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Automated Trucks

The next big disruptor in the automotive industry?

Roland Berger study



THE BIG 3

Disruption potential

Automated trucks address several challenges that the trucking industry is facing simultaneously: hours-of-service, safety, driver shortage and fuel costs

TCO benefit

In early stages, fast payback of technology investment can only be reached in few applications with high share of truck platooning – significant cost savings expected only long term with driverless trucks

Safety as true driver

As pull from fleet operators will be limited given the slow payback, safety regulation will become a major driver in the adoption of automated trucks

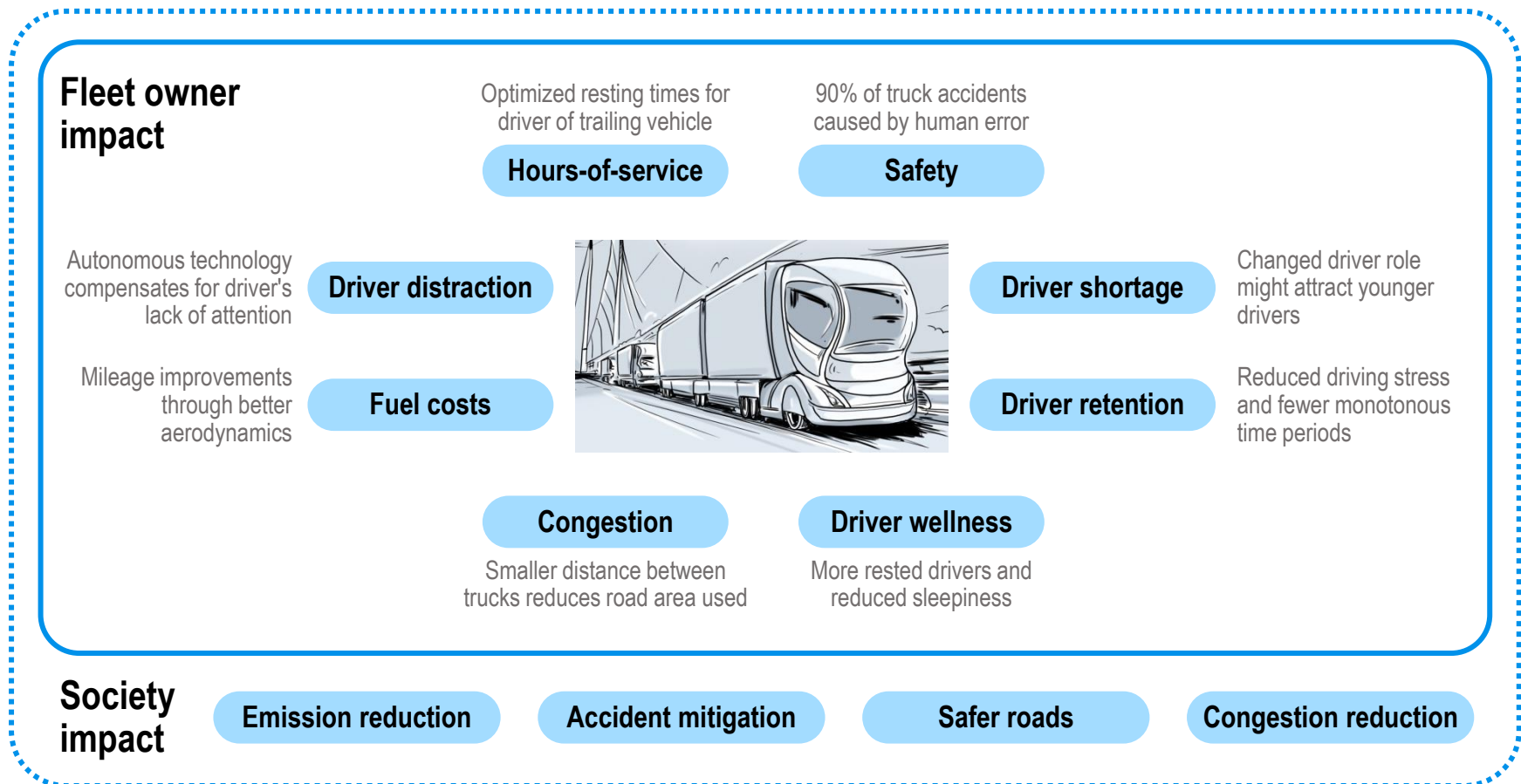
Hours-of-service, safety, driver shortage and fuel costs are top issues of the trucking industry

Top issues of the trucking industry



Most of the top trucking industry issues can be addressed by automated trucks – Benefits expected also for wider society

Top industry issues addressed by automated trucks



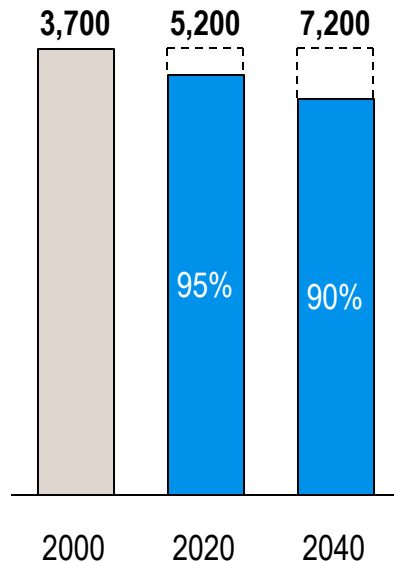
Automated trucks have the potential to bring a disruptive change to the trucking industry

Automated trucks – Disruption potential

Indicative

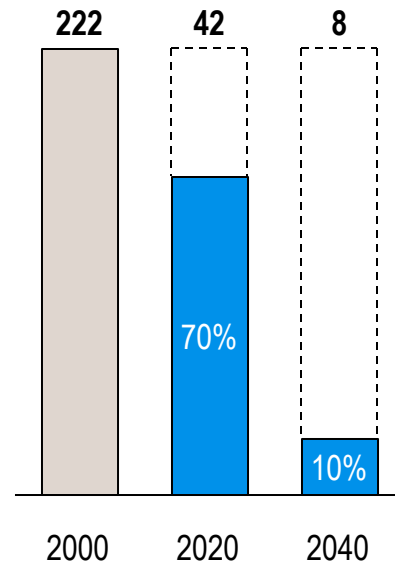
Fuel consumption

Energy consumption heavy duty trucks [tn Btu]



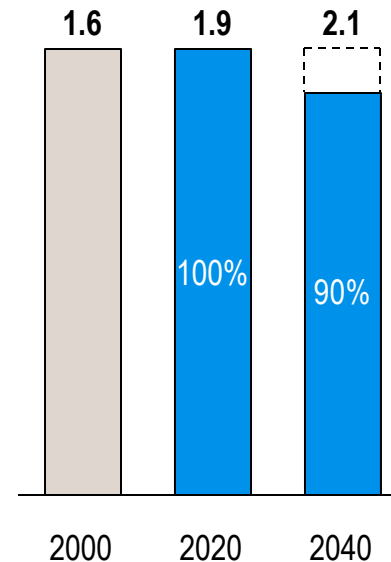
Safety

Trucks involved in crashes [per 100 m vehicle-miles]



Driver demand

Number of heavy duty truck drivers [m]



Others

- > Reduction of traffic jams
- > Higher driver retention
- > Improved truck utilization
- > Lower transport cost
- > Emergence of new business models

Base year 2000

Projected development w/o automated trucks

Potential development with automated trucks

Benefits of automated trucks are twofold: safer and more comfortable vehicle operation and fuel savings from platooning

Benefits from automated trucks

Automated driving



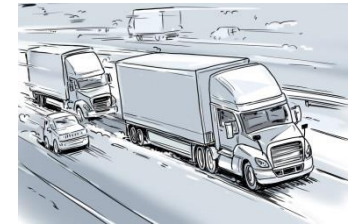
Increased driver comfort and safety through fully automated vehicle operation

Benefits

- > Optimized driver rest periods
- > Fuel efficiency gains from predictive driving
- > Eliminating human error
- > Better vehicle utilization
- > Eventually driverless vehicle

Cooperative automated driving

Improved aerodynamics and fuel consumption through reduced inter-vehicle spacing



Benefits

- > Additional fuel efficiency gains

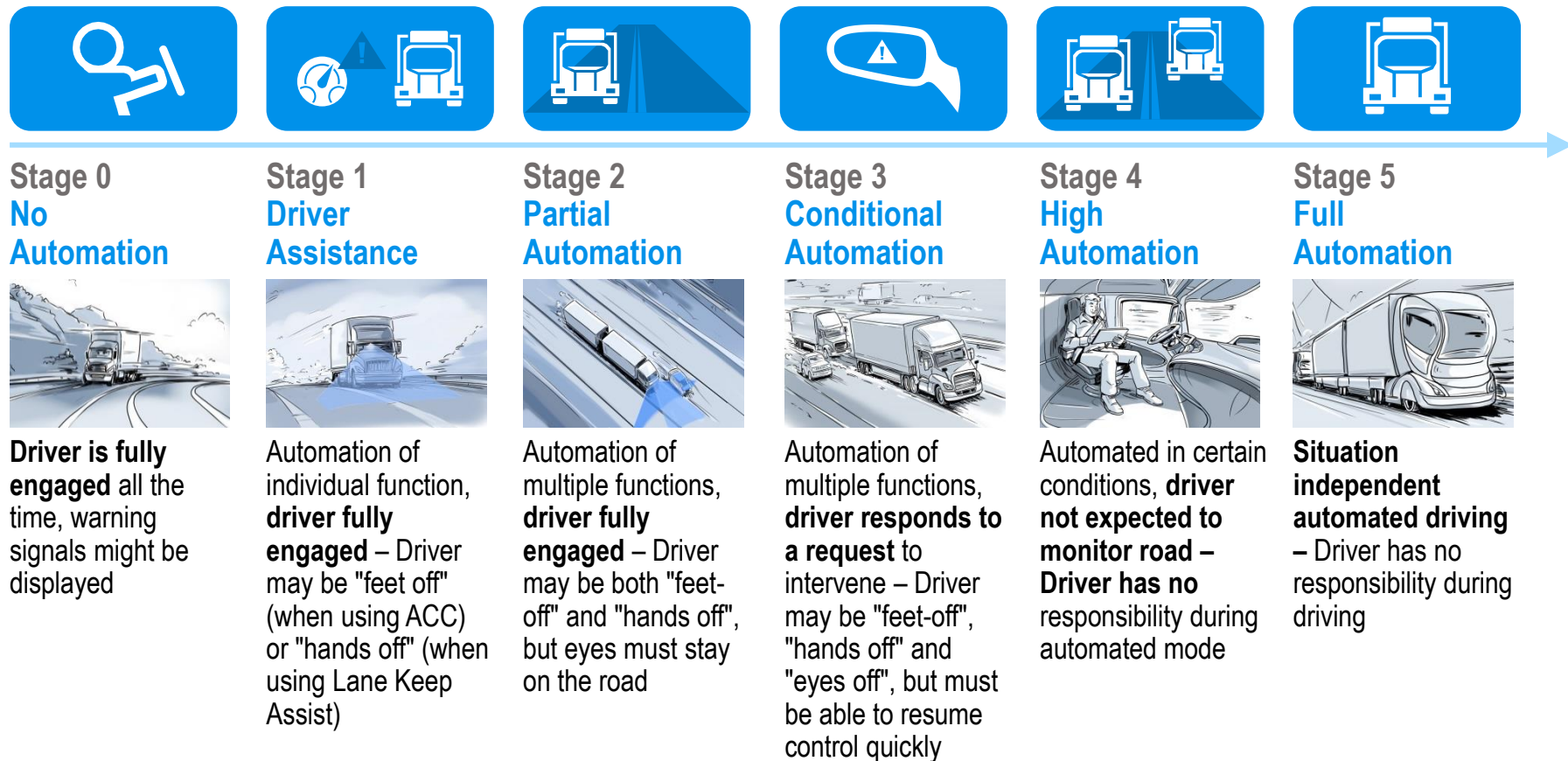


Self-driving trucks



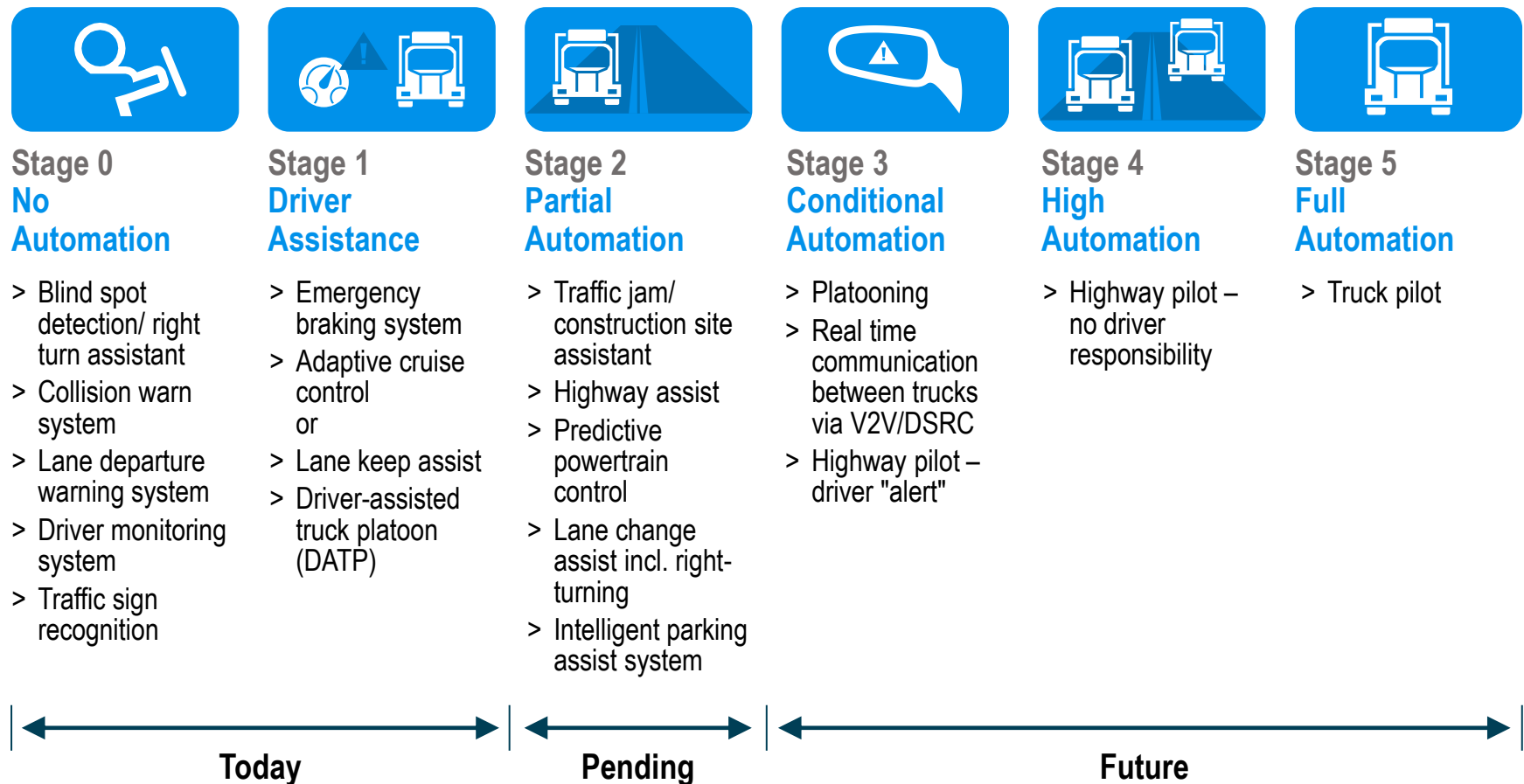
The technological development towards fully automated trucks takes place in stages – Driver engagement changes with stages

Technological roadmap (SAE stage definition)



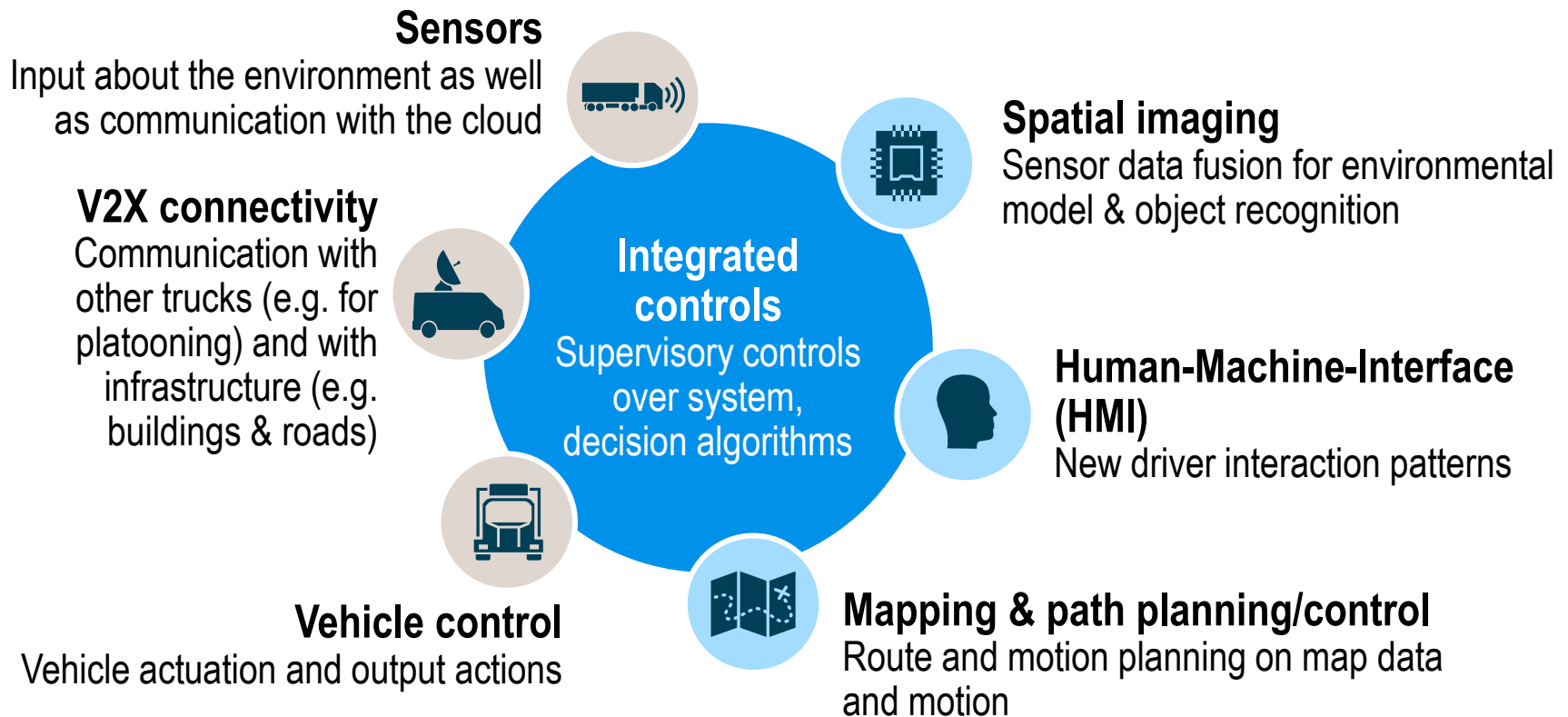
Each stage of automated trucks requires increasingly complex features that transfer more control from the driver to the truck

Required features by stage of automation



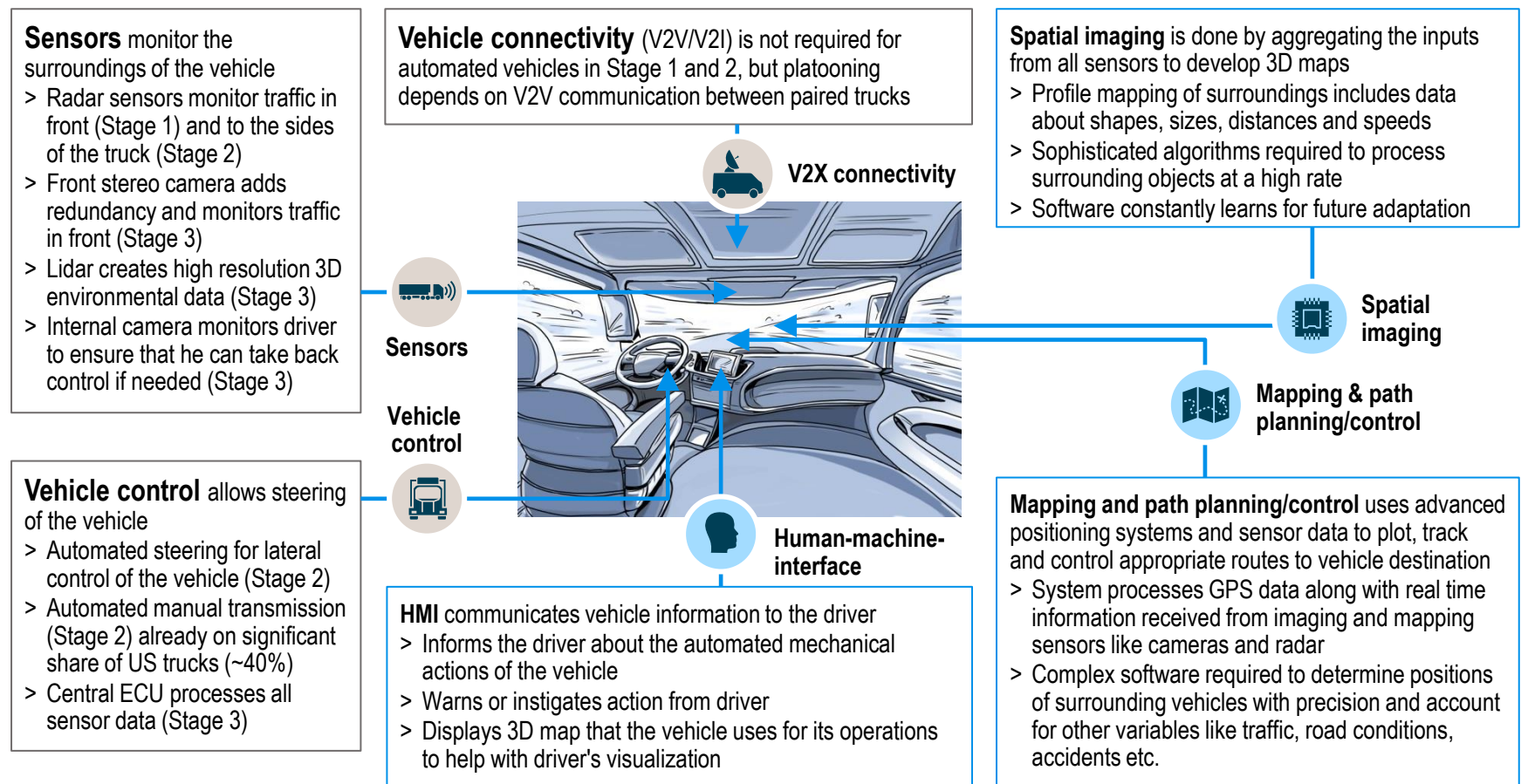
Autonomous trucks are enabled by an interplay of technology areas including hardware, software and integrated controls

Key technology requirements automated trucks



A variety of sensors, connectivity and vehicle control systems are used in automated trucks along with HMI and software modules

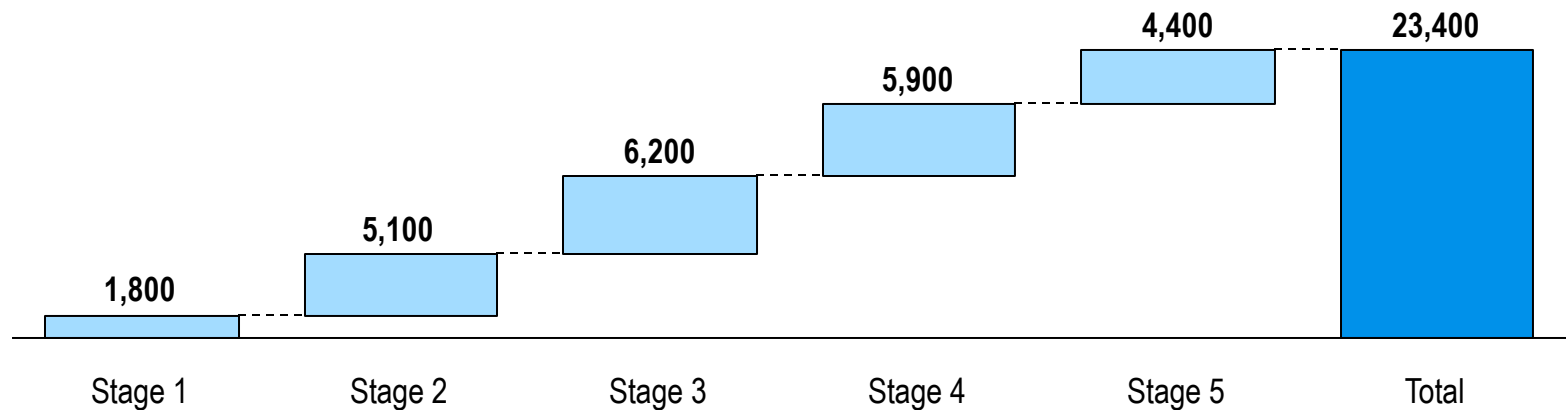
Technologies used in automated trucks



Incremental costs of automated driving increase from Stage 1 to 5

– Total incremental cost of stage 5 truck over 20 k USD

Incremental technologies and vehicle cost per stage [USD per truck]



Incremental software

~85%

- > Processing of sensor data from ACC and/or lane keep assist
- > Processing of add. sensor input
- > Higher level of environmental recognition required
- > Higher level of sensing required for conditional replacement of driver's sensory
- > Complete automation of sensing process for spec. environment
- > Calculation of environment map
- > Ability to correct for unknown variables in every situation is required

Incremental hardware

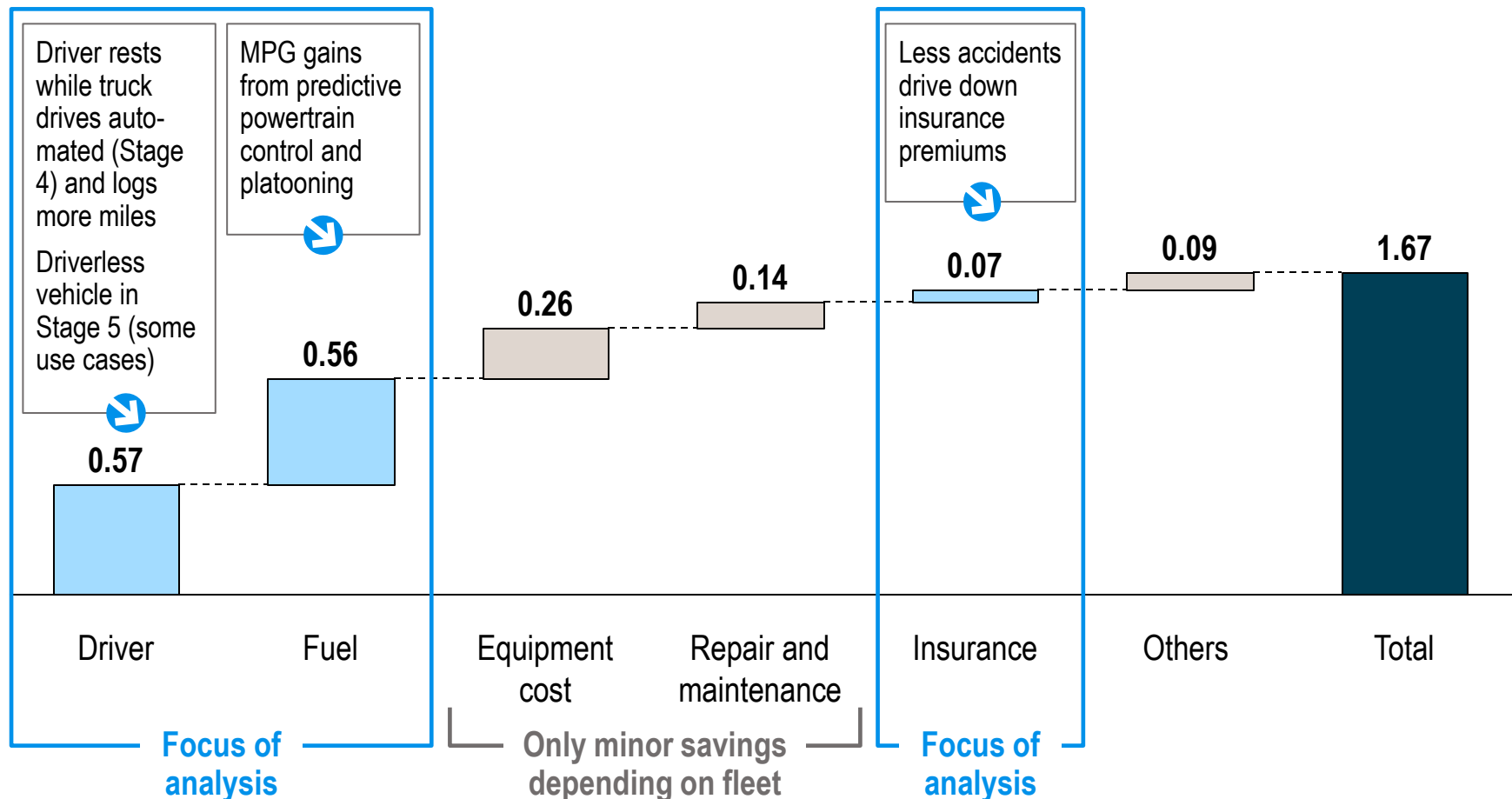
~15%

- > Long –range radar
- > Short-range radar (longitudinal sensing)
- > Wiring
- > Short-range radar (lateral sensing)
- > Automated steering
- > Front camera
- > HMI
- > Interior camera
- > Central ECU
- > Lidar
- > Connectivity systems

○ Share of cost

Driver and fuel are the largest cost items and will be impacted by automated driving – Additional savings on insurance cost possible

Impact of automated driving on operating costs [USD/mile]



We calculated operating cost benefits and investment paybacks for three representative use cases

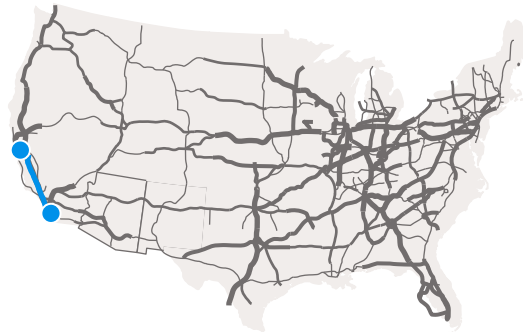
Use cases – Example USA

a Long-haul



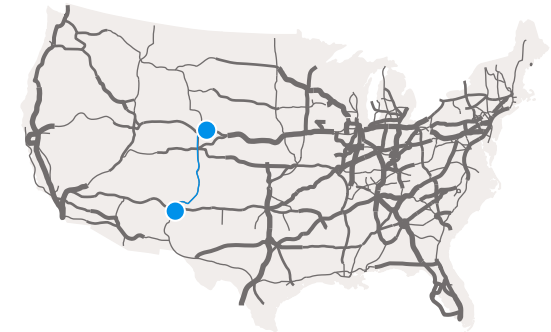
- > **Long distance traffic** between warehouse and harbor
- > Trip length **2,000 miles**
- > **Majority** of trip on **high traffic highways**
- > Likelihood to form a **platoon 40%-50%**
- > **Driver** not required any more in Stage 5 (fully automated warehouse with automatic loading/unloading)

b Regional – high traffic roads



- > **Short distance traffic** between harbor and distribution center
- > Trip length **400 miles**
- > **Majority** of trip on **high traffic highways**
- > Likelihood to form a **platoon 40%-50%**
- > **Driver** not required any more in Stage 5 (fully automated warehouse with automatic loading/unloading)

c Regional – low traffic roads

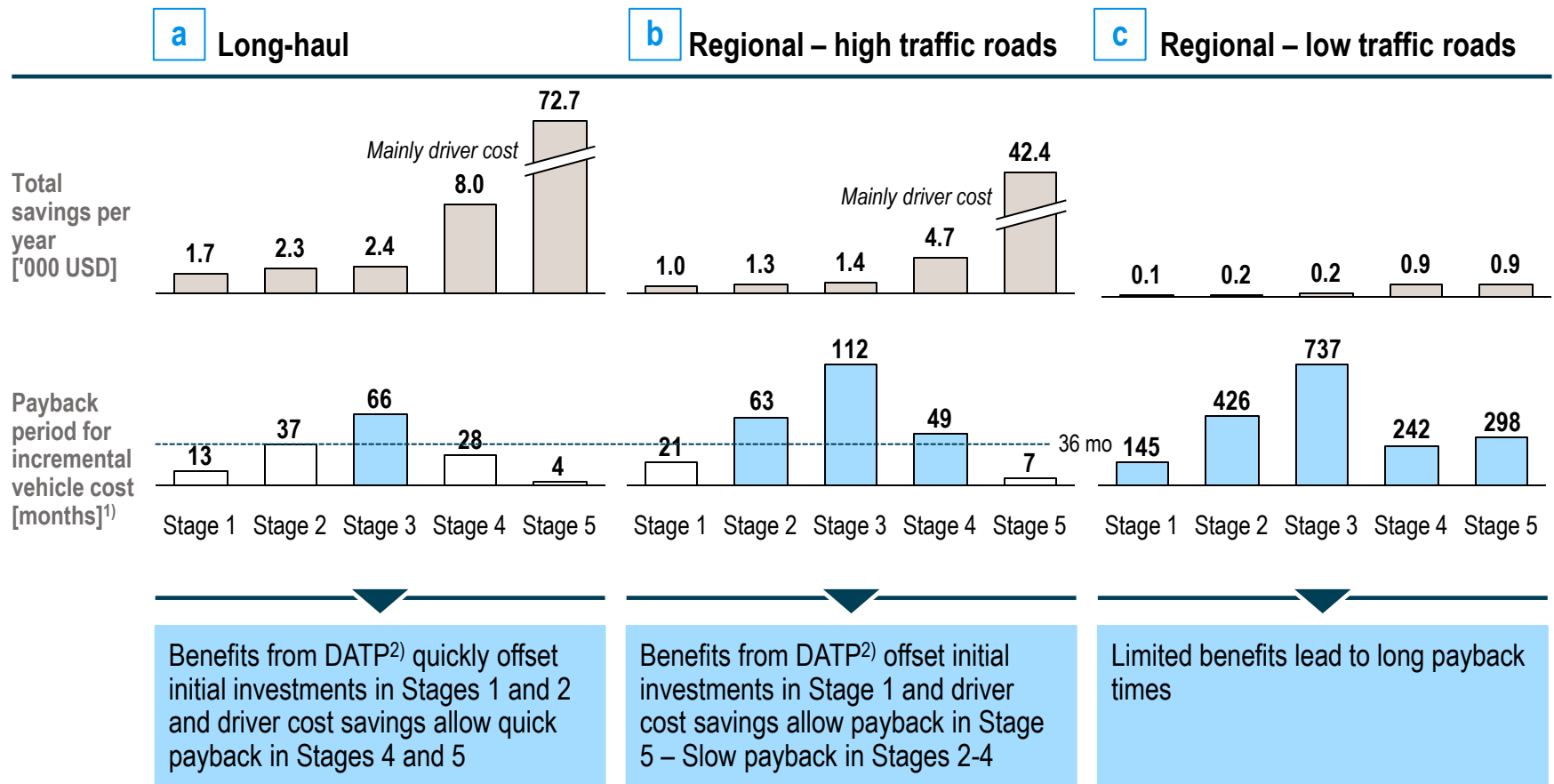


- > **Short distance traffic** between regional hub and local warehouse
- > Trip length **400 miles**
- > **Low share** of trip on **high traffic highways** – Majority on less frequented rural roads
- > Likelihood to form a **platoon 10%**
- > **Driver** still required in Stage 5, e.g. for loading and unloading

— Traffic intensity

Long-haul case allows payback in 3 years for all stages but stage 3 – Payback times too long for regional transportation

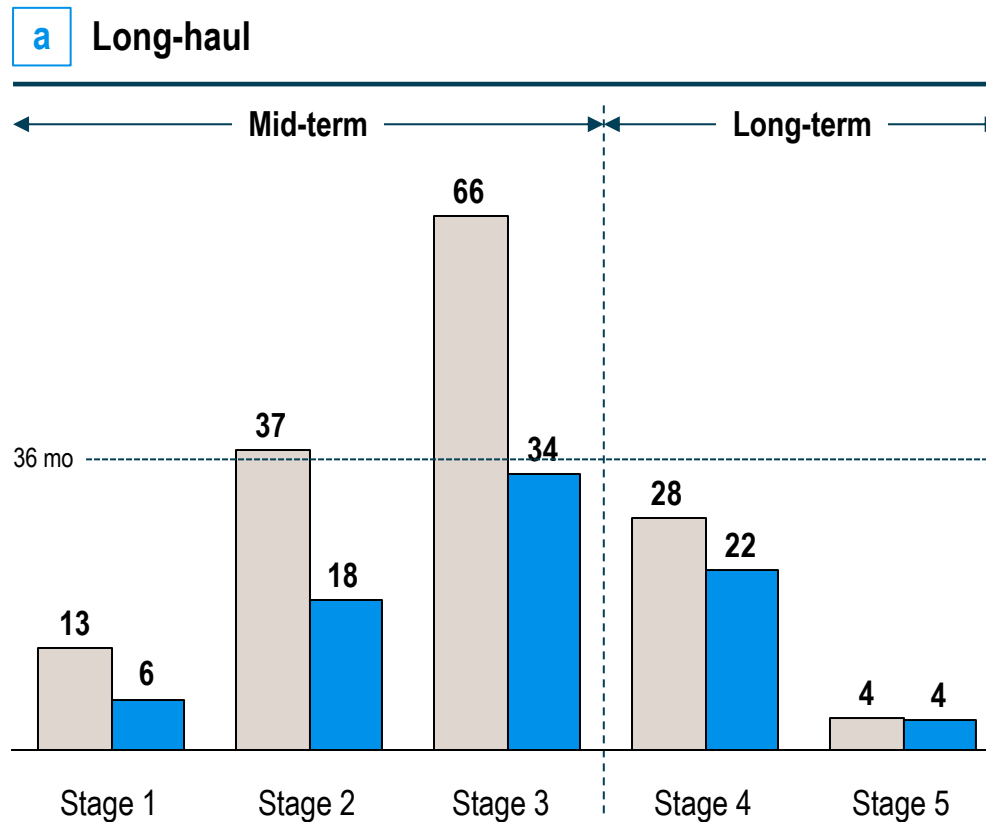
Payback calculation for use cases



1) Incremental vehicle cost: Stage 1: 1,800 USD, Stage 2: 6,900 USD, Stage 3: 13,100 USD, Stage 4: 19,000 USD, Stage 5: 23,400 USD 2) Driver-assisted truck platoon

Up to Stage 3, level of platooning will influence adoption of automated trucks, driver cost savings drive adoption in Stage 4

Impact of platooning on payback times [mo]



Likelihood of platoon formation: 45% (base assumption for use case a) 90%

Key insights

- > Adoption of automated trucks goes through two distinct phases
 - In the mid-term (Stage 1-3), payback periods increase significantly by stage as cost savings remain flat while per vehicle investments grow
 - Level of platooning has significant impact on payback periods up to Stage 3 – Payback within 3 years can only be reached by operating in platoon mode for over 90% of miles travelled
 - In the long-term, payback periods drop with Stage 4 due to additional driver cost savings – fast progression from stage 3 to 4 expected
 - Long-term adoption less impacted by level of platooning

To realize the potential of automated driving several ecosystem challenges need to be solved

Main requirements for self-driving trucks

1



Technological requirements

- > **Hardware** is largely available with incremental innovation needed
- > **Software & integration** need advanced development
- > **Geo-mapping** needed for highly detailed elevation maps for PPC¹⁾

2



Supply chain development

- > **Players** are **forming partnerships** and investing in autonomous trucks technology
- > **System integrator required**, but still **missing**/too early to define

3



Legal requirements

- > **Legal driving framework** needs to be updated
- > **Testing** of automated trucks must be enabled
- > **Liability issues** must be clarified

4



Ethical considerations

- > **"Dilemma"** of fair decision vs. rationale decision
- > Broad **dialogue among all stakeholders** required
- > Needs to serve as **key influence** in legal requirements

5



Enabling ecosystem

- > Availability of required **infrastructure** (e.g., LTE network)
- > Truck **driver** acceptance of systems and qualification
- > **Cyber security** standards to enable safe truck operation

1) Predictive Powertrain Control

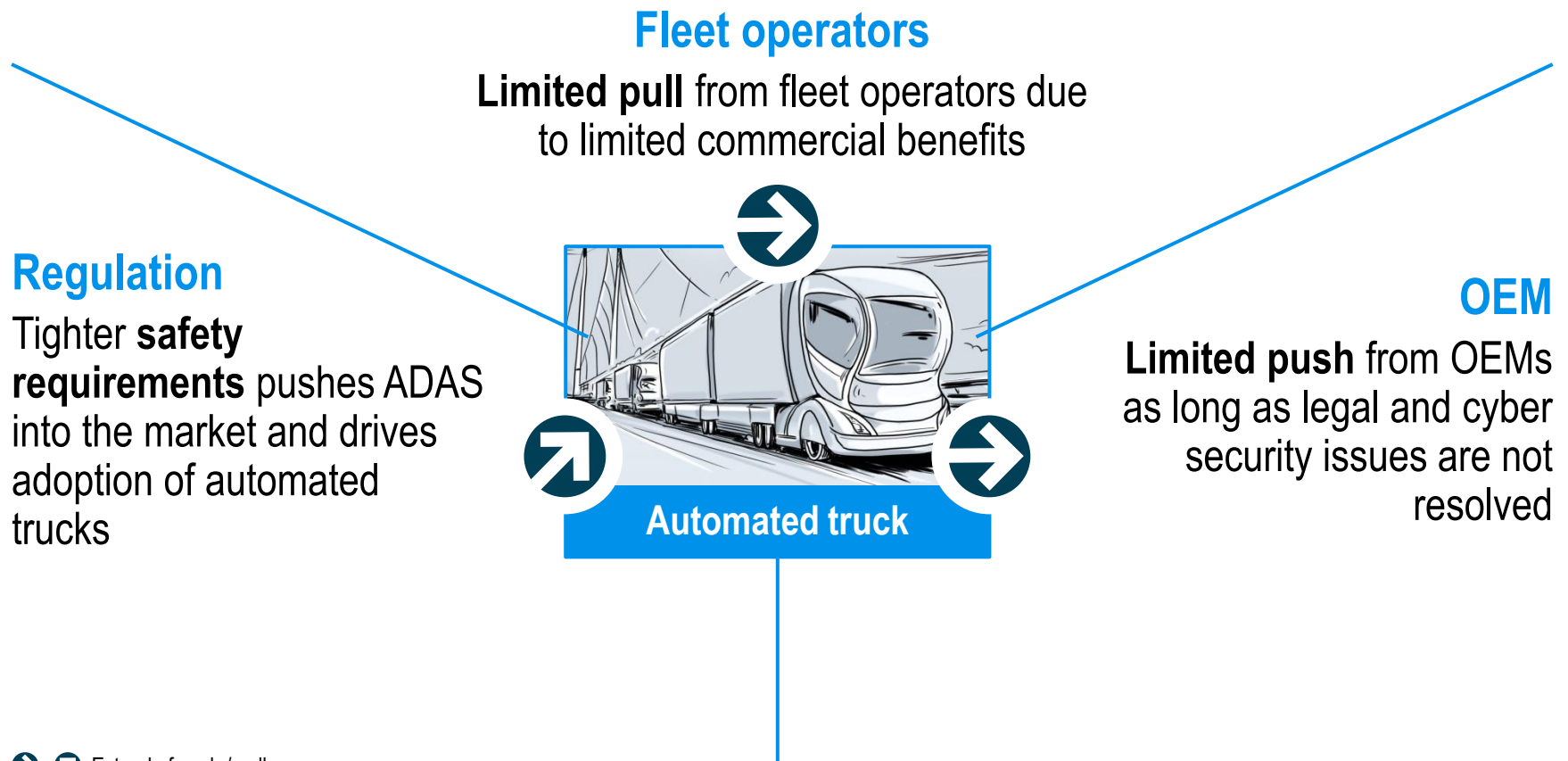
Four key implications for the trucking industry have been derived

Key implications for stakeholders of trucking industry

		Key insight from analysis	Implication for stakeholders
Safety as real driver behind adoption of automated trucks	1	Business case for fleet operators is positive only for few applications	<ul style="list-style-type: none"> > Limited pull from fleet operators due to limited commercial benefits > Limited push from OEMs as long as legal issues are not resolved > Tighter safety requirements pushes ADAS into the market and drives adoption of automated trucks
Roles and responsibilities within the value chain change	2	System complexity will significantly increase with higher stages of automation	<ul style="list-style-type: none"> > Definition of system architectures and responsibility for system integration remains the domain of OEMs across all stages > While OEMs continue to source complete functions from suppliers in Stage 2, a single entity will be required in Stage 3 to handle the higher complexity and interaction between systems (OEM or an ESP) > With Stages 4 and 5 being only software driven, and the need to realize scale effects, it is possible that a large software player gains a large share of the revenue and profit pool
New business models emerge	3	Commercial feasibility of automated platoons requires support functions	<ul style="list-style-type: none"> > New business models such as Platoon Service Providers or warehouses with automated loading and unloading functions will emerge
Operator models change	4	Magnitude of cost savings up to Stage 3 depends on ability to form a platoon	<ul style="list-style-type: none"> > Large fleet operators will gain a competitive advantage over owner drivers as they can more easily form intra fleet platoons and are more likely to platoon with peers than with owner drivers

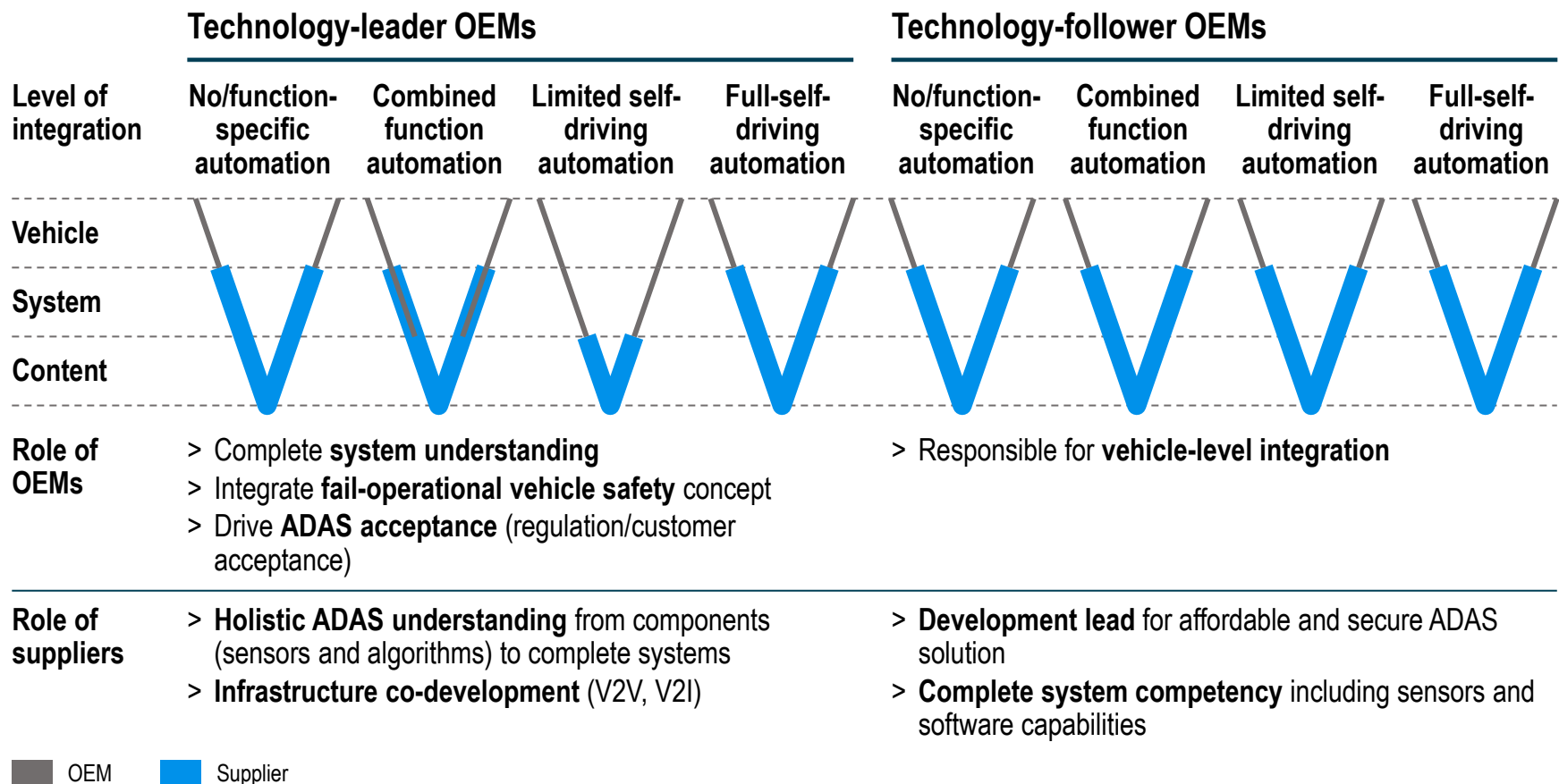
While pull from fleet operators and push from OEMs will remain limited, safety regulation will drive adoption of automated trucks

Technology push and pull from different stakeholders



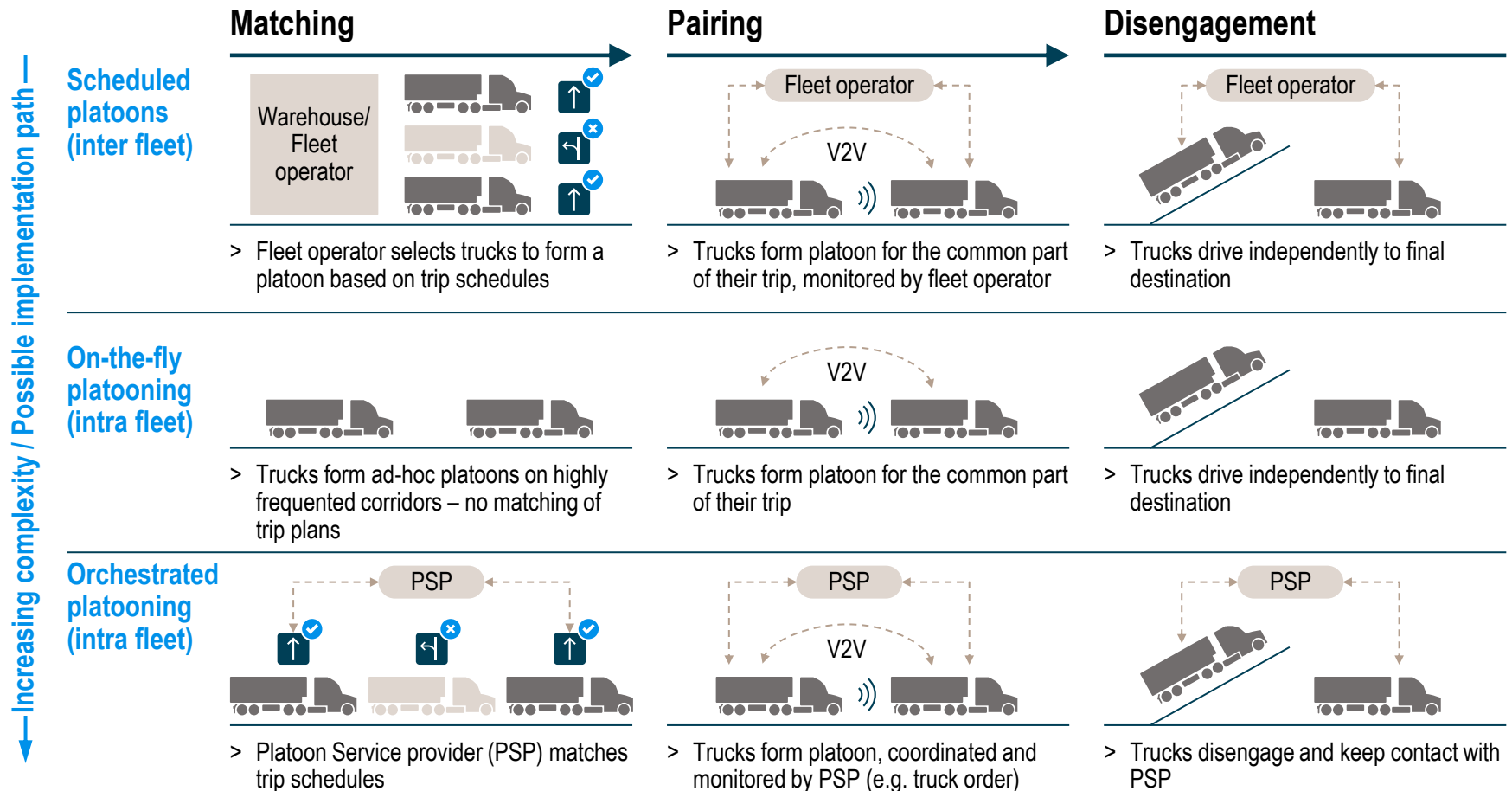
Roles and responsibilities within the value chain will change with different stages of automation

Role sharing between OEMs and suppliers



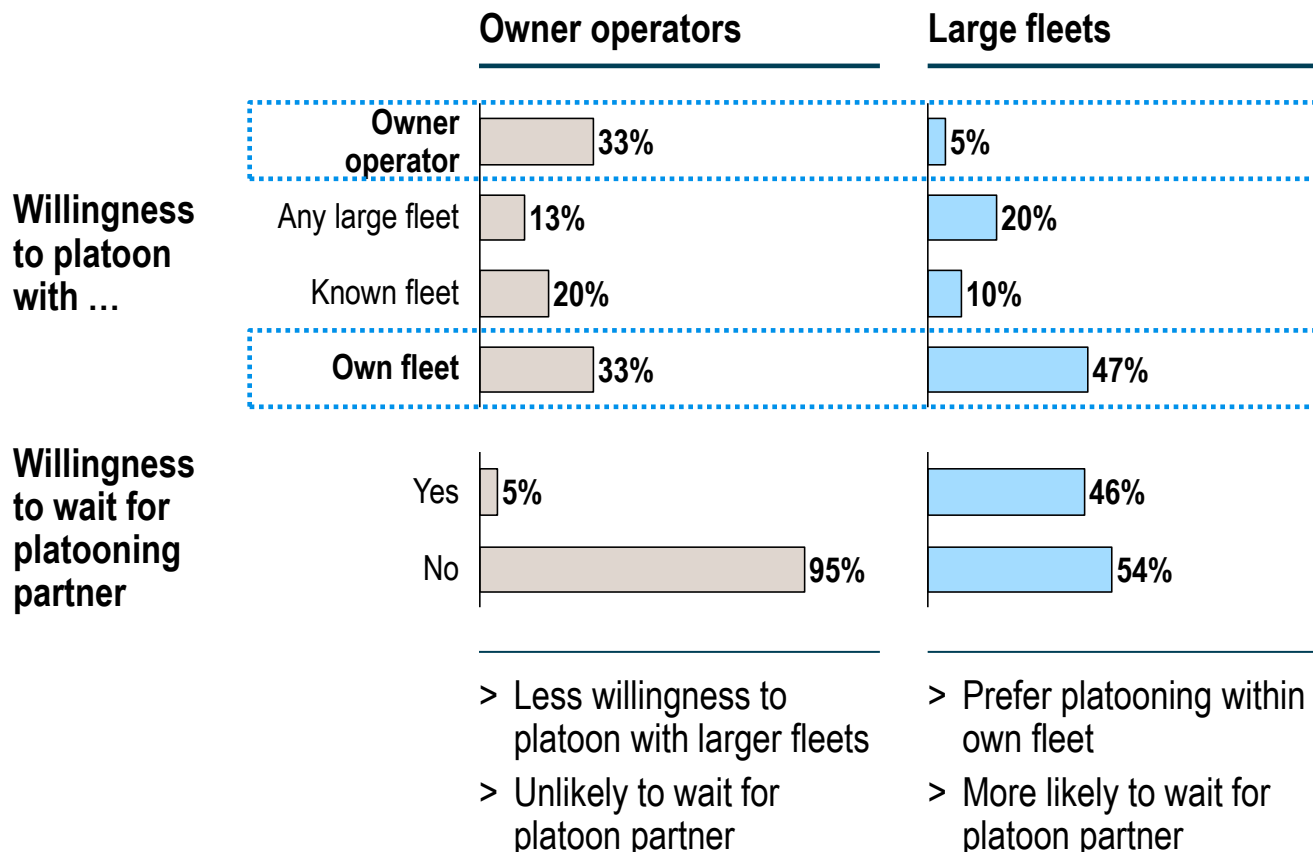
Platoon Service Providers are expected to emerge that orchestrate platoon formation across fleets

Business model change: Platoon formation options



Large fleet operators will gain a competitive advantage as they are more likely to find platooning partners

Options for platooning collaboration



Key insights

- > Platooning outside own fleet bears the risk to improve a competitors bottom-line
- > Large fleets have a competitive advantage as they can platoon within own fleet and also have stronger time latitude and can afford waiting for platooning partner

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