This project is co-funded by the European Union under the Horizon 2020 (H2020) Research and Innovation Programme (grant agreement No 769115)

ENSEMBLE

ENabling SafE Multi-Brand Platooning for Europe

Overview of the project, Marika Hoedemaeker

Overview

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- Introduction to ENSEMBLE
- Specifications & communication protocol
- Technical implementation
- Impact on infrastructure
- ENSEMBLE inputs to standardization

Why multi-brand platooning?

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PATH | CHAUFFEUR I/II | Energy ITS | GCDC | GCDC 2

Cooperative Driving | Communication | Platooning Optimization / Coordination | Standardization

1990 | 2000 | 2010 | 2016 | 2022

OTTO | KONVOI | SARTRE | Companion | European Truck Platooning Challenge | ENSEMBLE

Adapted from [An Overview on Approaches for Coordination of Platoon]

ENSEMBLE: Facts & Figures

Coordinator: TNO

- **The European truck manufacturers:**
  DAF, DAIMLER Truck, IVECO, MAN, SCANIA, VOLVO Group (Volvo trucks and Renault trucks)
- **The European suppliers**
  CLEPA
- **Suppliers:**
  Bosch, Brembo, Continental, NXP, ZF

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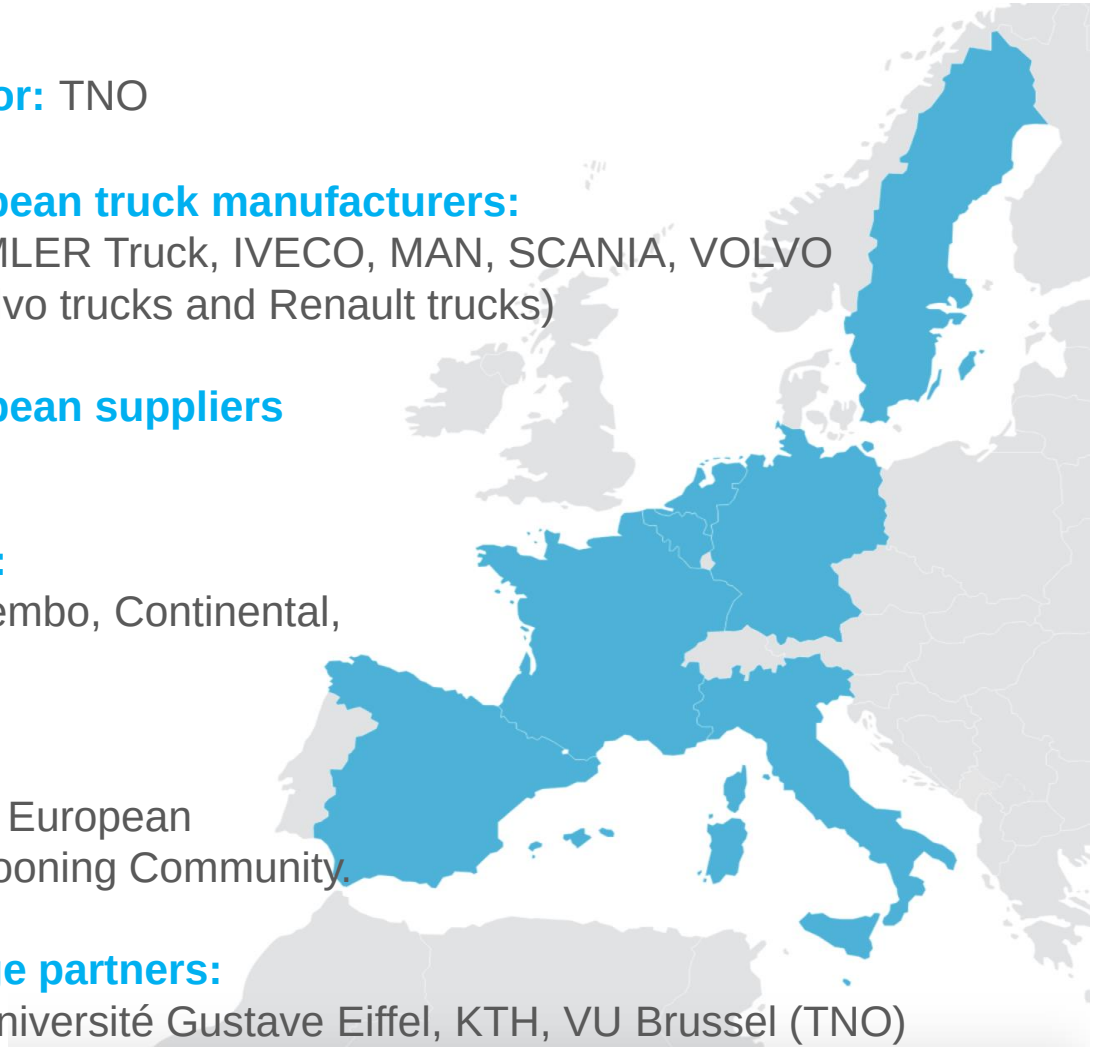
- **ERTICO:**
  Link to the European Truck Platooning Community.
- **Knowledge partners:**
  IDIADA, Université Gustave Eiffel, KTH, VU Brussel (TNO)



- Innovation Action no. 769115
- 4 year EU project (June 2018 – March 2022)
- 20 million EUR EC funding
- 19 partners representing the full value chain of the automotive sector

Objectives of the project

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Truck platooning =

The linking of two or more trucks in convoy, using connectivity technology and automated driving support systems (ACEA)

Pave the way for the adoption of multi-brand truck platooning in Europe

- ✓ Standardization of multi-brand specifications
- ✓ Implementing platooning in differently branded trucks
- ✓ Demonstrating under real world traffic conditions
- ✓ Assessing impacts

Success!

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Support VS Autonomous function

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Platooning as Support Function (PSF)	Platooning as Autonomous Function (PAF)
Lead truck driver responsible for driving task	Lead truck driver responsible for driving task
Following truck driver responsible for driving task	Following truck driver NOT responsible
Longitudinal support	Both longitudinal and lateral control
Time gap ~ 1,5 s	Time gap ~ 0,3 to 1.2 s
Quick deployment on road	Limited ODD
HOW the function should work	What the function should DO
Improved safety and traffic flow	Improved driver productivity. Improved fuel efficiency

Specifications, communication protocol

Platooning Layers

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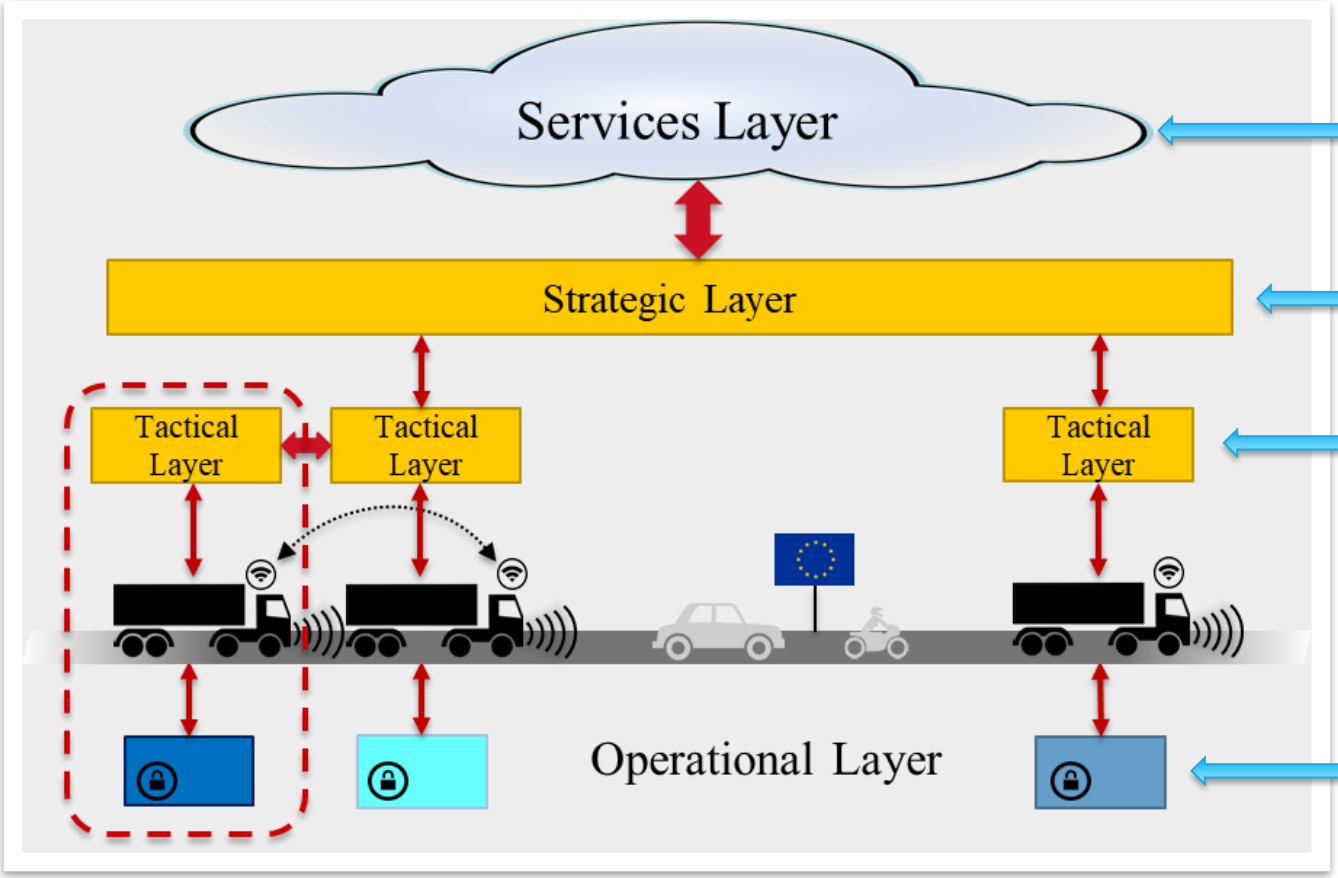
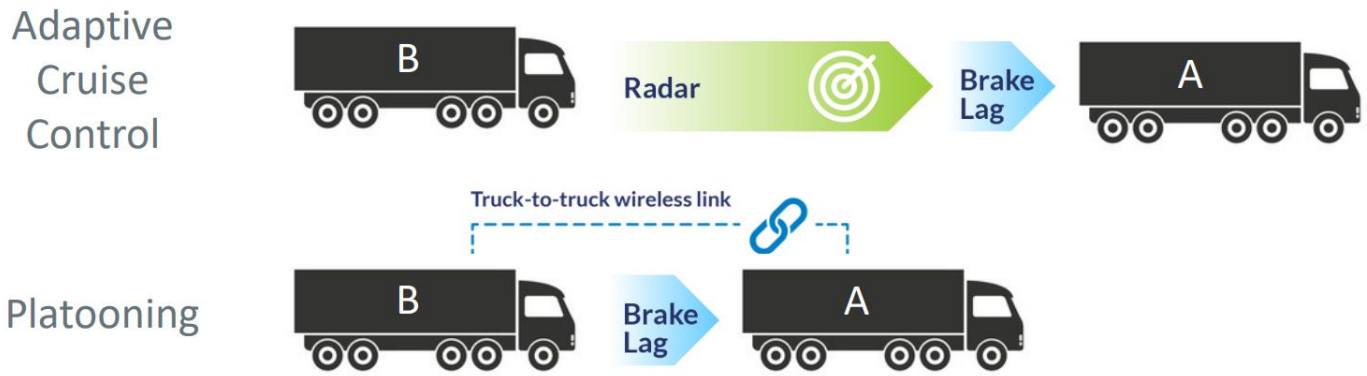
- Basis concept of ENSEMBLE
- Common to both platooning levels
- Ensures multi-brand platooning



Platooning Support Function (PSF)

- **Starting point is ACC (to comply with regulations)**
- **ENSEMBLE added the V2X communication part:**
  - Earlier notification of emergency braking, due to V2V communication being faster than an onboard sensor (e.g. radar)
  - Platoon coordination: cohesion control, limited speed differences, better shockwave damping (‘string stability’), roadside information (I2V)
  - Technology for communication is ITS-G5 but the protocol is technology neutral



Adapted from Peloton-tech.com

PSF platooning phases and communication

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(1) Engaging to platoon:

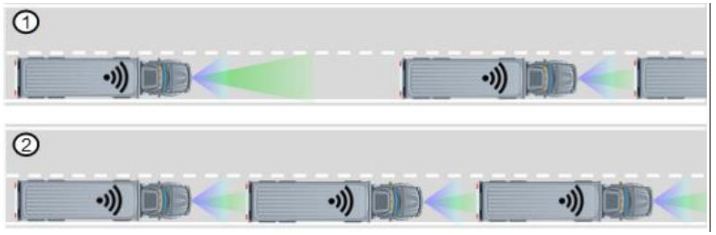
- Join from behind:
  - Join as a single vehicle
  - Join as a platoon
- Merge in-between as a single vehicle also possible
- Here V2V communication is established, including *cyber-security features*
- Use of ETSI CAM message.
- Use of new PlatoonManagement messages (PMM)

(2) Platooning:

- Specific situations considered
  - Follow to stop
  - Emergency Braking
  - Gap adaptation
  - Cut-In
  - Cohesion Request
  - Warning for system issue
- Use of new PlatoonControl messages (PCM)

(3) Disengage Platoon:

- Leave can be done by:
  - Activating a button
  - Pressing the brake pedal
  - Steering out from the platoon
  - Other issues (e.g. connection lost)
- Split of the platoon is also considered
  - Final condition with 2 smaller platoons
- Continued use of PCM messages



ENSEMBLE Security

Protocol security aspects:

- Message signing. Common in ETSI messages.
  - Message authentication: Message is not changed and coming from a trusted vehicle.
- Message encryption. New in platooning.
  - Asymmetric encryption: Used when joining a platoon.
  - Symmetric encryption: Used when being in a platoon.

Asymmetric encryption	Symmetric encryption
No shared key required	Fast
Slow	Shared key required

Platooning Autonomous Function (PAF)

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- Responsibilities:
  - First truck driver:
    - Safety of own vehicle
    - Bringing the platoon to destination (mission)
    - Respecting traffic rules for entire platoon
  - Following trucks system:
    - Safety of the ego vehicle =

    Obstacle detection, collision avoidance

- ODD = Hub to Hub
  - Split of the platoon needs to be avoided (e.g. by intelligent traffic lights)
  - If needed: following trucks will stop themselves in a safe way

Reducing the time-gap in a safe way (PAF)

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- Time Gap between 0,3s and 1,2s

- Brake performance estimation!
  - Brake status (temperature/wear/brake force)
  - Tyres (type/wear/pressure)
  - Load (axle loads, weight)
  - Road surface type

Predict and adapt

Technical Implementation

Implementation of PSF

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1. Reference implementation
   - Tested and verified HIL simulator

2. OEM specific implementations
   – Equipping the trucks
   – Mono-brand testing

3. Dual/triple/quadruple-brand testing

4. Multi-brand testing

Dual / Triple / Quadruple testing

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9-12 March 2020	AstaZero, Sweden	Volvo group, Scania, MAN
14-16 September, 2020	Helmond, Netherlands	DAF, Daimler, ZF/Wabco
23-25 March, 2021	Aldenhoven, Germany	DAF, IVECO, MAN (comm. only)
14 – 18 June, 2021	AstaZero, Sweden	Scania, Volvo group
21-25 June, 2021	Papenburg, Germany	DAF, Daimler, IVECO, MAN
20 – 22 July, 2021	Helmond, Netherlands	DAF, Daimler
16 – 20 August, 2021	AstaZero, Sweden	Scania, Volvo group
23 – 27 August, 2021	Jeversen, Germany	Daimler, IVECO
06-23 September 2021	IDIADA, Spain	DAF, Daimler, IVECO, MAN, Scania, Volvo Group

done in COVID times!

Impact on infrastructure (roads, bridges, tunnels)

Infrastructure impact of platooning

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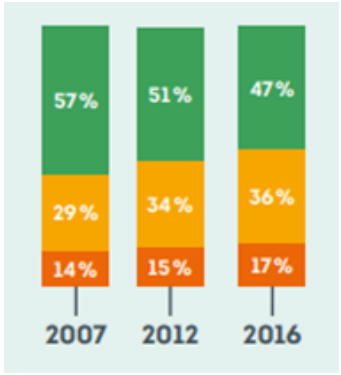
- A main proportion of the roads is (heavily) damaged (*example France)*

  22 years: Average time between first damage signs and repair
- Truck platooning influences the wear of roads and bridges



- *Benefit:* road authorities can influence the parameters of platoons on their roads depending on the status of the pavement (speed, following distance, number of trucks).

- Tunnels:
  - Increase efficiency by increasing number of trucks in tunnel: decrease long time gap between trucks in a safe manner

Inputs to standardization

ENSEMBLE contribution to standardization

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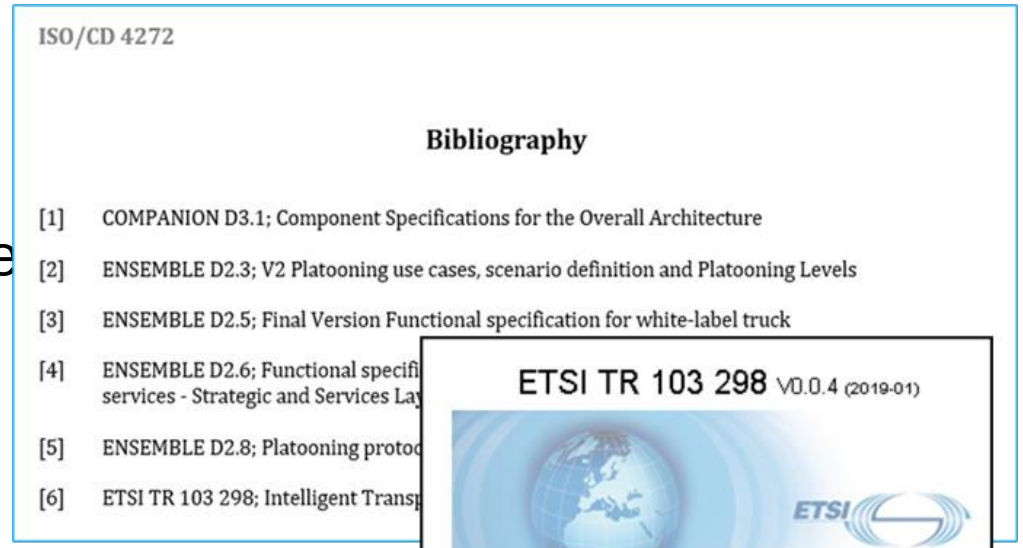
- **ENSEMBLE** has developed a platooning communication protocol fitting the already existing ecosystem of ITS protocols supporting day one applications

- ENSEMBLE has contributed to ISO/CD 4272 "Intelligent transport systems — Truck platooning systems (TPS) Functional and operational requirements“

- ENSEMBLE contributed to ETSI TR 103 298 ”Intelligent Transport Systems (ITS); Platooning; Pre-standardization study”

- The **platooning protocol** developed in ETSI will support both the platooning support function and the platooning autonomous function


ISO/CD 4272

Bibliography

[1] COMPANION D3.1; Component Specifications for the Overall Architecture

[2] ENSEMBLE D2.3; V2 Platooning use cases, scenario definition and Platooning Levels

[3] ENSEMBLE D2.5; Final Version Functional specification for white-label truck

[4] ENSEMBLE D2.6; Functional specifi
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[5] ENSEMBLE D2.8; Platooning protoc

[6] ETSI TR 103 298; Intelligent Transp

More results in final event

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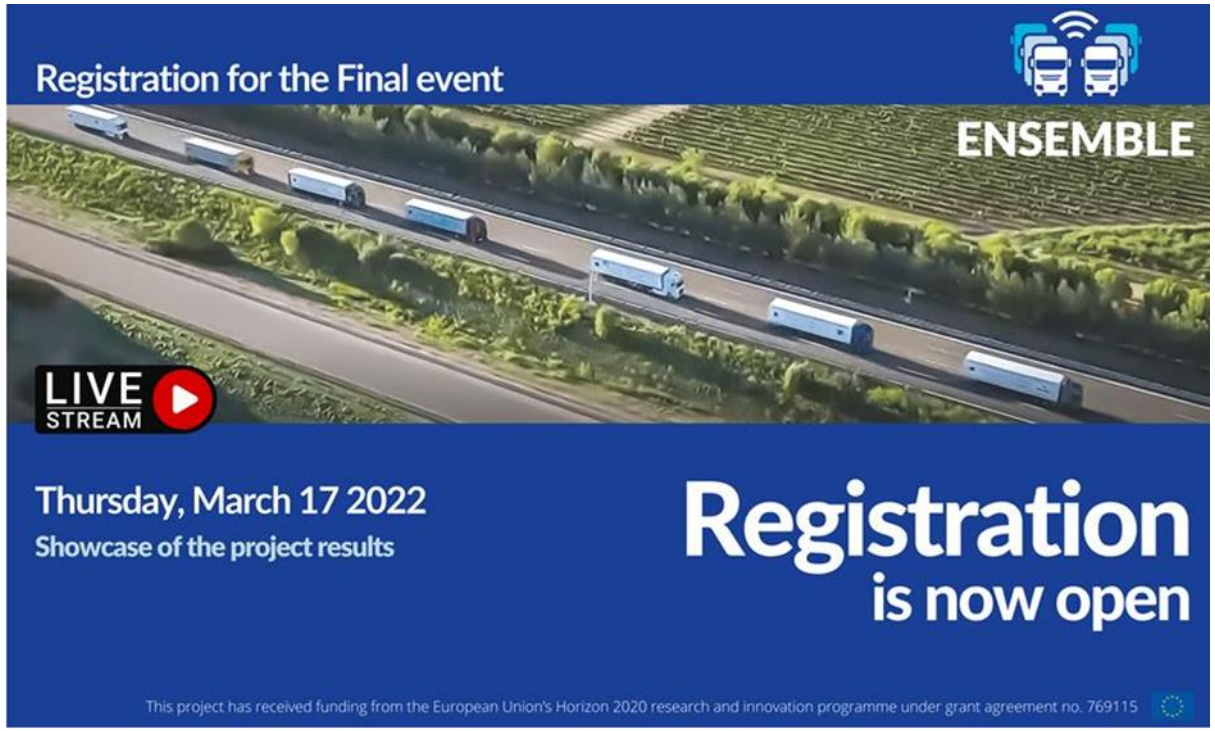

ENSEMBLE FINAL EVENT PROGRAM		
10:00	**Start**	**Carin ten Hage**
		Opening session
10:05		**Joost Vantomme**, CEO ERTICO and former ACEA
10h15		**Lydia Peeters,** Flemish (Belgium) minister of mobility
10:30		**Georgios Sarros,** Project officer, European Commission, CINEA
	Introduction to ENSEMBLE	
10:45	Overview of the project	**Marika Hoedemaeker,** TNO, project coordinator
11:05	Results from real life testing	**Dehlia Willemsen**, TNO
11:25	ENSEMBLE Movie	
	The Impact of multi-brand platooning	
11:35	On other road users	**Christoph Jallais,** Université Gustave Eiffel
11:55	On fuel consumption	**Robin Vermeulen,** TNO
12:15	On traffic flow	**Kinjal Bhattacharyya,** Université Gustave Eiffel
12:35	*Break*	
	The future of multi-brand platooning	
13:15	Platoon occurrence & matching	**Ernst-Jan van Ark,** TNO
13:35	Economic Business case	**Francois Combes,** Université Gustave Eiffel
14:00	Future regulations	**Carlos Lujan**, IDIADA
	Panel discussion	
14:20	CEDR (**Steve Philips**) ACEA (**Katrin Sjoberg**) IRU (.....)	CCAM (**Serge van Dam**) ENSEMBLE (**Marika Hoedemaeker**)
15:00	Signing of MoU	**Frank Daems**
15:30		**END**

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Thank you for your attention

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platooningensemble.eu

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