Enabling automation for Heavy Duty Vehicles - What the key aspects are

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SUMMER SCHOOL 2020

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PROBLEM DESCRIPTION

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WHAT MAKES AUTOMATION OF HEAVY DUTY VEHICLES SPECIAL COMPARED TO CARS?

WHAT MAKES AUTOMATION OF HEAVY DUTY VEHICLES SO SPECIAL?

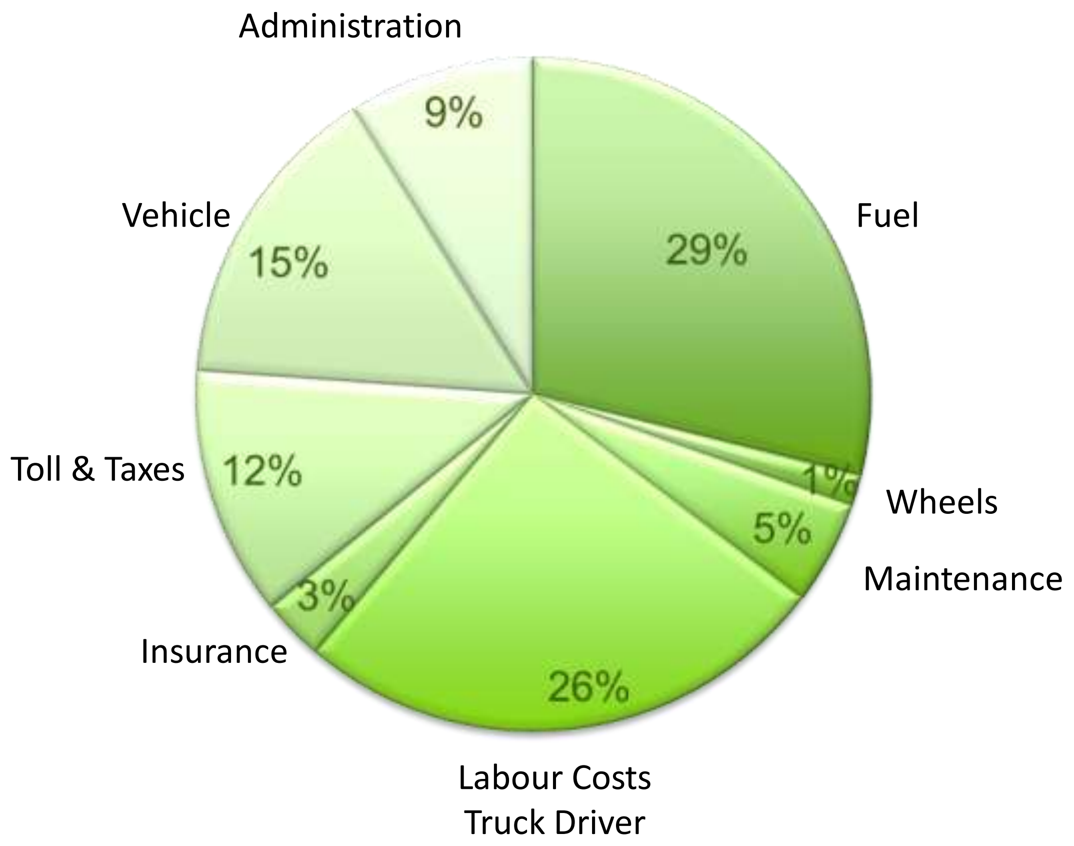
- Transporting goods
- Professional drivers
- Commercial activity
- Vehicles are much bigger and heavier than cars.
  Sometimes they pull a trailer.
  → More difficult to manoeuvre.

Source: MAN T&B

Source: SCANIA CV AB

EXEMPLARY DISTRIBUTION OF TRANSPORT COSTS FOR LONG HAULAGE TRANSPORT IN EUROPE

- Labour costs for truck driver sum up to 25 % … 30% of total transport expenses



Source: Goodyear internal

CURRENT SITUATION IN EUROPEAN LOGISTICS BUSINESS

- Demand on transports is growing
- Enormous international competition
- Truck driver shortage

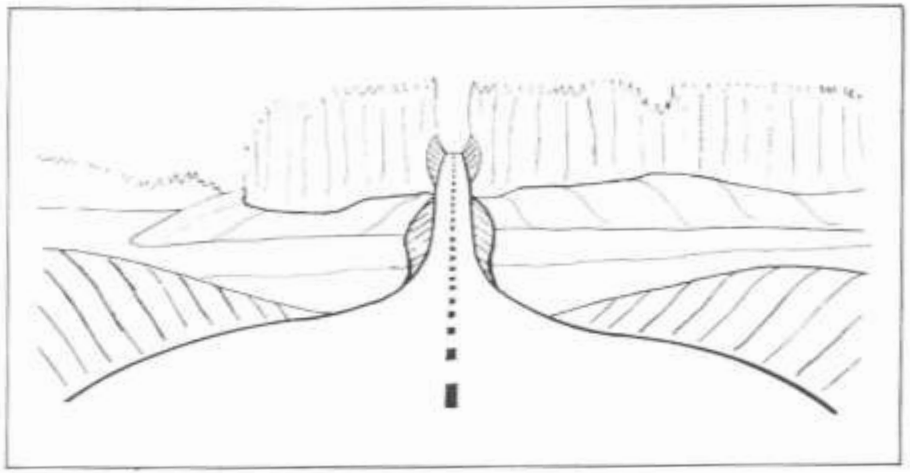
Source: MAN Truck & Bus SE

CRUISE CONTROL

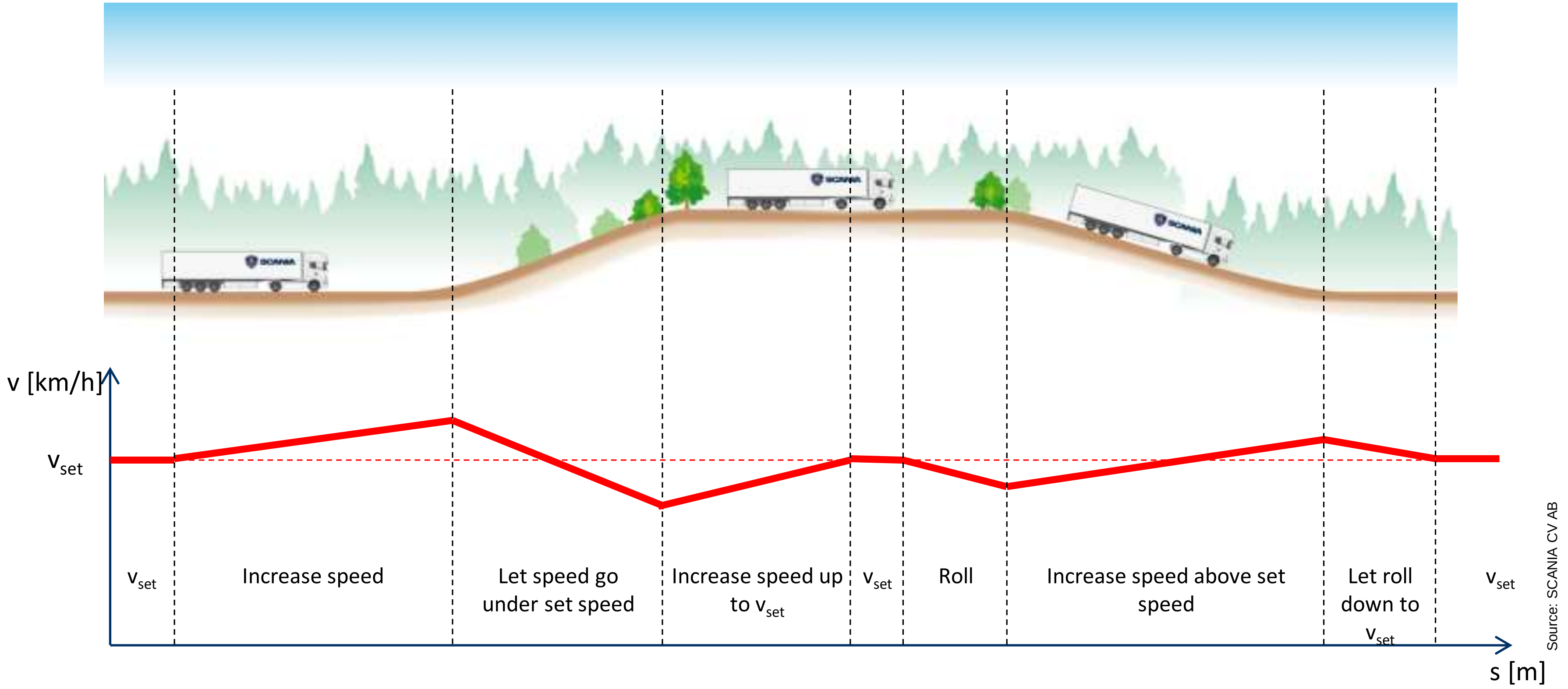
EVOLUTION IN LONGITUDINAL ASSISTANCE

Aspects		Cruise Control	Adaptive Cruise Control	Adaptive Cruise Control – Active Prediction
Functionality	Keep set speed	✓	✓	✓
	Keep distance to vehicle ahead		✓	✓
	Incorporate vertical road layout			✓
Main design criterion		Keeping speed limits	Keep safety distance to vehicle ahead	Reduction of fuel consumption
Technology			• Radar sensor	• Radar sensor • Map with vertical road layout info
HMI				

ADAPTIVE CRUISE CONTROL – ACTIVE PREDICTION



- Adaptive Cruise Control – Active Prediction bases on ACC
- Goal: Predictive adaptation of speed
  to minimize fuel consumption taking into account vertical shape of road
- Result: Reduction of fuel consumption up to 5% (highly depending on geometry)



PLATOONING

PLATOONING – FUNDAMENTAL CONCEPT

- Air drag force of single (isolated) vehicle: $F_L = \frac{1}{2} \cdot c_W \cdot A \cdot \rho \cdot v^2$
- Platooning idea:
  Driving in air shadow reduces air drag, reduces fuel consumption

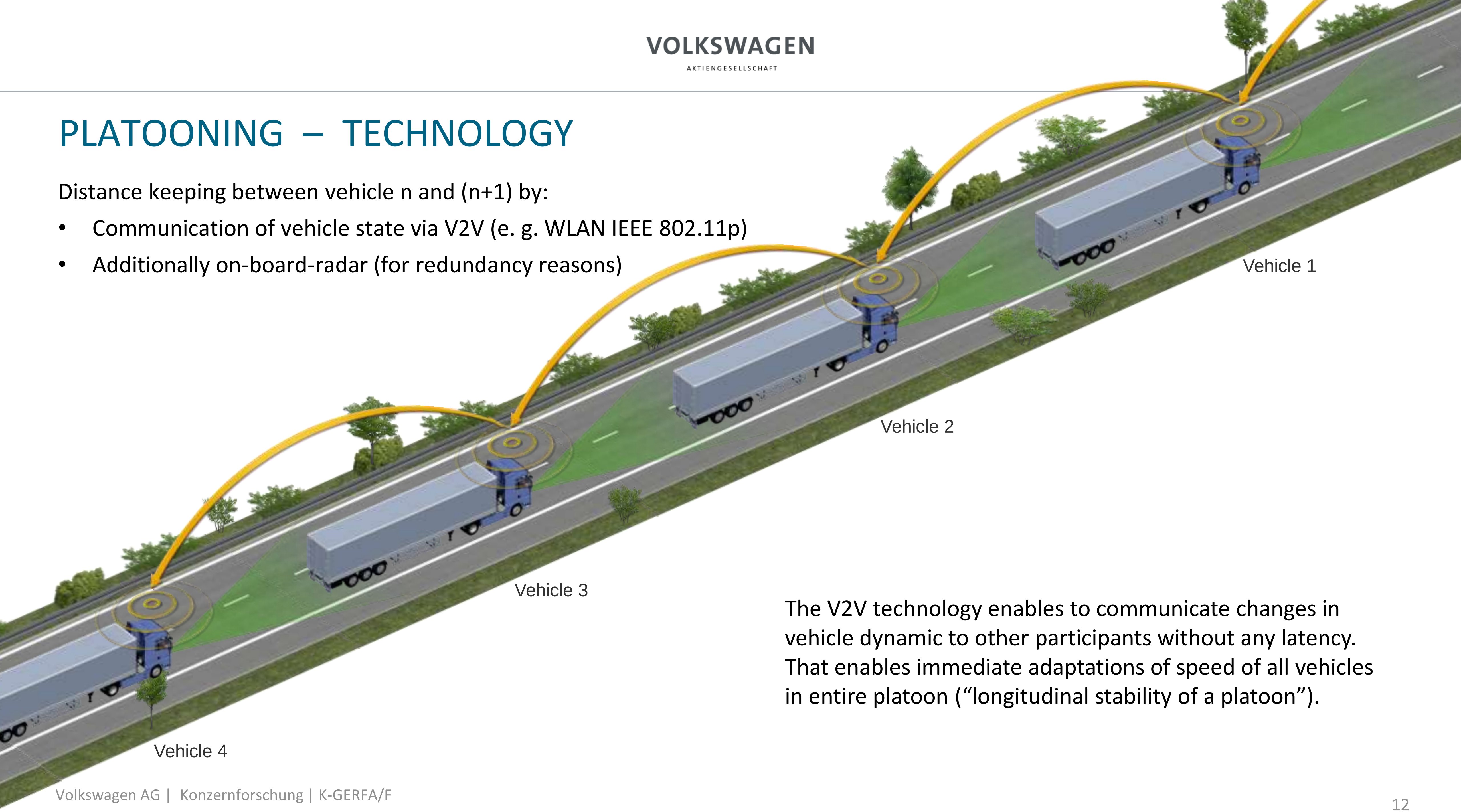
Source: SCANIA CV AB

Source: Assad Alam, KTH Stockholm

PLATOONING – TECHNOLOGY

Distance keeping between vehicle n and (n+1) by:

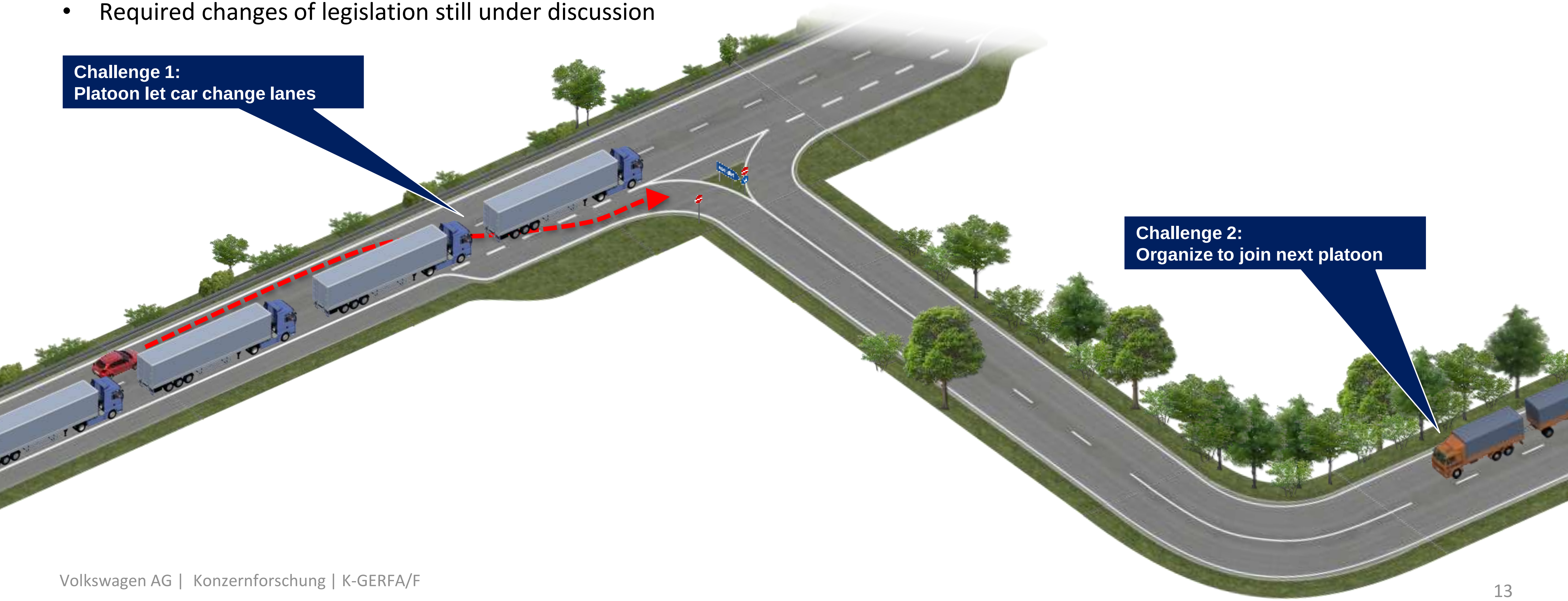
- Communication of vehicle state via V2V (e. g. WLAN IEEE 802.11p)
- Additionally on-board-radar (for redundancy reasons)



The V2V technology enables to communicate changes in vehicle dynamic to other participants without any latency. That enables immediate adaptations of speed of all vehicles in entire platoon (“longitudinal stability of a platoon”).

PLATOONING – CHALLENGES

- Platoons consisting of many vehicles increase savings
- Platoons consisting of many vehicles might be recognized as a traffic blockage
- Required changes of legislation still under discussion



PLATOONING – EXAMPLES

Source: SCANIA CV AB

Source: MAN Truck & Bus SE

PLATOONING – PRO’S AND CONT’S

Aspect	Pro’s	Cont’s
Reduced fuel consumption	Possible due to lowered air drag	• Difficult to keep short distance due to other interfering traffic. • Tolerances in mass estimation, brake performance make it difficult to maintain required time gap. • In an optimized platoon still differences in savings for the individual platoon members remain.
Driverless automated following a leading vehicle	Possible in case time gap is very close	• Platoon might be separated (e. g. due to intrusion of other vehicles). In this case each vehicle has to be able operate without leading vehicle anyhow. • Automation of independed vehicles might be possible. So, no leading vehicle is necessary at all.

Source: https://www.youtube.com/watch?v=lpuwG4A56r0

ALTERNATIVE TRANSPORT SOLUTIONS BESIDE PLATOONING

ALTERNATIVE TRANSPORT SOLUTIONS BESIDE PLATOONING TECHNOLOGY

- Mechanically connected configurations with higher transport capacity
- Advantages:
  - Only 1 driver per truck-trailer-configuration needed
  - Less space occupied on roads
  - Less motor vehicles required
  - Less fuel consumption
  - Higher transport capacity
    in volume and weight

Standard Long Haulage Transport (16,50 m)

1 2 3 4 5 6

1 2 3 4

Transport with Longer Trucks (25,25 m)

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Road Train

Source: SCANIA CV AB

Longer Truck 32 m @ 80 tons

Source: SCANIA CV AB

Longer Truck 25,25 m @ 40 tons or 60 tons

Source: MAN Truck & Bus SE

AUTOMATION FOR HEAVY DUTY VEHICLES

EXAMPLES

EXAMPLE AUTOMATED DRIVING OF MOVING STREETWORK

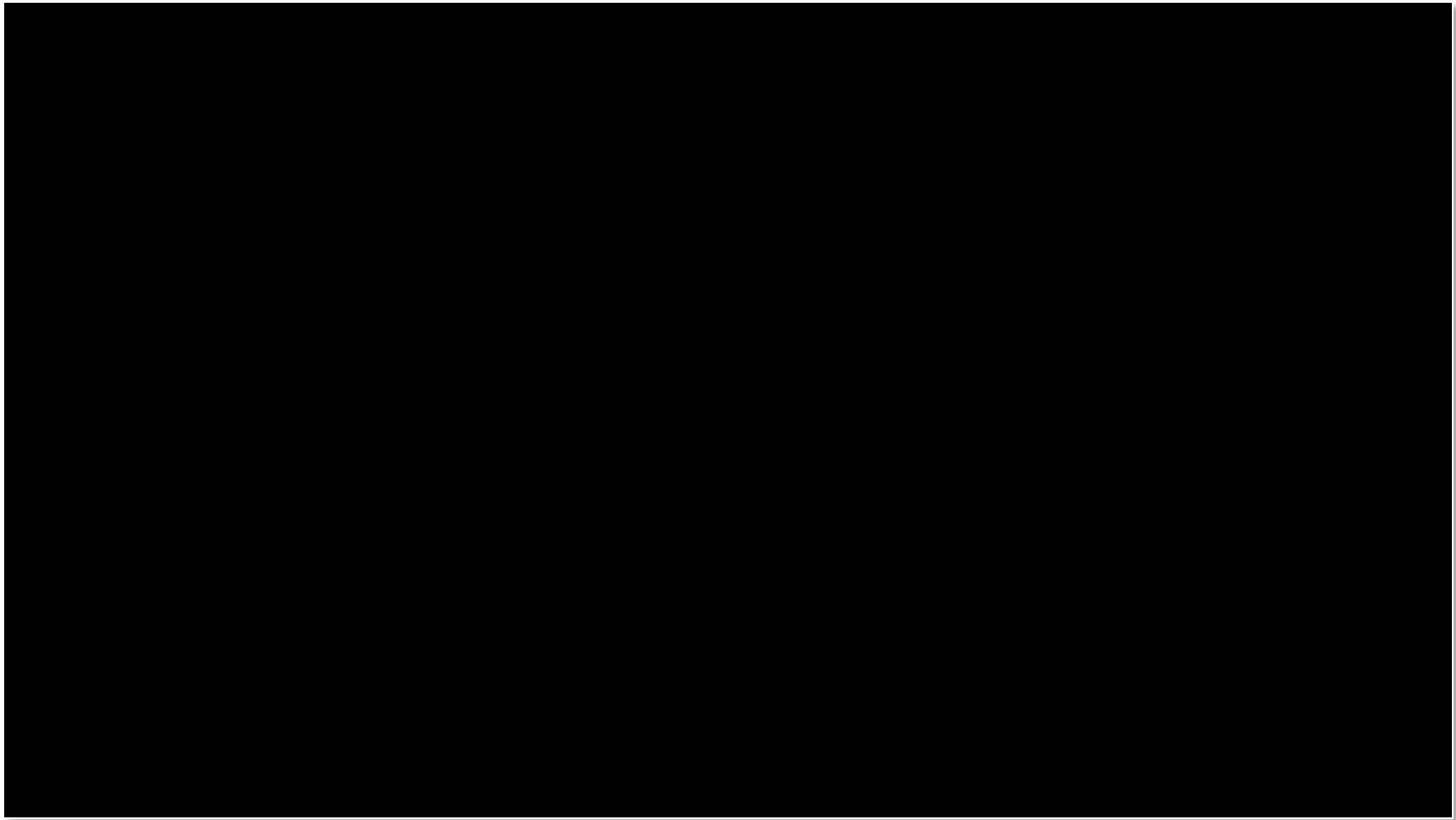
- AFAS: Automated driverless securing vehicle for moving street work on highways
- Autonomous following vehicle to service vehicle (e. g. street-cleaner, lawn-mower, etc.)
- Accompanying vehicle is highly endangered to be hit by other traffic because of their high speed difference.
- Accompanying vehicle keeps distance to vehicle ahead by radar measurements.
  Lateral control is mainly bases on perception by camera and radar.

Innovation Award
IAA Nutzfahrzeuge 2018

Source: www.afas-online.de

EXAMPLE OF AUTOMATED OFF-ROAD TRUCK

- Automation of a truck
  in off-road environment
- Sensors detecting surroundings,
  obstacles are represented in a grid map
- Path planner algorithm guides vehicle



Automated Driving in Offroad Environment by Volkswagen Group Research, MAN and SCANIA

Source: Volkswagen AG

EXAMPLE OF AUTOMATED MINING TRUCK

- Automation of tipper truck in Dampier salt mine in Rio Tinto/ Australia (in real customer operation)
- Automated truck follows a salt harvester machine and is being loaded.
  Afterwards the loaded truck drives automatically to an unload station.

Source: SCANIA CV AB

Automated Driving in Salt Mine by SCANIA

Source: SCANIA CV AB, Rio Tinto

EXAMPLE OF AUTOMATED MINING TRUCK

- Automated trucks
  does not need
  any space for a cabin
  any more
- Former space for cabin
  can be used
  to increase loading volume

Source: SCANIA CV AB

CONCLUSIONS

CONCLUSIONS – WHAT THE KEY ASPECTS ARE

- For commercial goods transportation only driverless makes sense.
  - Comfort and convenience of the driver/ passenger is always an issue for passenger cars but not for transports of goods. So, any driver assistance or L3 functions targeting these topics are not relevant for trucks.
  - Automation for fuel savings is already achieved with ADAS functions. So, this is also not a driver for autonomous vehicles.
- Commercial vehicles have a business case, they can afford expensive technical equipment and still save money by removing the driver. For passenger cars it is either a luxury function or a new mobility business model is required (like shared mobility and robo taxi).
- It’s easier to identify a limited ODD for a commercial vehicle since many transports by nature is very repetitive. Most commercial transports use the same main roads, e. g. through Europe.
- Technology-wise there are many similarities between heavy vehicle automation and passenger car automation.
- Future research activities will focus on increasing the performance of the perception system.

THANK YOU VERY MUCH FOR YOUR ATTENTION

ΕΥΧΑΡΙΣΤΏ ΓΙΑ ΤΗΝ ΠΡΟΣΟΧΉ

Source: SCANIA CV AB

BACKUP

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KONZERNFORSCHUNG

ENABLING AUTOMATION FOR HEAVY DUTY VEHICLES

WHAT THE KEY ASPECTS ARE

SEPTEMBER 9-10, 2020 • L3PILOT SUMMER SCHOOL • ATHENS/ GREECE

DR. MARC-MICHAEL MEINECKE (VOLKSWAGEN), MIKAEL JOHANSSON (SCANIA)

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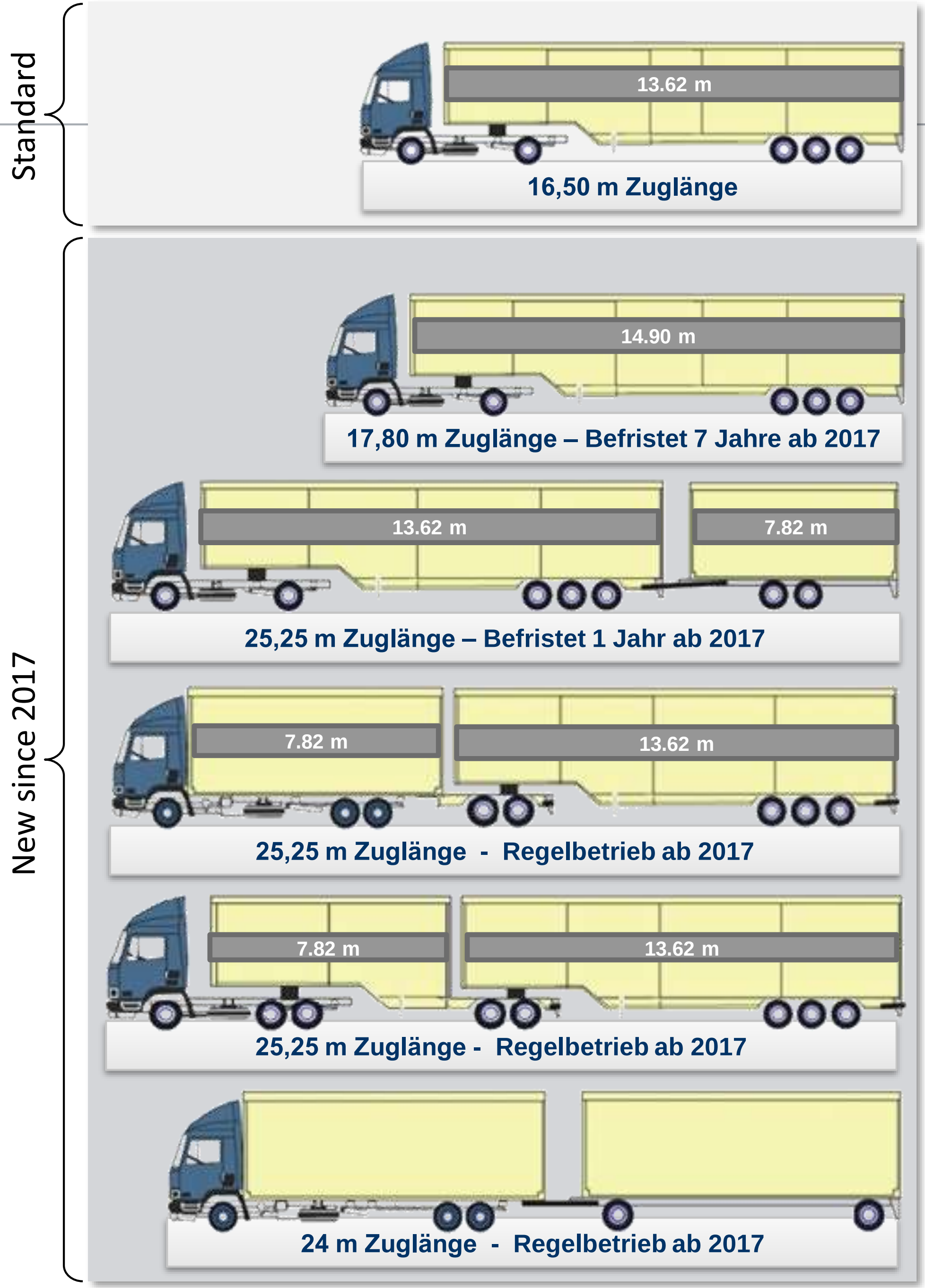
“NEW” ALLOWED COMBINATIONS IN GERMANY

- Combinations depicted are additionally allowed in Germany since 2017
- Limited to 40 tons weight
- Additional constraints have to be kept into consideration (for driver and route)

Longer Truck 25,25 m @ 60 tons on Swedish Highway



Source: Schmitz Cargobull, Altenberge

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  Most commercial transports use the same main roads, e. g. through Europe.

- Technology-wise there is not a huge difference between heavy vehicle automation and passenger car automation.