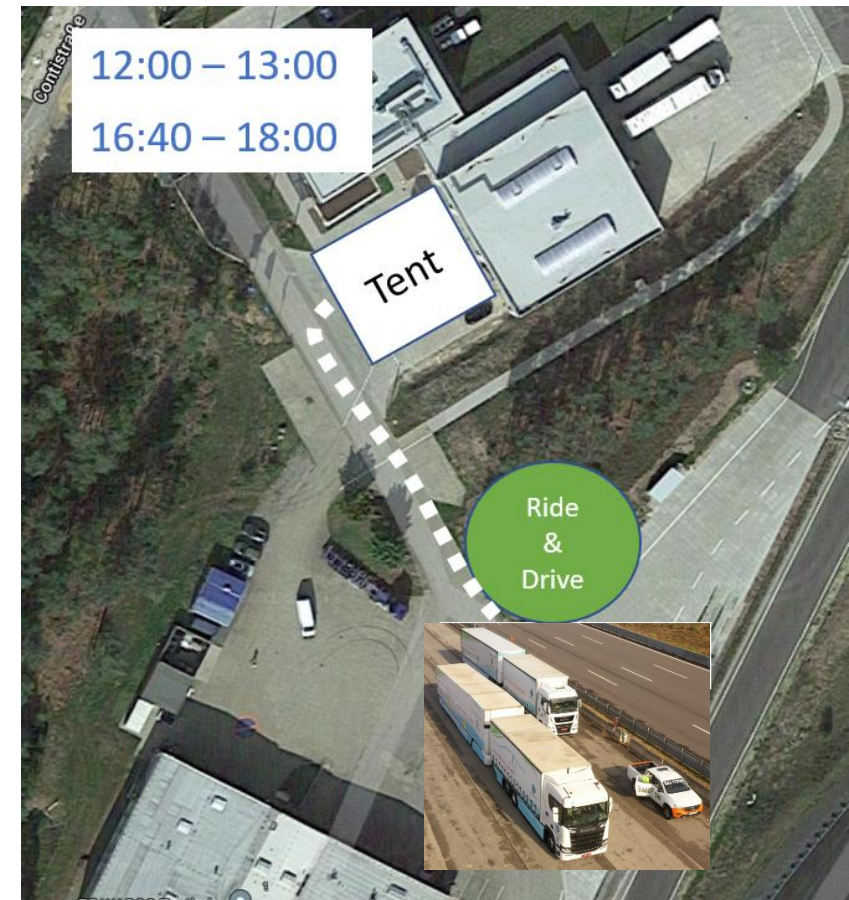


Final event



Instructions Ride & Drive 12:00-13:00hf and 16:40-18:00hr

- 🚛 Instructions Ride & Drive 12:00-13:00hr and 16:45-17:30hr
- 🚛 Look at your voucher!





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Distributed Powertrain Demonstrator Vehicle

Also referred to as AEMPT (Advanced Energy Management Powertrain) in the project

Components

Communication: Automotive Ethernet, new Protocol Energy/Torque Management; no new connectors

eTrailer: Schmitz-Cargobull from EU-Project "Transformers"



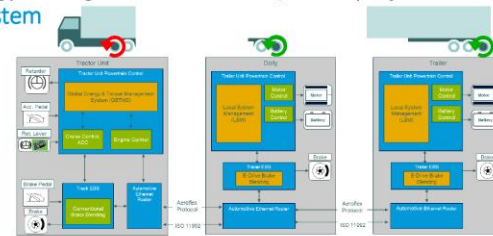
MAN 6x2 TGX580; Energy and Torque Management; Full integration of e-drives into the truck control system.

Hydraulically Steered Dolly front axle

eDolly: Axle: ZF AVE130, 250kW; Battery: AKASOL 75kWh

eTrailer: Axle: Bosch 80kW; Battery: Bosch 22kWh

System



Core Functions

Function	Request	Actuation
Endurance Brake Blending Endurance brake requests are directed from the truck to the e-drives.	 OR  OR 	  
Service Brake Blending Service Brake requests in Dolly/Trailer are directed to the e-drive. Dolly blending of both axles.	 OR 	 
Load Point Shifting The e-drives push the combustion engine of the truck into a more efficient operating point.	 OR 	 

Test Program

- The Demonstrator was run 5000km on a Spanish Highway and the IDIADA test track. No technical problem interrupted the measurement program
- A fuel saving of 4,7% could be measured on the specific route
 - If prototype restrictions were eliminated savings could be increased to 10,1%
 - Operating the vehicle as plug-in-hybrid did further increase fuel saving up to 13,5% (measured)



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Poster e-dolly



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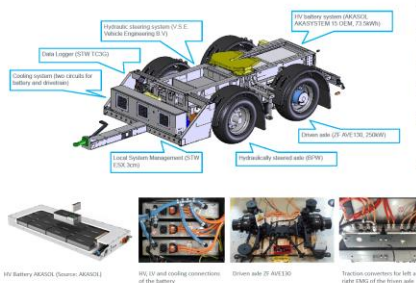
General objective

- Develop an electrically driven and steerable dolly
- Support the Advanced Energy Management and Powertrain framework for operation in EMS1/EMS2 vehicle combinations
- Enable automated operation of dolly without towing unit for shunting on yards

Technical Concept

- Electric drivetrain
- driven rear axle, 250kW
- lithium-ion high voltage battery, 75kWh
- liquid cooling system
- Local System Management for control of drivetrain components and manual operation mode
- Steerable front axle
- Remote control for manual operation

Smart Power Dolly



Advantages & Opportunities EMS1/EMS2 vehicle combinations

- Optimize performance of distributed powertrain in hybrid vehicle configurations
- Save fuel by maximizing recuperation of brake energy
- Increase traction and performance
- Extend overall vehicle range
- Automated yard operation
- Reduce time for coupling
- Reduce tractors needed for shunting of semitrailers
- Quick cost / benefit regarding handling, safety and planning



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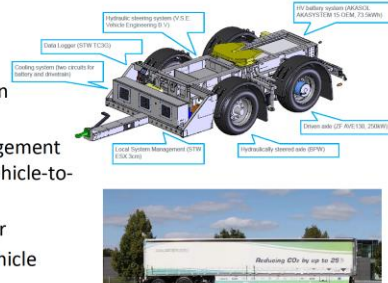
Challenge

- Need to reduce contribution of transport sector to CO2 emissions
- Need to reduce running costs of trucks (vehicle kilometers, energy & emissions, number of drivers)
- Need to reduce costs of pre & post related processes

Solution: Smart Power Dolly

- Electric drivetrain as part of a drivetrain distributed among vehicle units
- Integrated in the holistic energy management system of a complete vehicle due to vehicle-to-vehicle communication system
- Compatible with any kind of semitrailer
- Additional drivetrain extend overall vehicle range
- Capability to drive remote controlled without towing vehicle

Smart Power Dolly



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Advantages & Opportunities

- Compared to a conventional dolly the e-dolly
- Enables flexible and adaptable EMS1 & EMS2 vehicle combinations
- Enables long vehicles driven with standard trucks/tractors with conventional/down-sized engines.
- Enables the use of battery electric driven trucks in EMS1 & EMS2 vehicle combinations.

Unique Value Proposition

- Can be used to split longer vehicles into independent self-driving units
- Safe handling of longer vehicles
- Reduce time for coupling
- Reduce tractors & drivers needed for shunting of semitrailers
- Later the e-dolly will drive autonomous, shunting trailers in a terminal hub.





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AeroLoad EMS1 demonstrator

Innovations and their drag reduction potential
(DCd in counts)

Adaptable box and trailer shape (40 cts)

Adjustable air deflector (10-30 cts)

Gap reducer (7 cts)

Boat-tail (35 cts)



Underbody panel (5 cts)

Rear side skirt
extension(4 cts)

Dolly side
skirts (12 cts)

Rear wheel tails (5 cts)

Truck side skirt
extensions (25 cts)

Active ride height (3-10 cts)

Trailer active side skirt
extensions(15 cts)

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Windtunnel animation





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Using Automotive Ethernet as backbone technology for future electrified and autonomous Truck Trailer Applications

Objectives

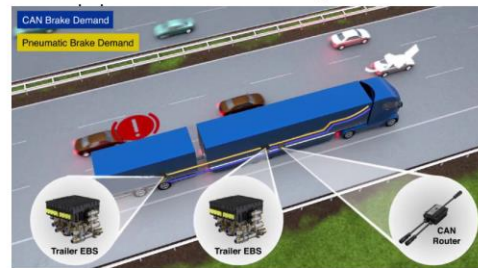
- Within AeroFlex the development of **new interface solutions for a safe communication between truck and trailers** with high bandwidth and flexibility for Advanced Energy Power-Train (AEMPT) and Aerodynamic control functions were requested.

Challenges

- The selected communication technology has to be **fast, flexible, reliable and extendable**
- The **control and monitoring of generic electric engines architectures** shall be possible
- No additional plugs** shall be installed but **reuse of existing ISO plugs and cables** is preferred.
- Legacy Support** for classic truck trailer combinations shall be given, no adapters wanted

State of the Art

- Since 1998 the **ISO 11992 CAN** based protocol family is commonly used in Europe. It **combines trucks and a maximum of up to 5 Trailers to build road trains**.
- ISO-CAN is over the years exploited and not promising to fulfill future application requirements where fast and time sensitive communication with high bandwidths are



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Using Automotive Ethernet as backbone technology for future electrified and autonomous Truck Trailer Applications

Approach

- Usage of **Automotive Ethernet technology (100 Mbit/s, OA BroadR Reach)** on existing ISO CAN plugs and cables
- Prototype is based on existing serial ISO CAN Router Repeater + AE module
- To support legacy CAN based vehicles, an **automated detection procedure** is implemented to **switch to Automotive Ethernet only when both vehicles supports this technology**.
- New communication protocol draft** for control and monitoring of electrified engines

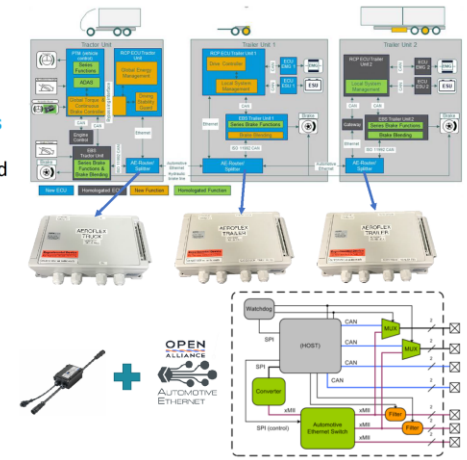
Results

- Stable communication** with cable lengths < 20m (15m specified)
- Auto switching between CAN and Automotive Ethernet mode successful.
- Automotive Ethernet on ISO Cables does not fulfill EMC Requirements (Source: VDA FAT project)

Next steps

- Creation of **international standardisation proposal** (SAE/ISO) for Automotive Ethernet communication using 1Gbit/s on 40m (shielded twisted pair cables on additional connector) with suitable protocol.

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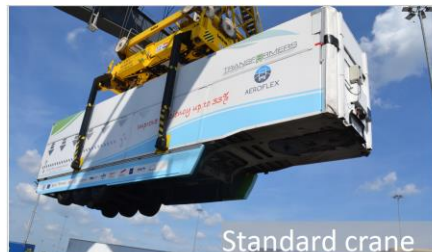
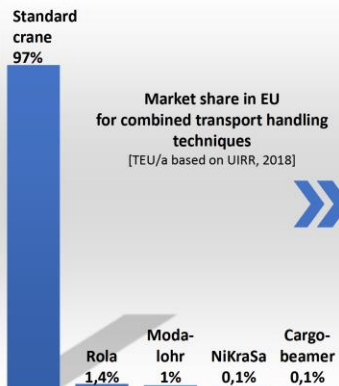
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Multimodal flexibility - Aeroflex VanEck trailer successfully tested

CFL Bettembourg – Le Boulou 2021



More details in Eiband et. al. (2020) "Aeroflex deliverable 4.2"

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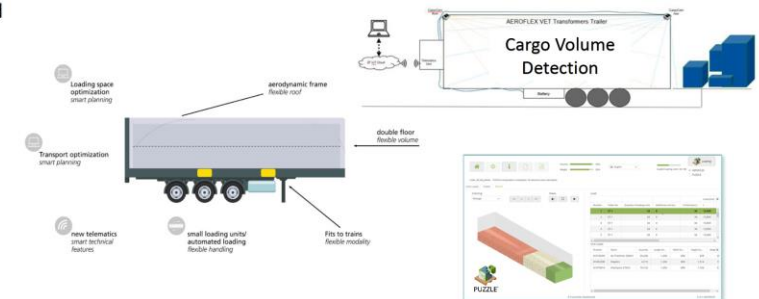
Smart Loading Units

Results

- Craneable Aeroflex VanEck trailer
- Fraunhofer IML Puzzle software for load optimization
- ZF Cargo Volume Detection 360 (*2) monitoring camera system
- Concepts to prove/realize real customer Use cases regarding load factor and fill speed

Benefits

- Multimodal** aero-trailer for rail/road transport
- Performed concepts will prove the benefit of real-time monitor and optimize all loaded goods as enabler for future automatic (un)/loading



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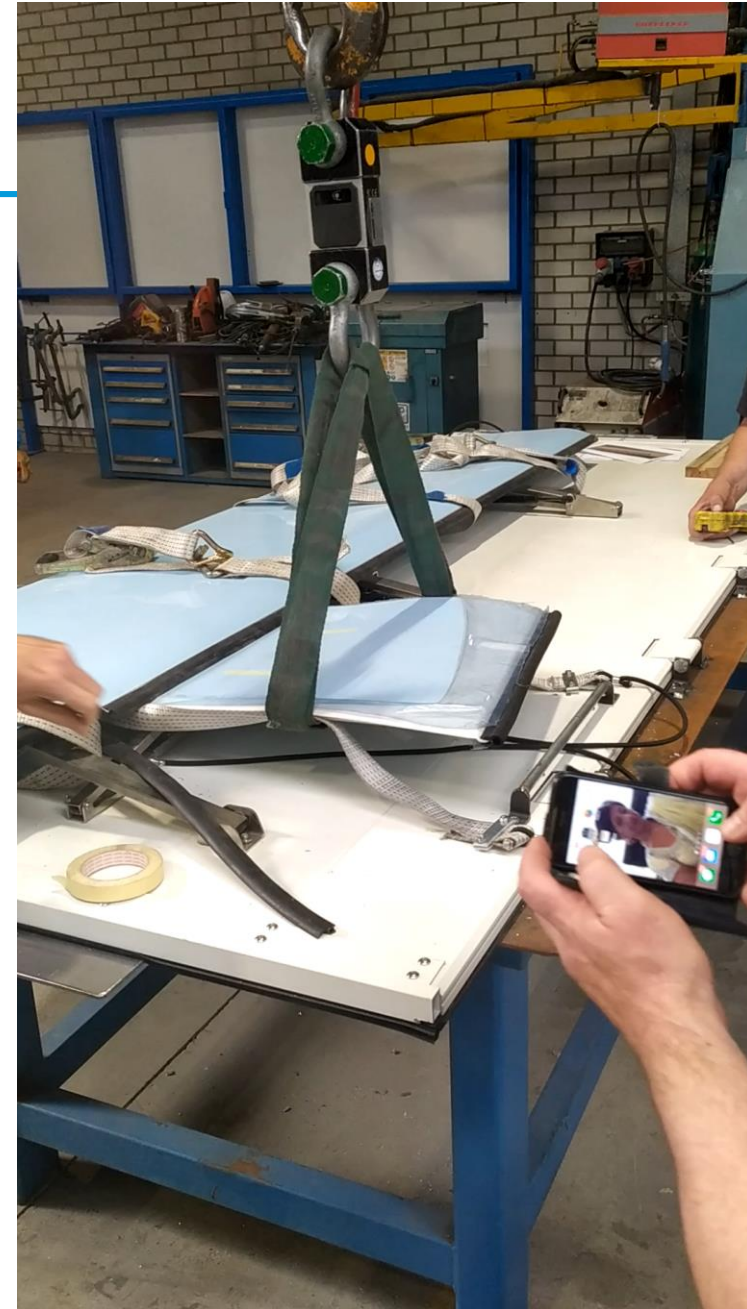


Film test of flaps



Slide 9

AEROFLEX – FINAL EVENT



28.09.2021

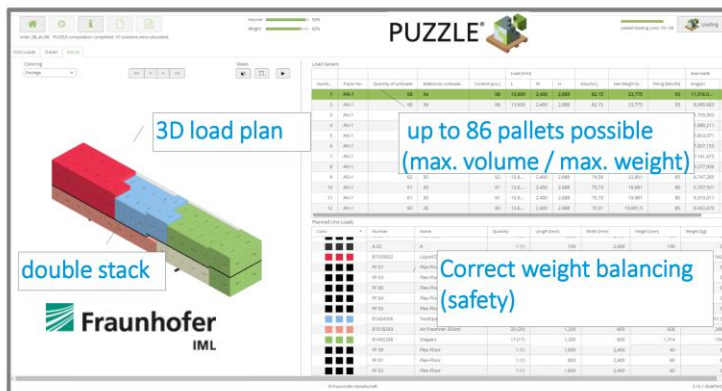


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Double stack trailer loading >>> optimisation with adapted PUZZLE® software



Test result 2020

P&G use-case:

38% higher filling rate
+
Fast and easy planning

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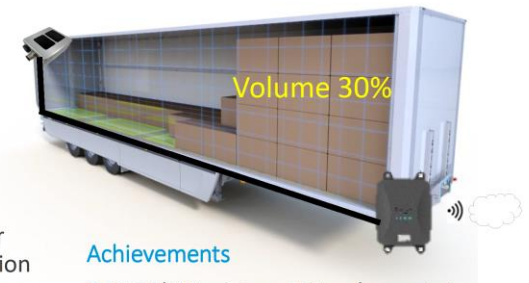
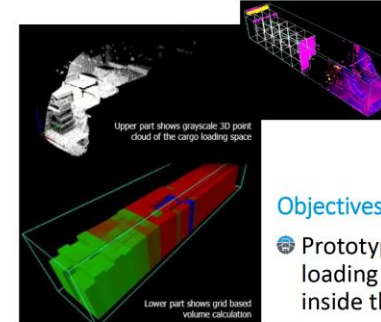


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Cargo Volume Detection



Objectives

- Prototype sensor solution for loading space volume detection inside the trailer
- 3D sensor technology, computer vision-based algorithms and software
- Improve load optimization, efficiency and indirectly vehicle aerodynamics

Achievements

- Grid/Object based free/occupied volume detection
- Grayscale image & 3D point cloud data provisioning
- Sensor setup installed in AEROFLEX VanEck trailer

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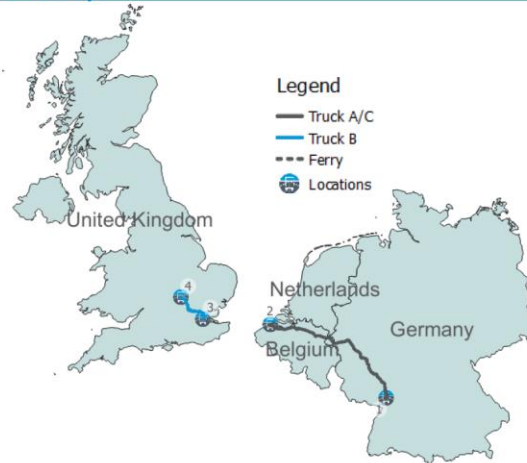
Customer use case – Germany – England – Germany intermodal

Use case:

Germany – England - Germany

- **automotive** parts from Germersheim (GER) to Milton Keynes (UK) by a Dutch logistics company.

Route-Map



The use case describes a typical **roundtrip delivery** from Germersheim to Milton Keynes

- **full truckload on outward journey**



- **full truckload or empty collection and delivery on return journey**



Prime candidates Current combination

1.3

TR4x2-ST3 (13.6m)



Possible future combinations

6.1

TR6x4-ST3-DV2-ST3 (2x45ft)



6.2

TR6x4-ST3-F12+3 (2x45ft)

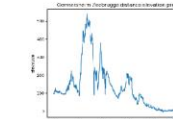


Prerequisites -

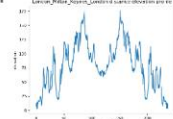
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Route profiles

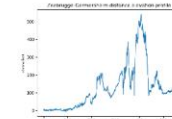
Truck A:
Germersheim- Zeebrugge



Truck B:
London – Milton Keynes – London



Truck C:
Zeebrugge – Germersheim



Freight

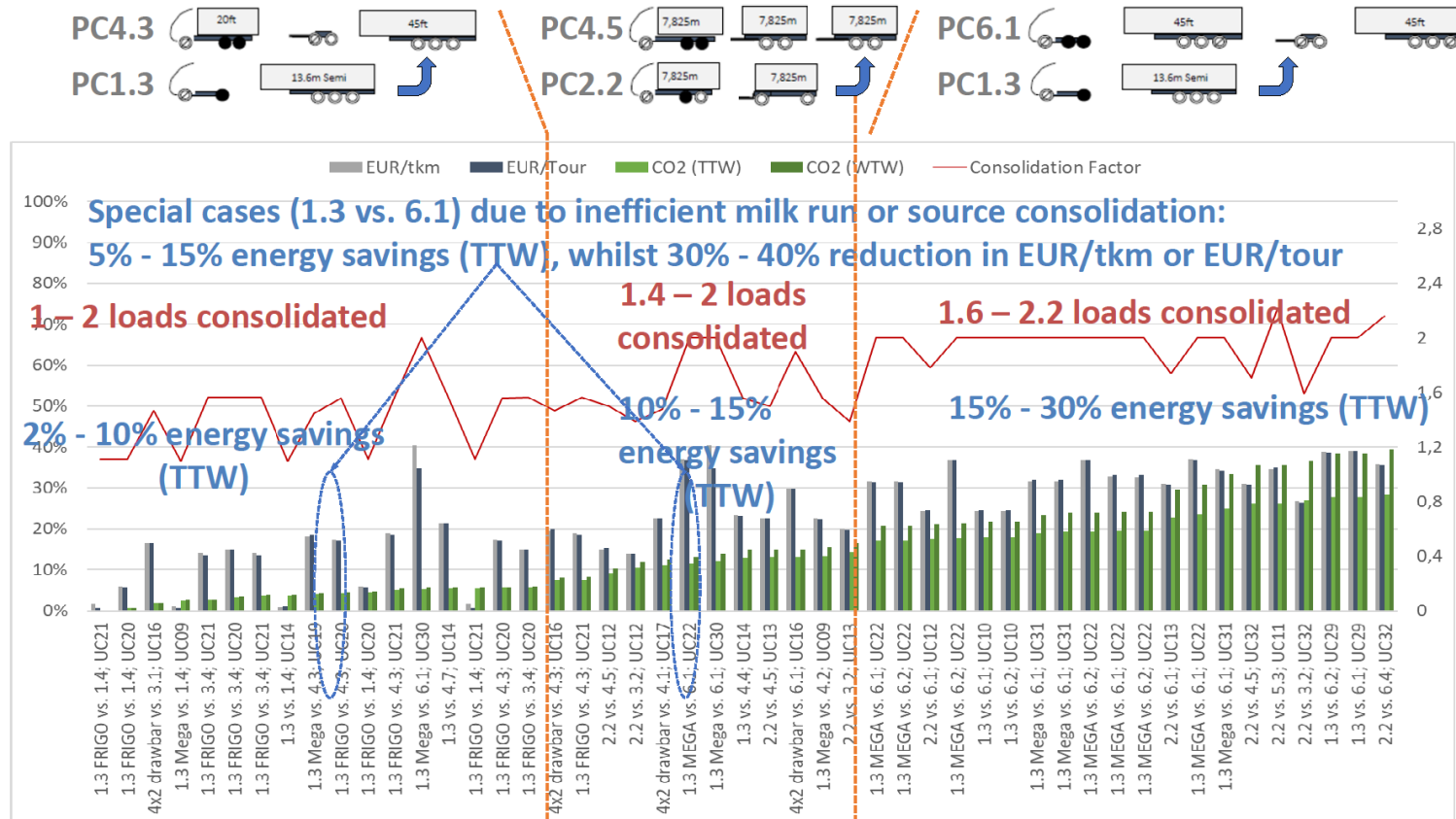
Product	Amount	loading unit	Weight [tonne]	Height [m]	length [m]	Width [m]	Load location	Unload location	Load time	Unload time
Automotive parts		Gitterbox	20.00			13	Germersheim (GER)	Milton Keynes (UK)	00:30	00:30
Automotive parts		Gitterbox	15.00			13	Milton Keynes (UK)	Germersheim (GER)	00:30	00:30

Routes

From	To	Ton	km	Travel time	Mod.	Trailer type	Truck/driver
Germersheim (GER)	Zeebrugge (BEL)		20	544	Truck	Megatautliner A	
Zeebrugge (BEL)	London (UK)		20		Ferry	Megatautliner -	
London (UK)	Milton Keynes (UK)		20	118	Truck	Megatautliner B	
Milton Keynes (UK)	London (UK)		15	118	Truck	Megatautliner B	
London (UK)	Zeebrugge (BEL)		15		Ferry	Megatautliner -	
Zeebrugge (BEL)	Germersheim (GER)		15	544	Truck	Megatautliner C	



Results of use cases



source of data: expert interviews

Impact – emission savings potentials up to 30% (TTW) due to load consolidation of up to 2.2 for use cases (see table above)

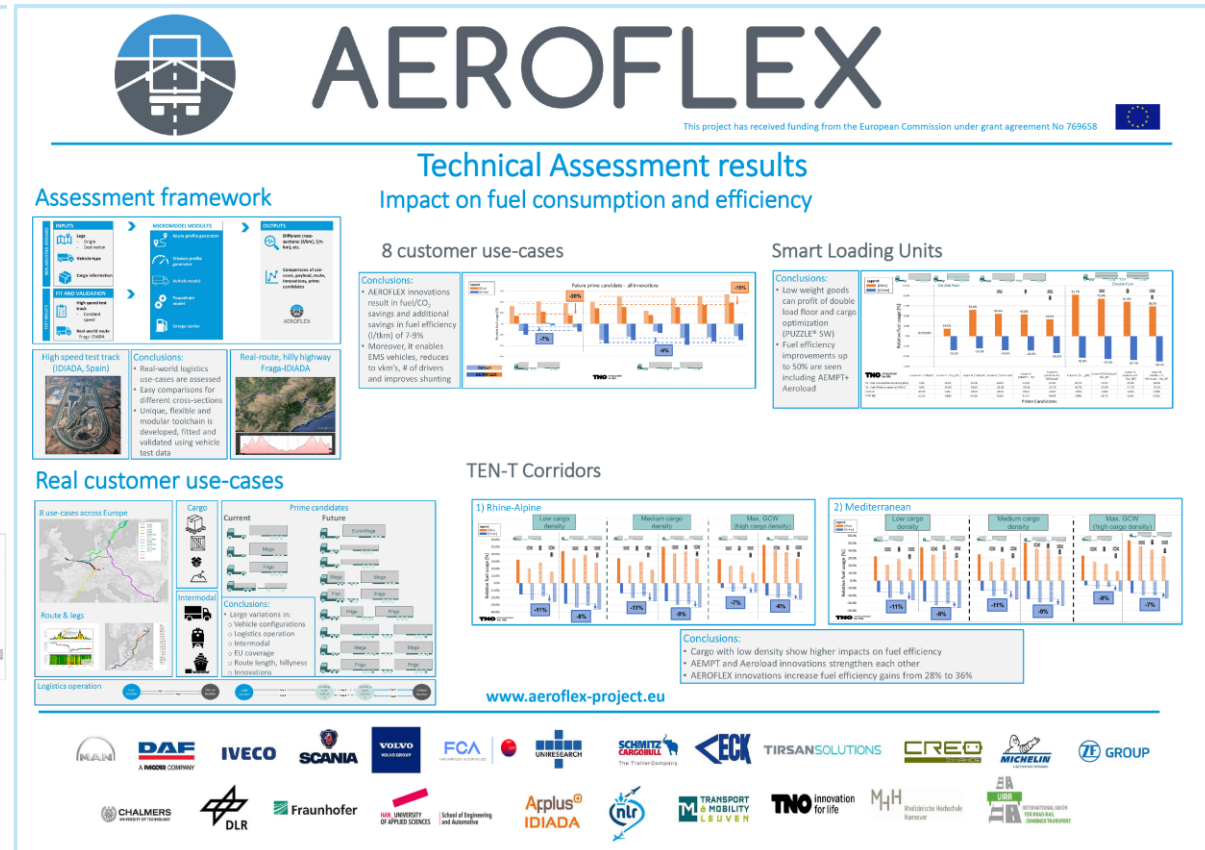
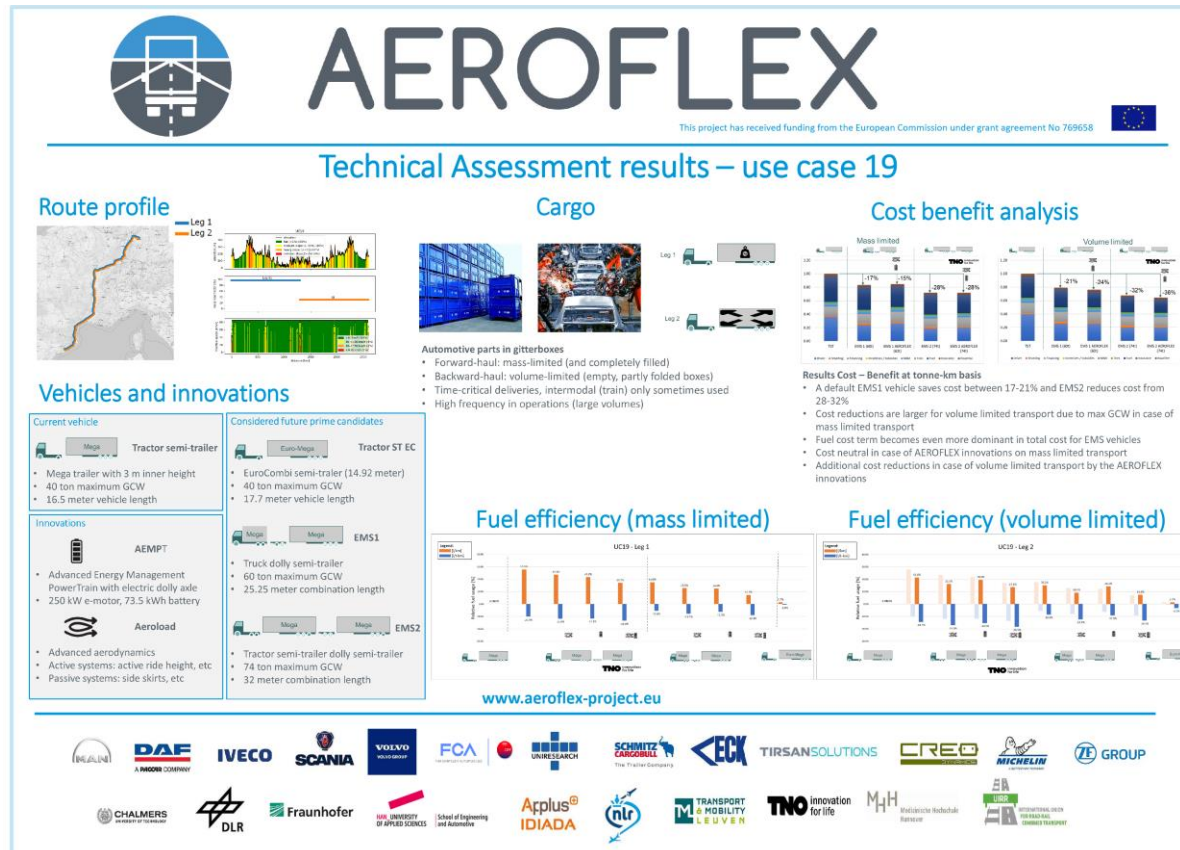
Average savings potentials by EMS with maximum load (€/tkm, cost/tour or CO2e WTW) show high efficiency achievements related to all use cases (see table right)

- 53 % of the interviewees vote for the following Prime Candidates (see table below)
- EMS 2 is the most preferred prime candidate (11.7 % of interviewees)

No.	Prime Candidate	Share of
6.1		11.7 %
2.1		9.7 %
3.1		9.7 %
1.4		9.3 %
2.2		6.6 %
4.7		6,2 %
1.3		10.1 %

KPI	€/tkm	Cost/tour	CO2e WTW
standard average load	18.7% (10.9)	19.0% (11.2)	20.0% (11.2)
maximum load; average savings for all use cases	-28.2% (16.4)	-28.1% (16.5)	-18.0% (16.5)

source of data: expert interviews





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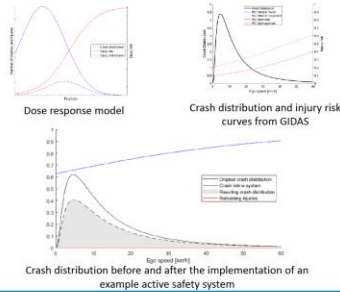
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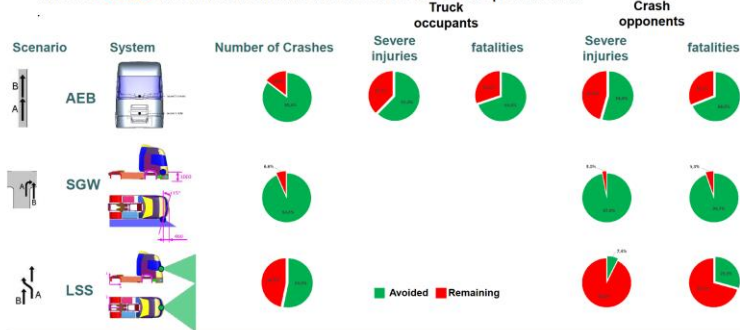
Predicted Benefits for Future Safety Systems

Method

- Dose response model used to combine crash distribution and injury risk to create the injury distribution
- Implementation of Active Safety Systems shifts the crash distribution curve
- Results are scaled from GIDAS to a European level through the weighting factor method



These **results** are based on the data scaled to a European level



Limitations

Simplifications were used for the estimates of



Small sample sizes from datasource and simulations



Combination of effects of AS and PS improvements presents a significant hurdle at this point



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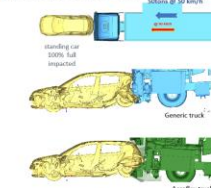
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Protection of car occupants

- Most relevant accident scenario involving truck and passenger cars is shown below. Specific crash absorber designed to preserve the car

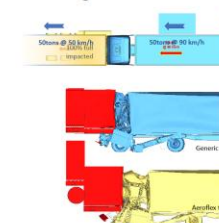


- Fuel tank and luggage compartments well preserved: intrusion on fuel tank compartment -50%

Passive safety

Protection of truck occupants

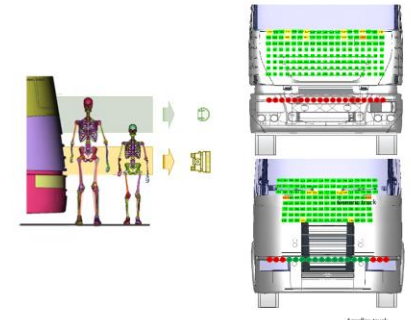
- Most relevant accident scenario involving trucks and commercial vehicles highlights huge amount of crash energy cannot be effectively absorbed, despite frontend elongation.



- Reduction of the survival space up to 500mm: too high to avoid serious injuries.

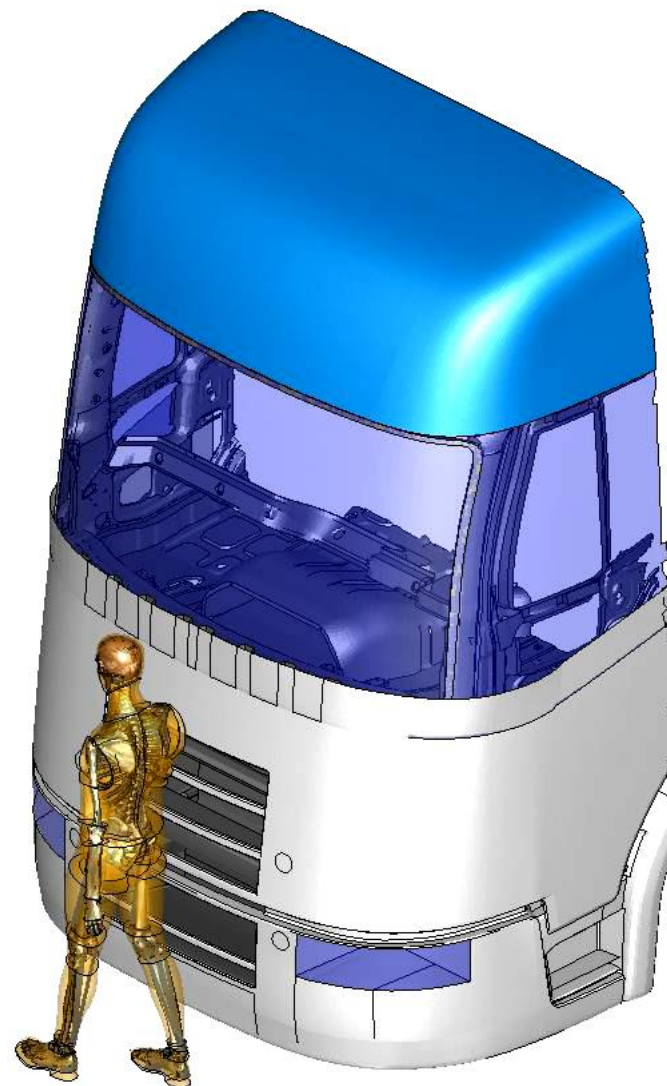
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Pedestrian protection



- Soft materials and specific design solution adopted in the Aeroflex project provided positive results. More space available due to frontend elongation allowed also a better performance at the pelvis level.







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Safety Issues for Safety System Development

Background

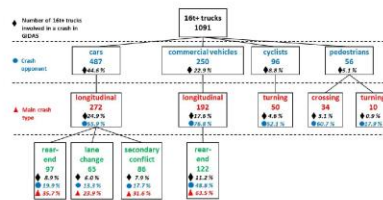
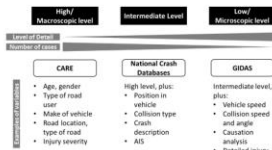
- In 2015, more than 1 million crashes happened on European roads out of which 24,000 resulted in fatalities.
- Heavy goods vehicles (HGV) were involved in 4.5% of all crashes and 14.2% of fatal crashes, indicating an over-representation of HGV involvement in fatal crashes.
- The basis for the design of active and passive safety systems is identification of target scenarios and an understanding of the influencing factors.

Method

- Identifying relevant crash scenarios comprises a three-level analysis of:
 - Community Database on Accidents on the Roads in Europe (CARE)
 - National crash databases from Sweden, Spain and Italy
 - German In-Depth Accident Study (GIDAS)

Results

- Most crashes involving HGVs in EU-28 occur in dry and clear weather conditions (81%), daylight (78%), on roads that are not highways (77%), on roads with a dry surface (72%) and additionally, the majority of crashes occur in rural areas (57%). The following most frequent and critical crash scenarios for HGVs were identified:
 - Scenario 1: rear-end crashes with cars and commercial vehicles as collision partners.
 - Scenario 2: conflicts between a HGV that is turning to the right and a cyclist that is travelling alongside with the intention to go straight.
 - Scenario 3: conflicts between pedestrians crossing the road and HGVs.



Overview of databases used for analysis

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Poster scenario 2040



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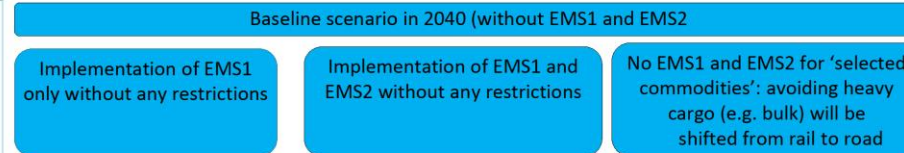
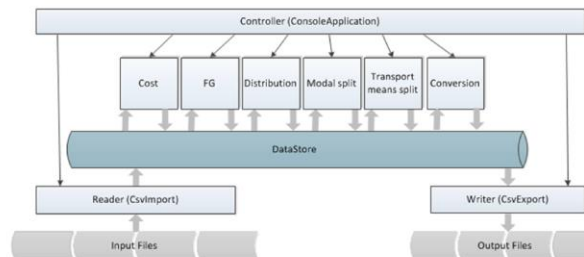
Scenario projection by freight modell DEMO-GV

Simulation of the impact of EMS 1/2 bases at **macroscopic freight model 'DEMO-GV'**, NST-2007 commodity classes and continental/maritime combined transport (CT) separately

'DEMO-GV' includes c. **431 German and 170 foreign, European traffic cells**

4-step simulation:

- I. freight generation
- II. distribution
- III. modal split on three modes:
rail, road, inland waterways (IWW)
- IV. mean split on road: truck-types, corresponding to gross value mass (GVM)



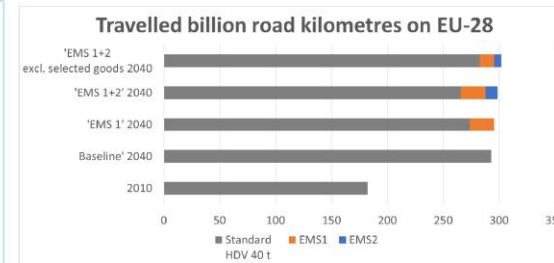
Assessment of EMS in relation to baseline: modal split and CO₂ emissions

Output data for each origin-destination-relation:

- modal split in tons [t]
- transport in ton-kilometres [tkm]
- travelled kilometres on road, each truck-type [km]

Important parameters for scenarios are transportation cost:

- fixed costs [€/vehicle]
- time costs [€/h]
- distance costs [€/km]
- toll costs on road [€/toll-km]



- Baseline: increase of road mileage between 2010 and 2040 of HDV (above 12 t GCW) by 61 %
- EMS 1 realizes up to 7 % of mileage of HDV above 12 t GCW
- EMS 2 realizes up to 5.5 % of mileage of HDV (above 12 t)

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Thank you



The AEROFLEX project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement no 769658