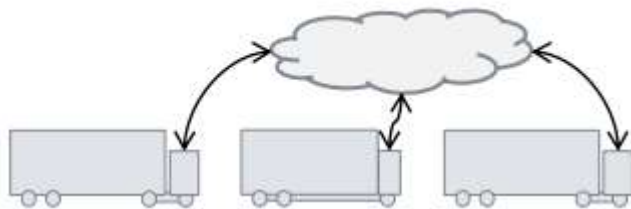# //Standardisation needs on C-ACC and Platooning (I)

- Common definition of platooning and C-ACC between SDOs
- New facilities layer protocol (or extension of existing ones)
  - Can current developed protocols for C-ITS (CAM and DENM) be used for platooning?
  - Can current message sets for C-ITS be used for platooning?
- Separate frequency channel for C-ACC and platooning (**SCH?**)

- Platoon control centralized or distributed?
  - How much control has the leader?
- Separate security solution for the platoon to reduce overhead
  - C-ITS security much overhead and introduce communication delays that can affect string stability
- How to arrange the platoon based on the truck specifications (brakes, load, height...)?
- How to prove that the system-of-systems is safe enough?
  - **Functional Safety - Extend ISO 26262**
- User acceptance and human machine interface (HMI)
- Legal framework (driver, safety distance) and liability (insurance)

Distributed control

Central control
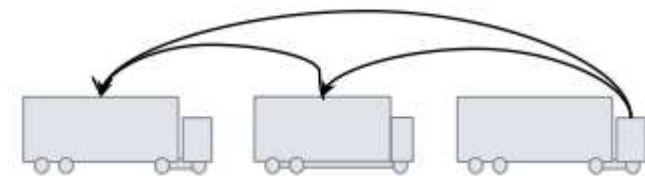
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// iGAME

Speed up real-life implementation and interoperability of wireless communication based automated driving accomplished by joint **development** and **demonstration**!

Development

- *Environmental perception, actuation and interaction*
- *Wireless communication*
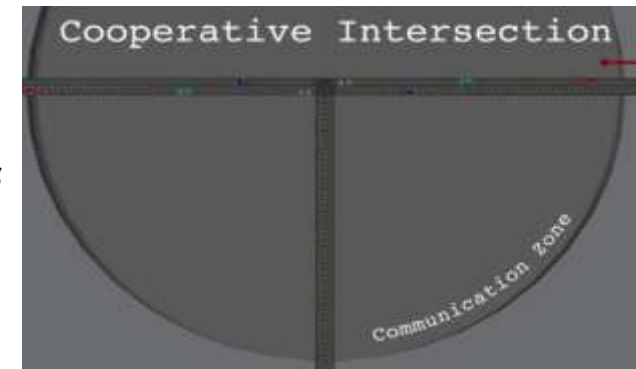- *Guaranteed safety*
- *Mixed-traffic operation*

**GCDC EVENT DATE
28-29 MAY – HELMOND (NDL)**

**Workshop on road automation
30-31 May**

**Demonstrating** it in a multi-vendor challenge: the 2nd **GCDC**

- *Accelerate multi-vendor solutions, based on an interoperable architecture*
- *Accelerate standardization, verification and validation tools & methods*
- *Enhance governmental & public awareness*

Cooperative Intersection

Communication zone

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Evaluation of safety and performance – IDIADA PG April 2016

- **Specific workshop on safety and performance: The aim is to determine minimum performance and safety of the vehicles in order**
  - We gave guidelines but we do not know the specifics of the implementation of each of the teams
  - Each team has a different approach → Safety assessment needs to be multibrand

- **Vehicle will be qualified as GCDC participant vehicle once ALL SAFETY stations are passed satisfactorily**

- **Performance tests were organised so that teams and organisation have a view of their current status**

Three stage approach for safety validation

- The team will need to pass these three stages:
  1. **Documentation:** The team must provide a technical description of the vehicle characteristics, team details and so on (Stations 1 and 2).
  2. **Inspection:** An inspection matrix with special relevance of the safety elements of the vehicle
  3. **Dynamic validation:** Proving ground tests to assess vehicle safety performance
     - Manual driving assessment
     - Override of the AD system
   - Longitudinal and lateral control
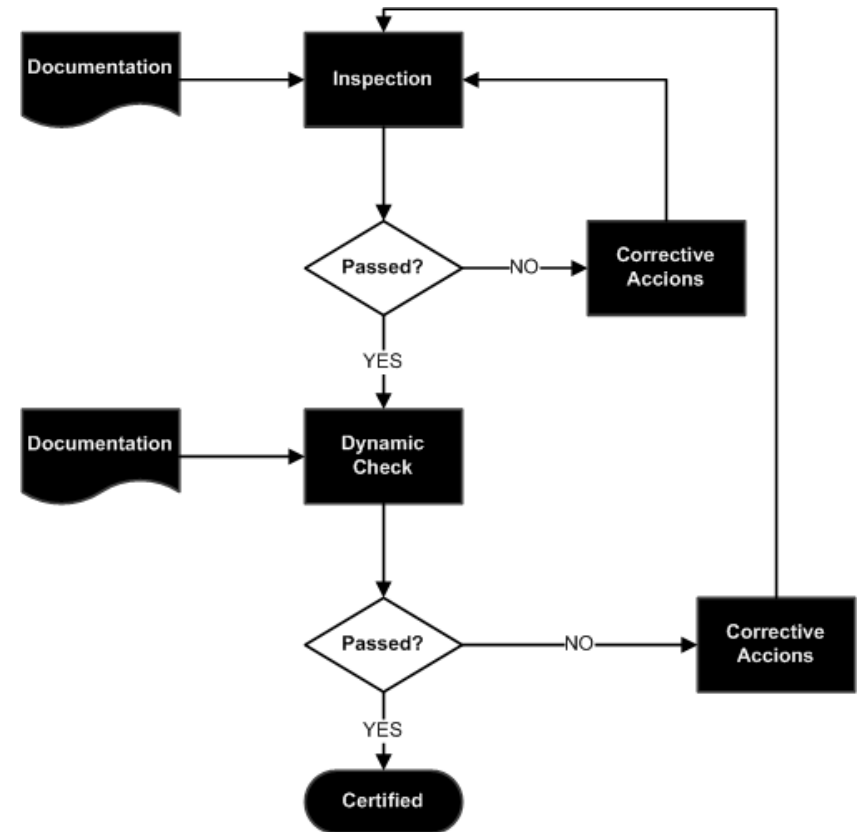
// iGAME

1. Override

- The AD mode must be disconnected if the driver acts on:
    – Steering wheel
    – Brakes
    – Accelerator
    – Emergency button
- The AD mode can only be reactivated manually

2. Longitudinal control

- Evaluate the ability of the vehicle to maintain the longitudinal control and to brake in an emergency.
- Target vehicle as defined in Euro NCAP AEB protocol
- VRU targets optional
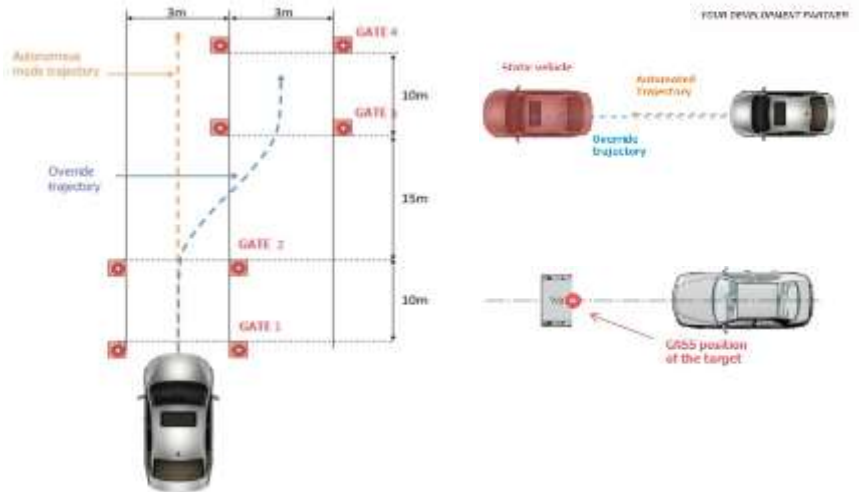
3. Lateral control

- Evaluate the vehicle capacity to stay in a lane
    – with visible road markings
    – And/or following the Benchmark Vehicle (depending of the technology used)
- The vehicle shall be able to stay in the defined lane under different test conditions.

> **Tests based in UNECE regulations, Euro NCAP protocols & Spanish license exemption procedure**

//PROSPECT

PROSPECT aims to significantly improve the effectiveness of active VRU safety systems compared to those currently on the market

- By better understanding and expanding relevant VRU scenarios

- Improving overall system performance

- Proposing new validation methodologies



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Validation

- Realistic traffic scenarios:
  - Instrumented vehicle fleet driving in urban roads
  - Real world scenarios to be reproduced in controlled environments.
- Test methodology and test procedures to be proposed to Euro NCAP:
  - Intervention performance tests considering evasive actions.
  - Unjustified system interventions.
- User acceptance tests:
  - Influence of false warnings and incorrect system interventions.
  - Predictive model of acceptance.

Ongoing data acquisition in Barcelona

Scene capture of video: Barcelona_44
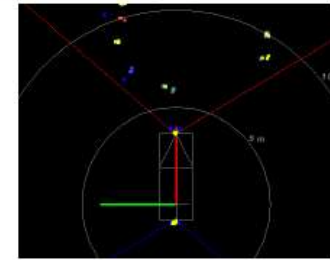
Map: Carrer de Pelai, 13, 08001 Barcelona
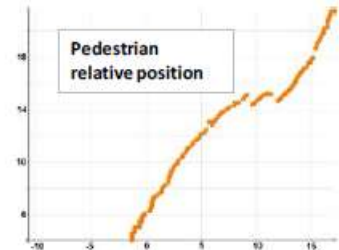
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Pedestrian relative position

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//Other standardisation activities
Standardisation and regulation

- Amsterdam declaration (last week)
  - Support from member states and industry on standardisation and regulation
- ISO working groups
  - ISO 26262
    - Extensions suggested by some projects (iGAME & COMPANION)
    - Extensions under work (cybersecurity, failsafe operation, etc...)
  - Other working groups on HMI, ergonomy, ADDR, etc..
  - ISO/TC 22 & ISO/TC 204 projects:
    - Divided highway assist systems (DHAS) - Functional/ operational requirements and test procedures"
    - Partially Automated Lane Change Systems (PALS) - Functional/operational requirements and test procedures
    - Traffic Jam Assist Systems (TJAS)
- UNECE WP.29 ITS/AD working group progress on regulation
- Other non-SDO actors: Openautodrive forum (ADASIS, TISA, NDS, Sensoris, etc...)

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Co-funded by
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**Automated Driving Applications and
Technologies for Intelligent Vehicles**

Thank you.

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