Trucking's Future Now

MODERATOR: PAUL MENIG

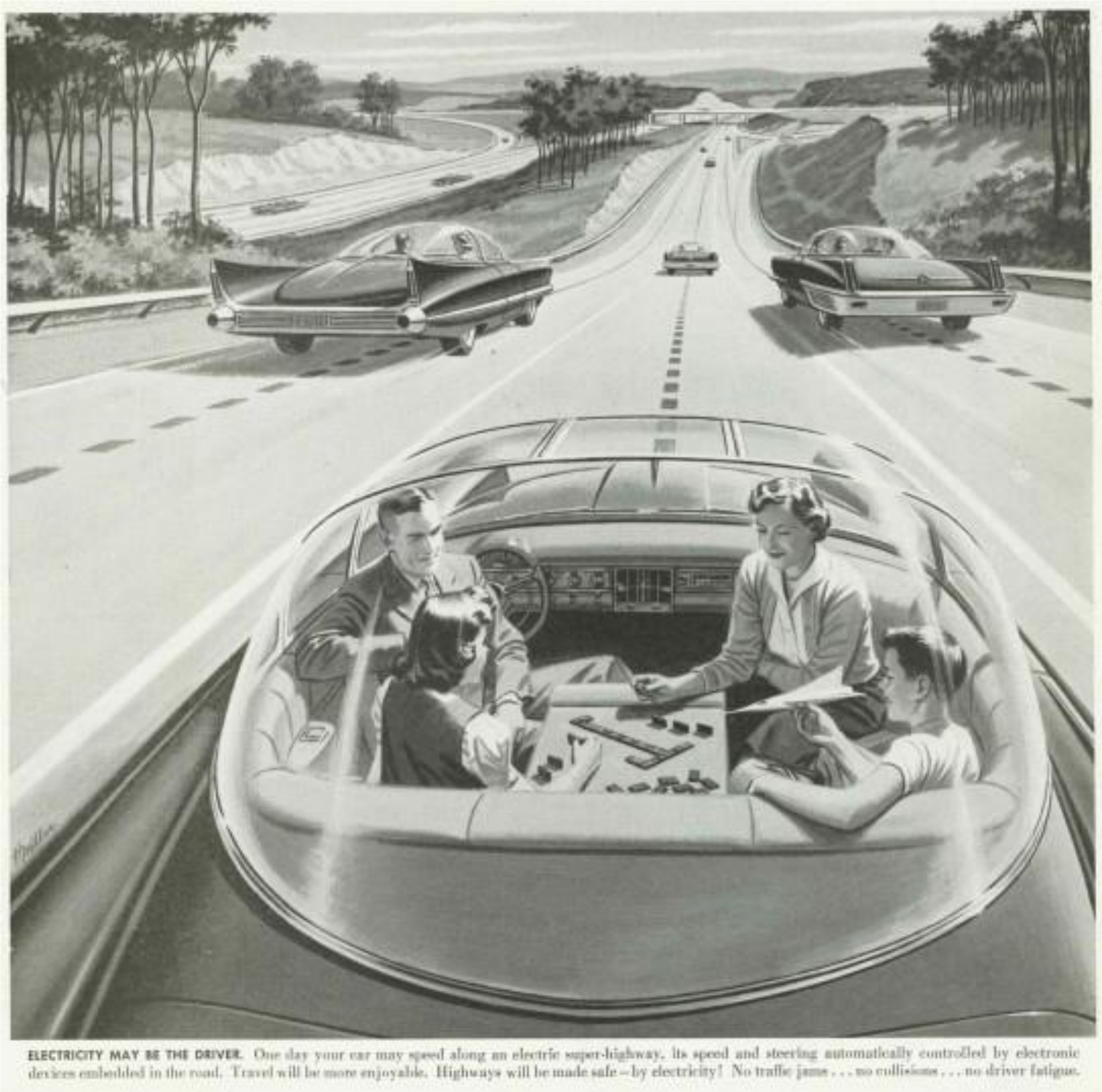
CEO

Tech-I-M

EQUIPMENT/TECHNOLOGY

COMMERCIAL VEHICLE OUTLOOK

Text Questions for the Speakers to: 862-781-0001.



Driverless Car of the Future, advertisement for “America’s Electric Light and Power Companies,” Saturday Evening Post, 1950s. Credit: The Everett Collection.

Mercedes-Benz F 015

Level 0	No automation
Level 1	Adaptive cruise control, auto windshield wipers, automatic lights, anything that supports the driver (e.g. ESC, V2V)
Level 2	Hands off and feet off but eyes on. *Driver is responsible* - *Low speed congested traffic*
Level 3	Hands off feet off eyes off – shared dual control but *vehicle is responsible*
Level 4	Complete machine control – *Driver has no responsibility at all*

TRANSPORTATION RESEARCH INSTITUTE
UNIVERSITY OF MICHIGAN

No-Automation (Level 0): The driver is in complete and sole control of the primary vehicle controls - brake, steering, throttle, and motive power - at all times.

Function-specific Automation (Level 1): Automation at this level involves one or more specific control functions. Examples include electronic stability control or pre-charged brakes, where the vehicle automatically assists with braking to enable the driver to regain control of the vehicle or stop faster than possible by acting alone.

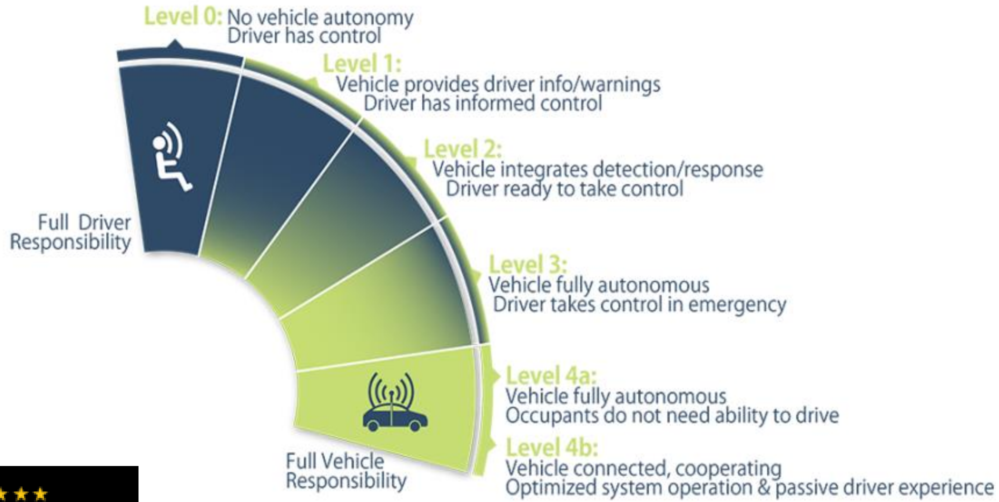
Combined Function Automation (Level 2): This level involves automation of at least two primary control functions designed to work in unison to relieve the driver of control of those functions. An example of combined functions enabling a Level 2 system is adaptive cruise control in combination with lane centering.

Limited Self-Driving Automation (Level 3): Vehicles at this level of automation enable the driver to cede full control of all safety-critical functions under certain traffic or environmental conditions and in those conditions to rely heavily on the vehicle to monitor for changes in those conditions requiring transition back to driver control. The driver is expected to be available for occasional control, but with sufficiently comfortable transition time. The Google car is an example of limited self-driving automation.

Full Self-Driving Automation (Level 4): The vehicle is designed to perform all safety-critical driving functions and monitor roadway conditions for an entire trip. Such a design anticipates that the driver will provide destination or navigation input, but is not expected to be available for control at any time during the trip. This includes both occupied and unoccupied vehicles.

NHTSA
NATIONAL HIGHWAY TRAFFIC SAFETY ADMINISTRATION

NHTSA Levels of Autonomy



NHTSA
NATIONAL HIGHWAY TRAFFIC SAFETY ADMINISTRATION

Levels of Autonomy		Existing Examples
1 Driver only	The vehicle is entirely under human control but may have some automated systems.	Cruise control, electronic stability control, anti-lock brakes
2 Driver assistance	The steering and/or acceleration are automated but the driver must control the other functions.	Adaptive cruise control: distance to car in front maintained. Parking assistant: steering is automated, driver controls accelerator and brakes.
3 Partial autonomy	The driver does not control steering or acceleration but is expected to be attentive at all times and take back control instantaneously when required.	Adaptive cruise control with lane keeping. Traffic jam assistance.
4 High autonomy	Vehicles are able to operate autonomously for some portions of the journey. Transfer of control back to the human driver happens with some warning.	Prototype vehicles.
5 Full autonomy	The vehicle is capable of driving unaided for the entire journey with no human intervention – potentially without a human in the car.	None

Table 1: Adapted from Autonomous Road Vehicles - POSTnote 443, September 2013, Dr Chandrika Nath, Parliamentary Office of Science and Technology, Parliamentary Copyright 2013

LLOYD'S

Puget Sound Regional Council

Autonomous Car Interest Questions	Not at all Interested	Somewhat Uninterested	Neutral	Somewhat Interested	Very Interested	Don't Know
Taking a taxi ride in an autonomous car without a driver	39%	8%	15%	19%	9%	10%
Commuting alone using an autonomous vehicle	38%	6%	12%	18%	16%	10%
Riding in an autonomous car for a short trip to get to a vehicle	34%	5%	12%	23%	16%	10%
Autonomous Car Concern Questions	***Not at all Concerned***	***Somewhat Unconcerned***	***Neutral***	***Somewhat Concerned***	***Very Concerned***	***Don't Know***
Equipment and system safety	7%	4%	13%	26%	39%	11%
Capability to react to the environment	7%	3%	9%	22%	48%	11%
Legal Liability of drivers or owners	7%	4%	13%	27%	38%	11%

Trucking's Future Now

JOSHUA SWITKES
CEO
Peloton Technology

DEREK ROTZ
Director, Advanced Engineering
Daimler Trucks North America LLC

MODERATOR: PAUL MENIG
CEO
Tech-I-M

BILL KAHN
Principal Engineer /
Manager Advanced Concepts
Peterbilt Motors

SANDEEP KAR
Global Vice President, Automotive & Transportation Research
Frost & Sullivan

EQUIPMENT/TECHNOLOGY

COMMERCIAL VEHICLE OUTLOOK

Trucking's Future Now

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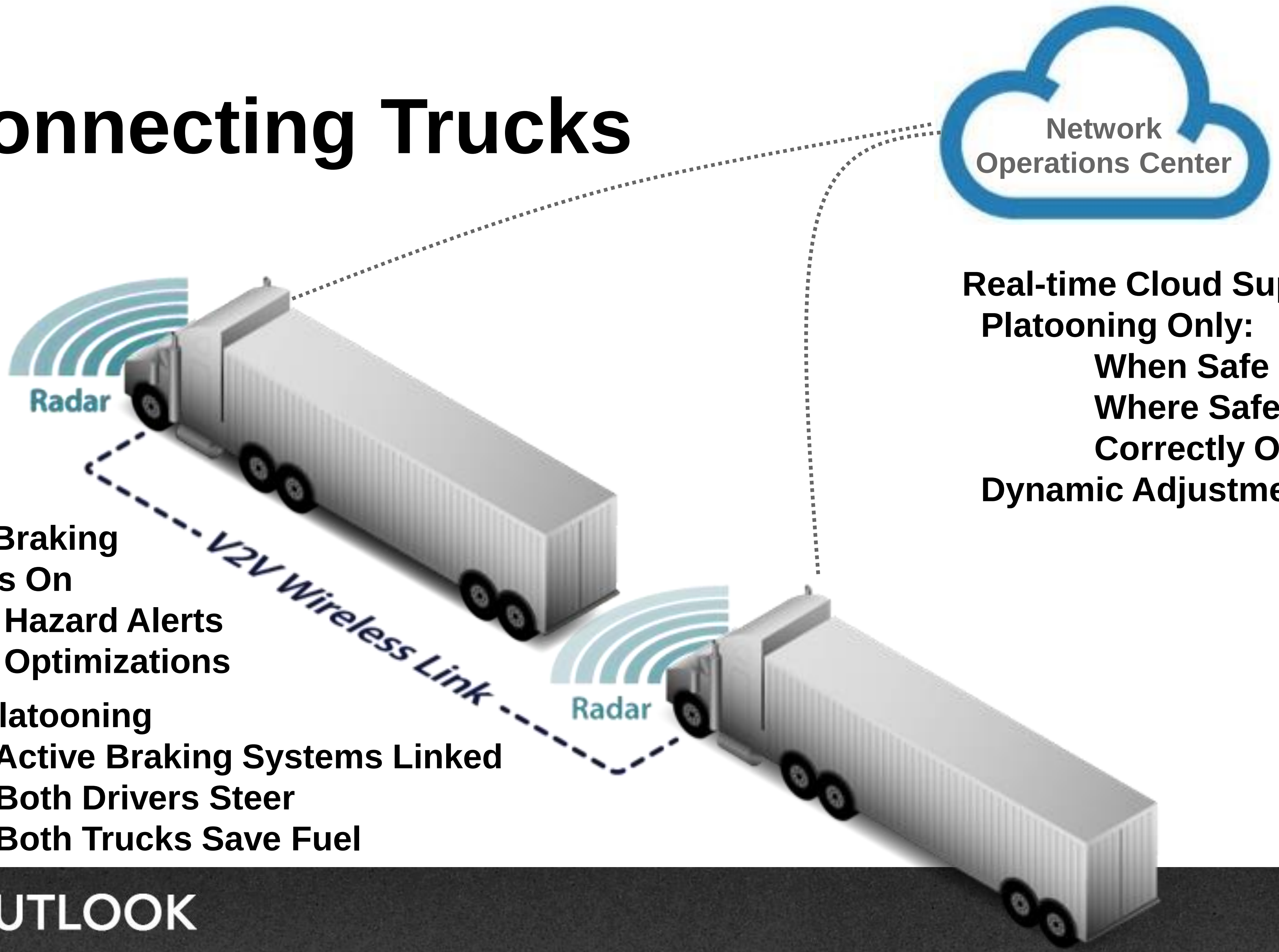
COMMERCIAL VEHICLE OUTLOOK

Text Questions for the Speakers to: 862-781-0001.

Prevent Accidents Save Fuel by Connecting Trucks

Peloton

Connecting Trucks



Real-time Cloud Supervision
- Platooning Only:
  - When Safe
  - Where Safe
  - Correctly Ordered
- Dynamic Adjustment to Conditions

Active Braking
- Always On
- Cloud Hazard Alerts
- Cloud Optimizations

Platooning
- Active Braking Systems Linked
- Both Drivers Steer
- Both Trucks Save Fuel

Integrations

Michigan
- Meritor-Wabco
- Volvo
- Freightliner

CA, NV, UT, AZ, NM, TX
- Meritor-Wabco
- Peterbilt

OH, FL
- Bendix
- Peterbilt
- Kenworth

Trucking's Future Now

BILL KAHN

Principal Engineer / Manager Advanced Concepts

Peterbilt Motors

EQUIPMENT/TECHNOLOGY

COMMERCIAL VEHICLE OUTLOOK

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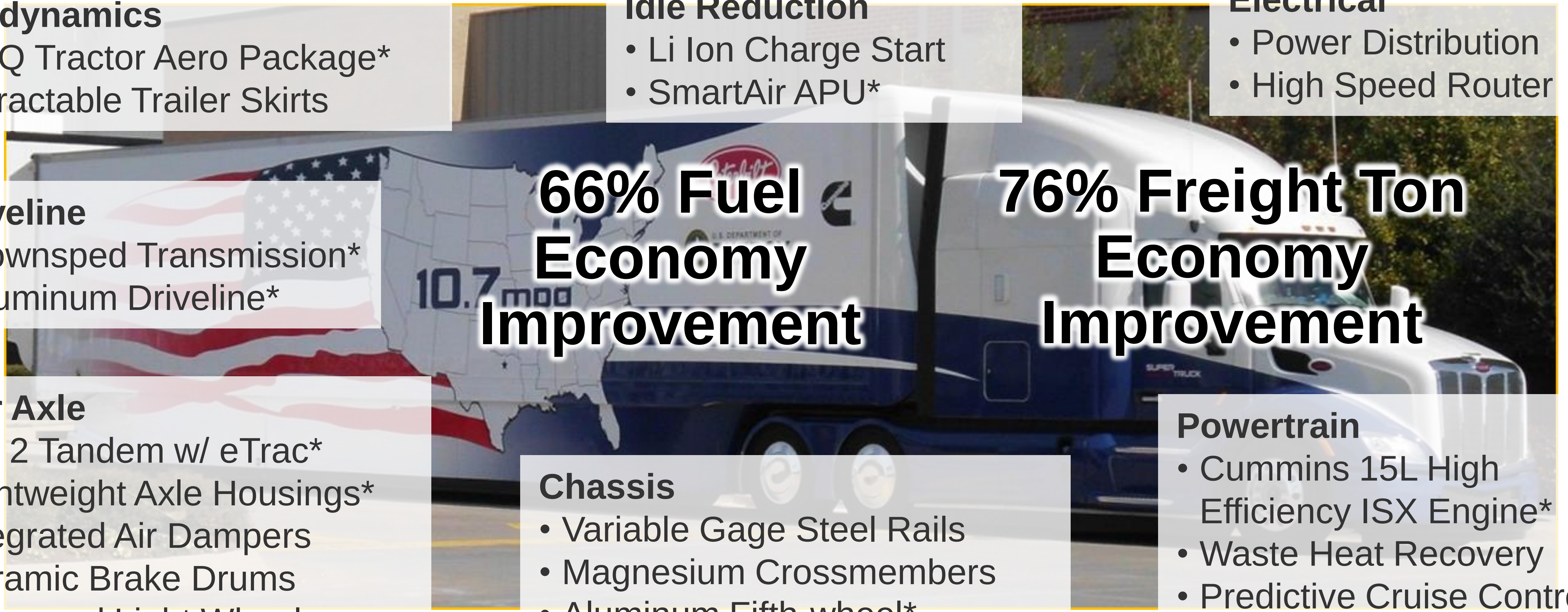
DOE SuperTruck



Aerodynamics
- EPIQ Tractor Aero Package*
- Retractable Trailer Skirts

Idle Reduction
- Li Ion Charge Start
- SmartAir APU*

Electrical
- Power Distribution
- High Speed Router

Driveline
- Downsped Transmission*
- Aluminum Driveline*

66% Fuel Economy Improvement

76% Freight Ton Economy Improvement

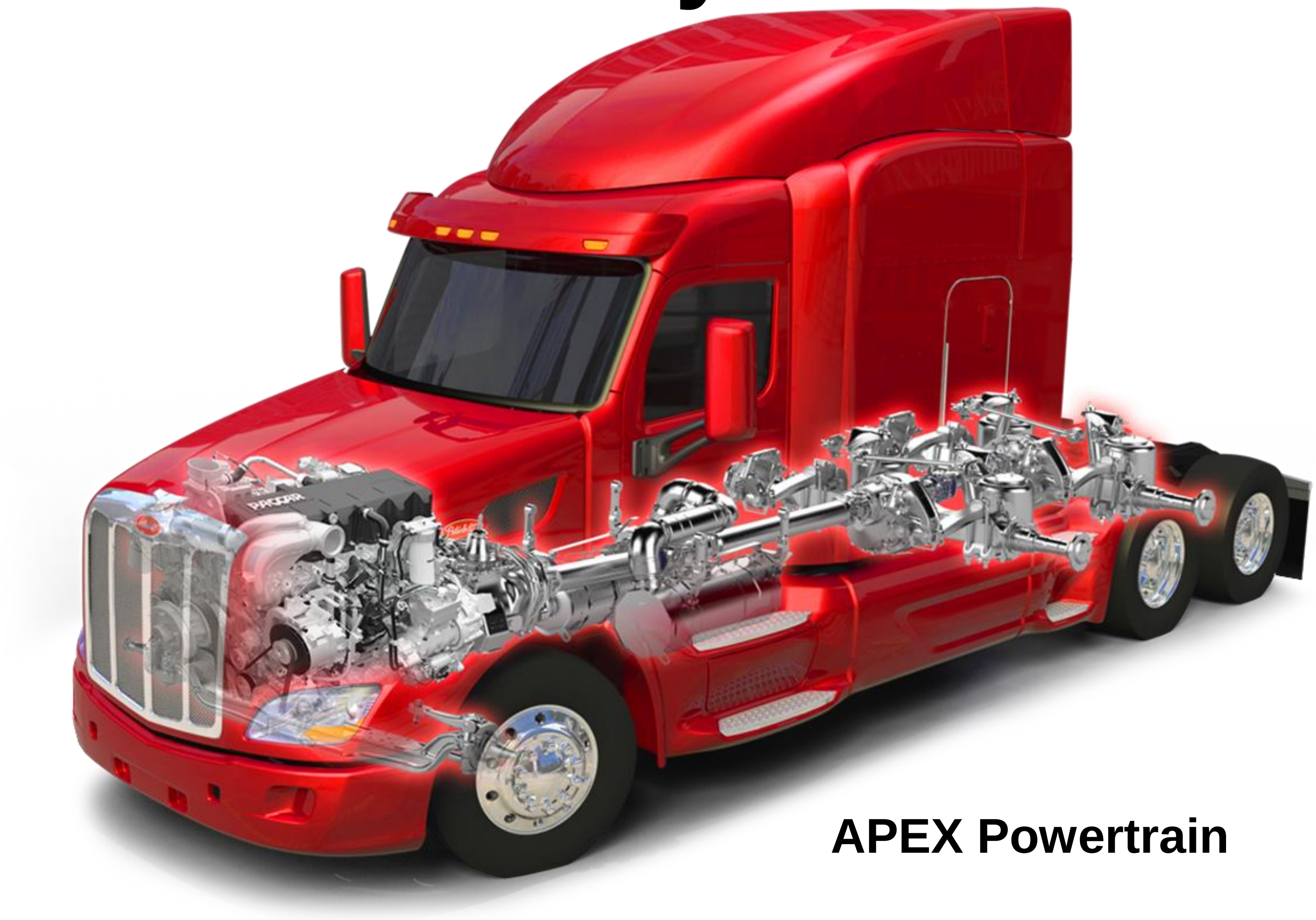
Rear Axle
- 6 X 2 Tandem w/ eTrac*
- Lightweight Axle Housings*
- Integrated Air Dampers
- Ceramic Brake Drums
- Advanced Light Wheels

Chassis
- Variable Gage Steel Rails
- Magnesium Crossmembers
- Aluminum Fifth-wheel*

Powertrain
- Cummins 15L High Efficiency ISX Engine*
- Waste Heat Recovery
- Predictive Cruise Control*

Peterbilt Model 579 EPIQ

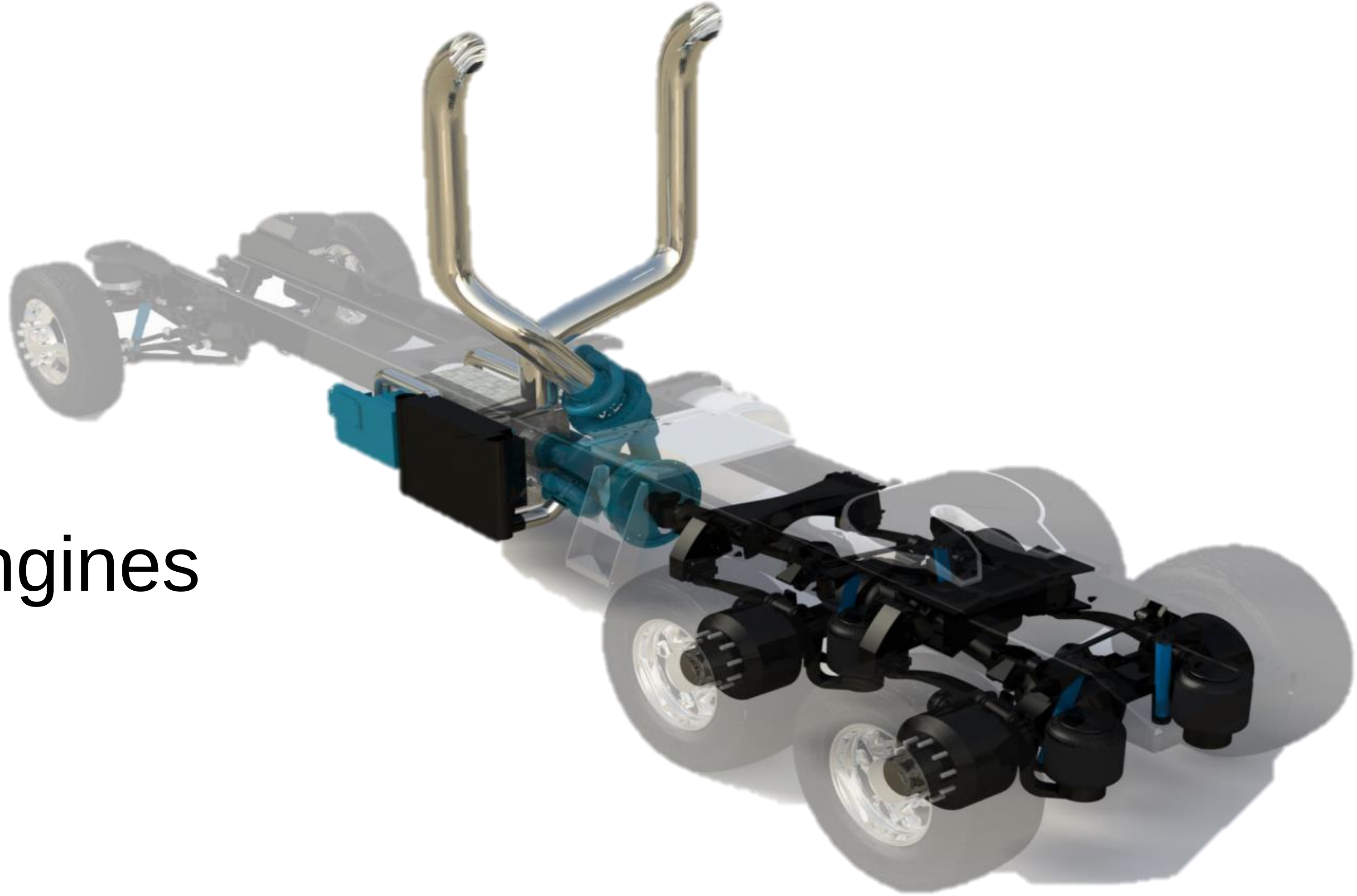
Fuel Efficiency



APEX Powertrain

Advanced Powertrain Research

- Alternative Fuels
- Hybrids
- Turbines
- Fuel Cells
- 2-Stroke Diesel Engines



Technology Demonstrators

Model 386 Aero 2 Package

Lightweight Optimization

HD Hybrid Development

Electrified A/C Condenser

Corvus Energy Demo

2012 & 2014 Tech Truck


1333573
Walmart
53'
Walmart

Peterbilt Advanced Driver Assist Systems

Autonomous Roadmap

2014 | 2016 | 2018 | 2020 | 2022

Base Functionality Development

- TRW Torque Overlay
- GPS Navigation Demo
- Lane Keeping
- Recorded Route Demo

Legend:
- Demonstrated Task
- Active Testing
- Industry's Production Est.

Platooning

- Platooning w/ Steering via DSRC
- Platooning – Same Lane (Peloton)

Sensor Fusion

- Object Detection / Stop Action
- DSRC Safety Messaging
- Object Detection / Avoidance Action

Production Functionality

- Lane Keeping
- Traffic Jam Assist – Same Lane
- Platooning
- Autonomous Driving w/ Driver
- Autonomous Driving

Trucking's Future Now

DEREK ROTZ

Director, Advanced Engineering

Daimler Trucks North America LLC

EQUIPMENT/TECHNOLOGY

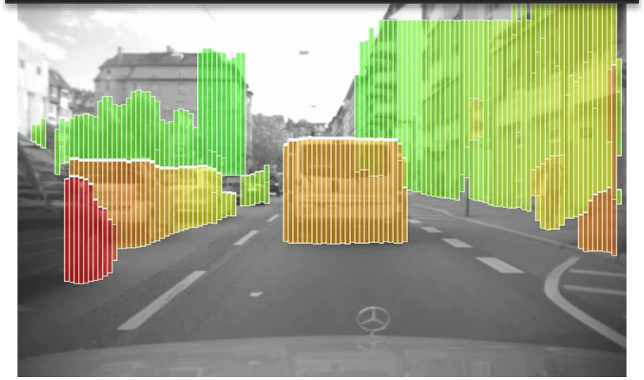
COMMERCIAL VEHICLE OUTLOOK

Text Questions for the Speakers to: 862-781-0001.

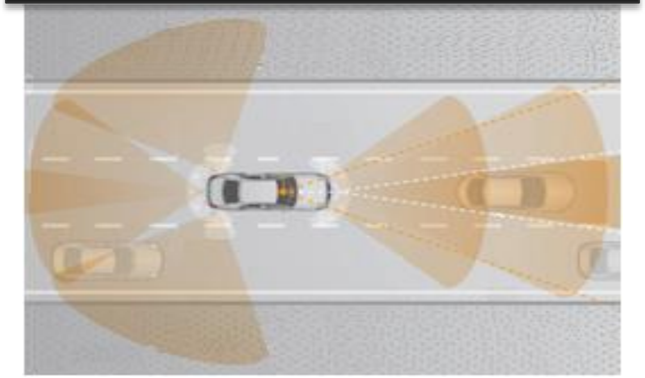
Daimler’s Vision for Safety

“The Road to Accident-free Driving”

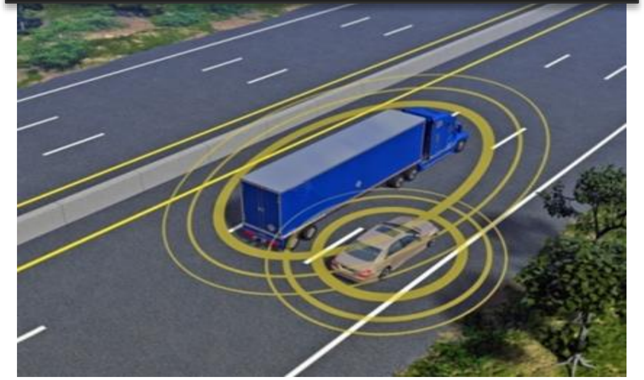
Vision Systems

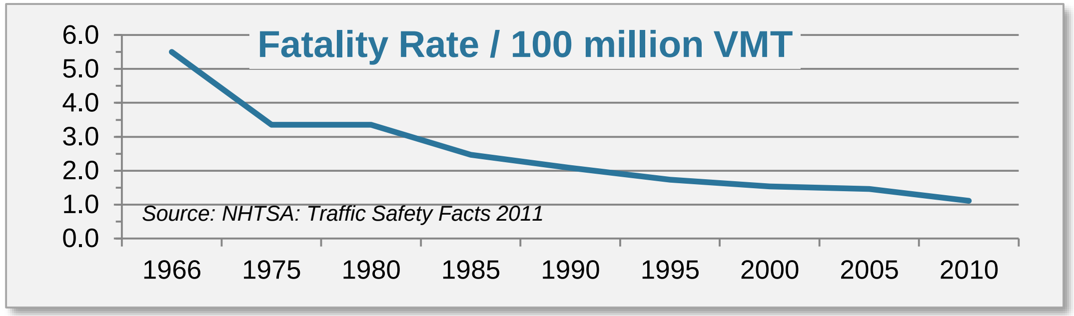


Radar

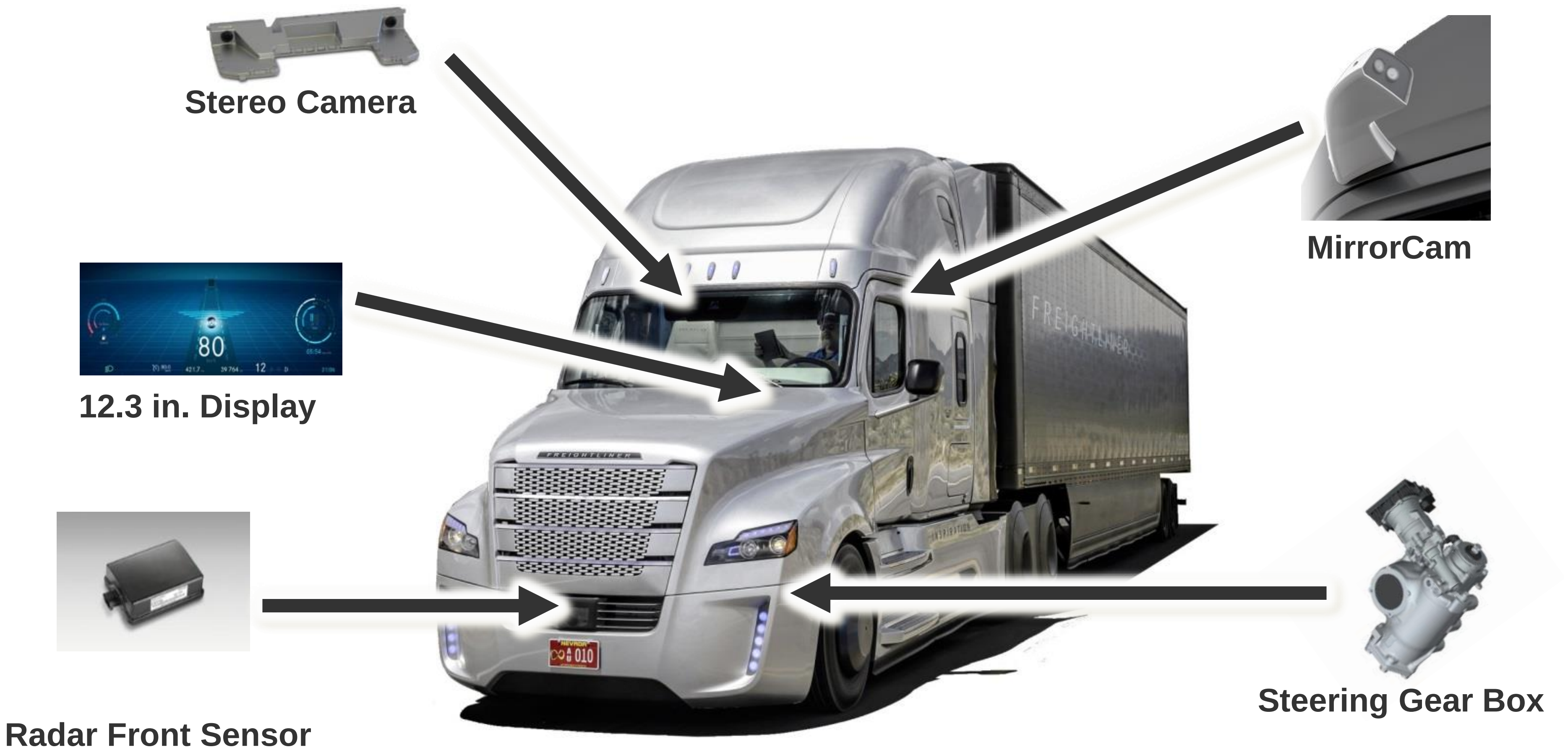


Communications





Automated Driving Achieved by Full Vehicle Integration



Consistent National Approach to Enable Automated Driving

Trucking's Future Now

SANDEEP KAR

Global Vice President, Automotive & Transportation Research

Frost & Sullivan

EQUIPMENT/TECHNOLOGY

COMMERCIAL VEHICLE OUTLOOK

Text Questions for the Speakers to: 862-781-0001.

How OEMs Will Differentiate Their Brands in the Future

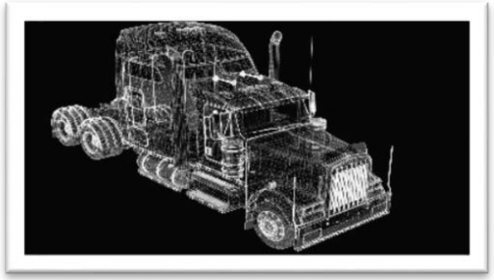
POWERTRAIN EFFICIENCY

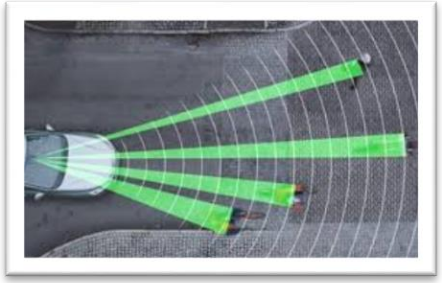
SERVICE & MAINTENANCE

ADVANCED SAFETY

SUSTAINABILITY & ENVIRONMENT

AUTOMATED MOBILITY





QUALITY & RELIABILITY

COMFORT & CONVENIENCE

COST OF OWNERSHIP

CONNECTIVITY & SMART

HEALTH , WELLNESS, WELLBEING

PRE 2010

TODAY

FUTURE

Automated Driving- Comparative Benchmarking

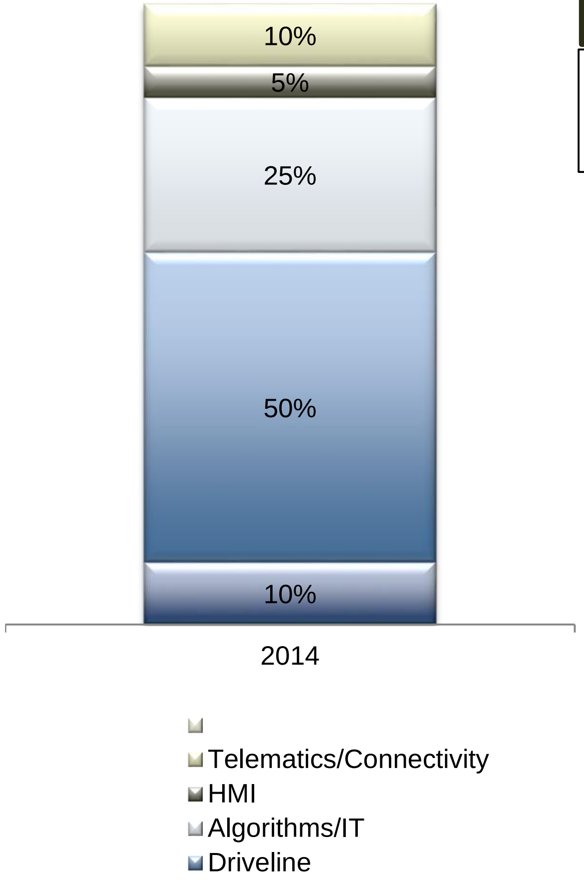
Level of Automation	Level 1	Level 2	Truck Platooning	Level 3	Level 4
Enabling Technology	None	Electric-hydraulic power steering (EHPS), electric braking systems (EBS), electronic throttle control, adaptive cruise control (ACC), advanced driver assistance systems (ADAS)	+ V2X, DSRC, integrated safety systems (ISS), cameras, sensors, ACC	+ Intersection assist, redundancy backup for connectivity, self-driving capability until driver takes over control	+ Multiple redundancies (hardware) and artificial intelligence (software)
Incremental Cost to OEMs	$0	$5,000–$10,000	$5,000–$10,000	$20,000–$25,000	$30,000 +
Year Expected	Today	~2010–2020	~2018–2022	~2021–2025	~ 2035 +
Distance/ Duration of Automation	**None**	**Low**	**Moderate**	**Moderate-High**	**High**
Driver Involvement	**Very High**	**High**	**Moderate**	**Moderate-Low**	**None**
Vocation Application (Long-haul, Regional, Vocational)	**All**	**Long-haul** (High) **Regional** (High) **Vocational** (Medium)	**Long-haul** (High) **Regional** (Medium) **Vocational** (Low)	**Long-haul** (High) **Regional** (Medium) **Vocational** (Low)	**Long-haul** (High) **Regional** (Medium-High) **Vocational** (Medium-High)

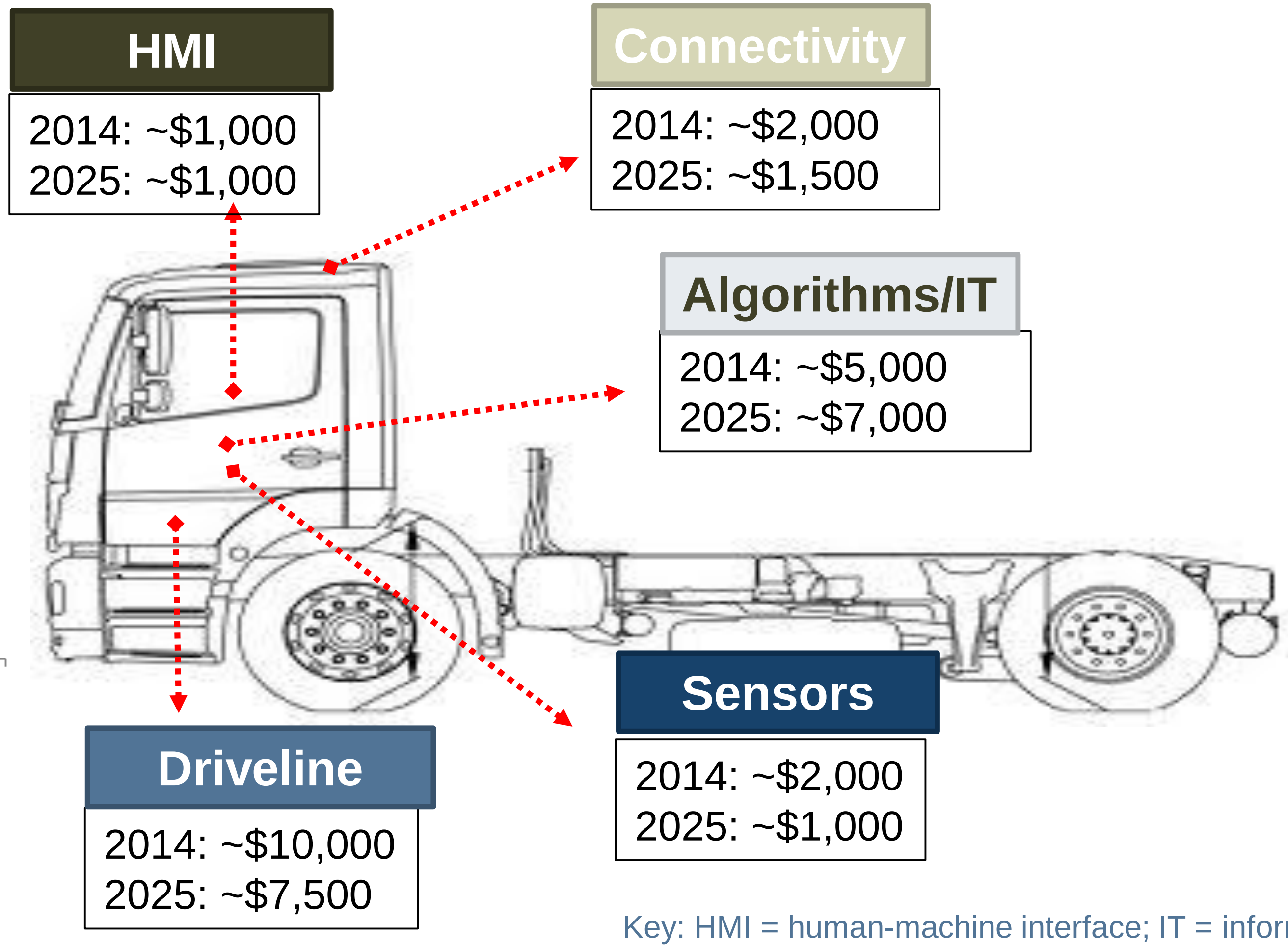
● High ◕ Medium-High ◑ Medium ◔ Low

Source: Frost & Sullivan

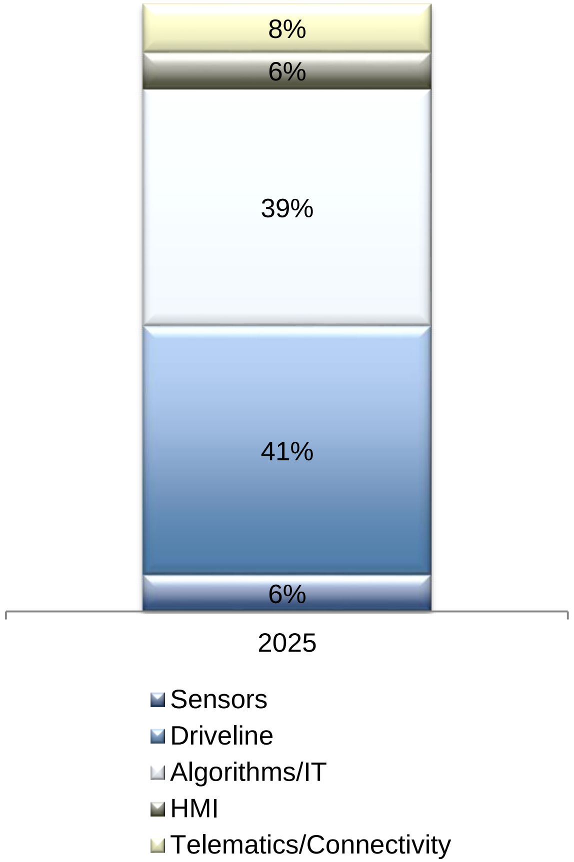
Autonomous Commercial Vehicle Incremental Cost Analysis –Now to Level 3

Cost ~$20,000





Cost ~$18,000



Key: HMI = human-machine interface; IT = information technology. Source: Frost & Sullivan

The leap from semi- to highly automated will be simpler in comparison to the leap to fully automated driving (Level 4)

Level of Automation	Driver-assisted Level 2	Semi-automated Level 3	Fully Automated Level 4
Automatic transmission	Required	Required	Required
Throttle, steering, and braking automation	Optional	Required	Required
Radar	Required	Required	Required
Ultrasonic sensors	Optional	Required	Required
Forward-looking camera	Required	Required	Required
Rear-vision camera	Optional	Required	Required
Surround-view camera	Optional	Required	Required
Night vision	Optional	Optional	Required
LIDAR	Optional	Optional	Required
GPS and map-supported ADAS	Optional	Optional	Required
Telematics (prognostics and diagnostics)	Optional	Required	Required
Wireless and communication networks	Optional	Required	Required
Artificial intelligence	Optional	Optional	Required
Multiple redundancies	Optional	Optional	Required
Self-healing systems	Optional	Optional	Required

Source: Frost & Sullivan

Implications on Human Factors

Recruiting Drivers

Retaining Drivers

Driver Performance

Driver Safety

Driver-related Fuel Efficiency

Driver Wages

Level 4 Automation- No Driver?

Driver Productivity

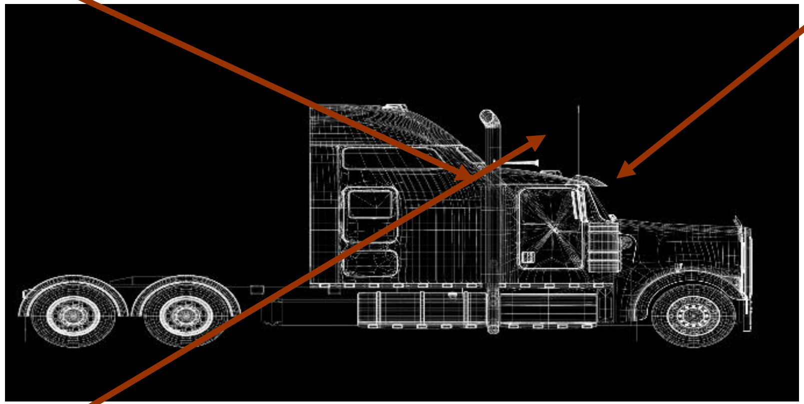
Source: Frost & Sullivan

Cybersecurity and Data Encryption- Absolute Necessity

Critical Vehicle Data

- Engine control unit
- Transmission control unit
- Body controllers (locks/lights)
- Air bag control unit
- Steering, suspension, and stability

Cybersecurity Attack Points



External Interfaces

- Keyless entry
- TPMS
- V2X communication/DSRC
- Satellite data
- Sensor and camera data

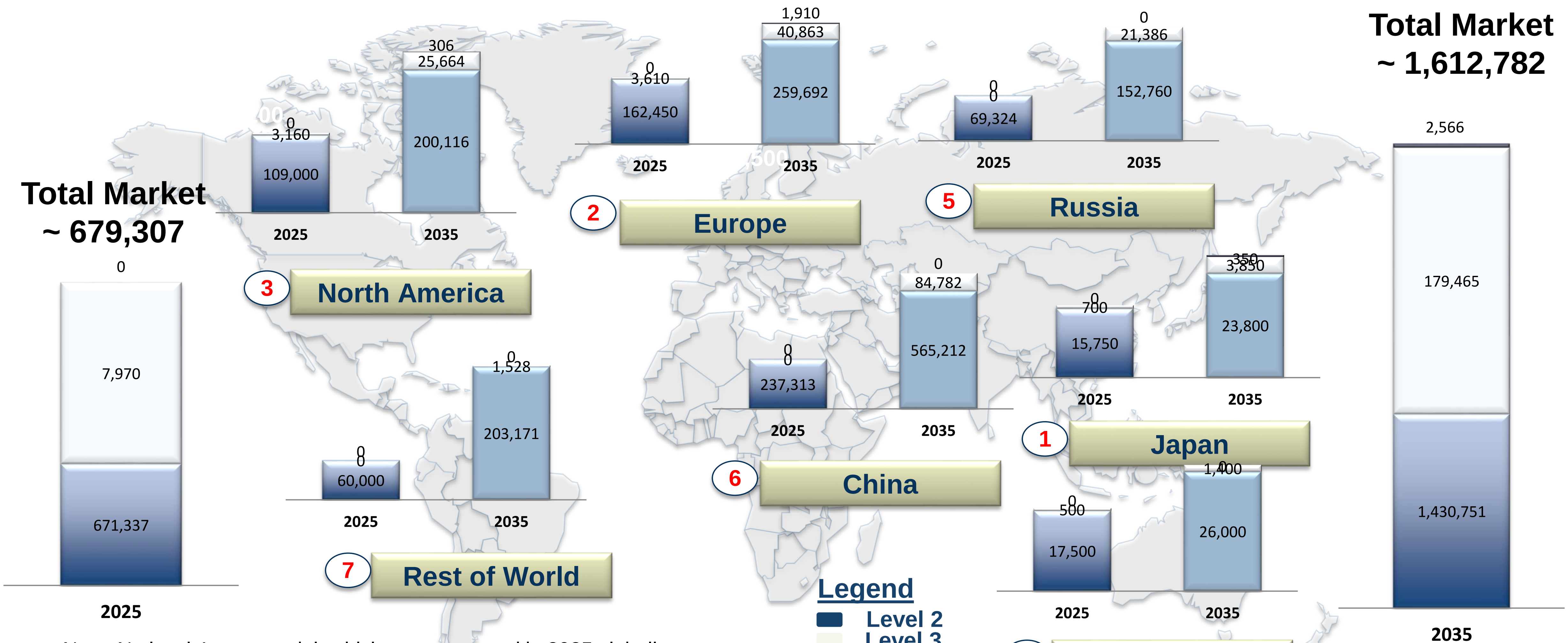
Infotainment & Telematics

- Vehicle data from OBD II, GPS coordinates, driving patterns, diagnostics
- Internet, smartphone interfacing, Bluetooth, Wi-Fi, app store
- Radio and media streaming

In the automated scenario, there is a high possibility of a vehicle being compromised. Drivers must be provided with a fail-safe switch to shut down ADAS systems to regain full control of the vehicle.

Dependence on an Internet network remains; the exchange of data must be managed properly. Encryption of data exchange will bring third-party security solution providers into the value chain.

Snapshot of Global Automated Truck Adoption, 2025 and 2035



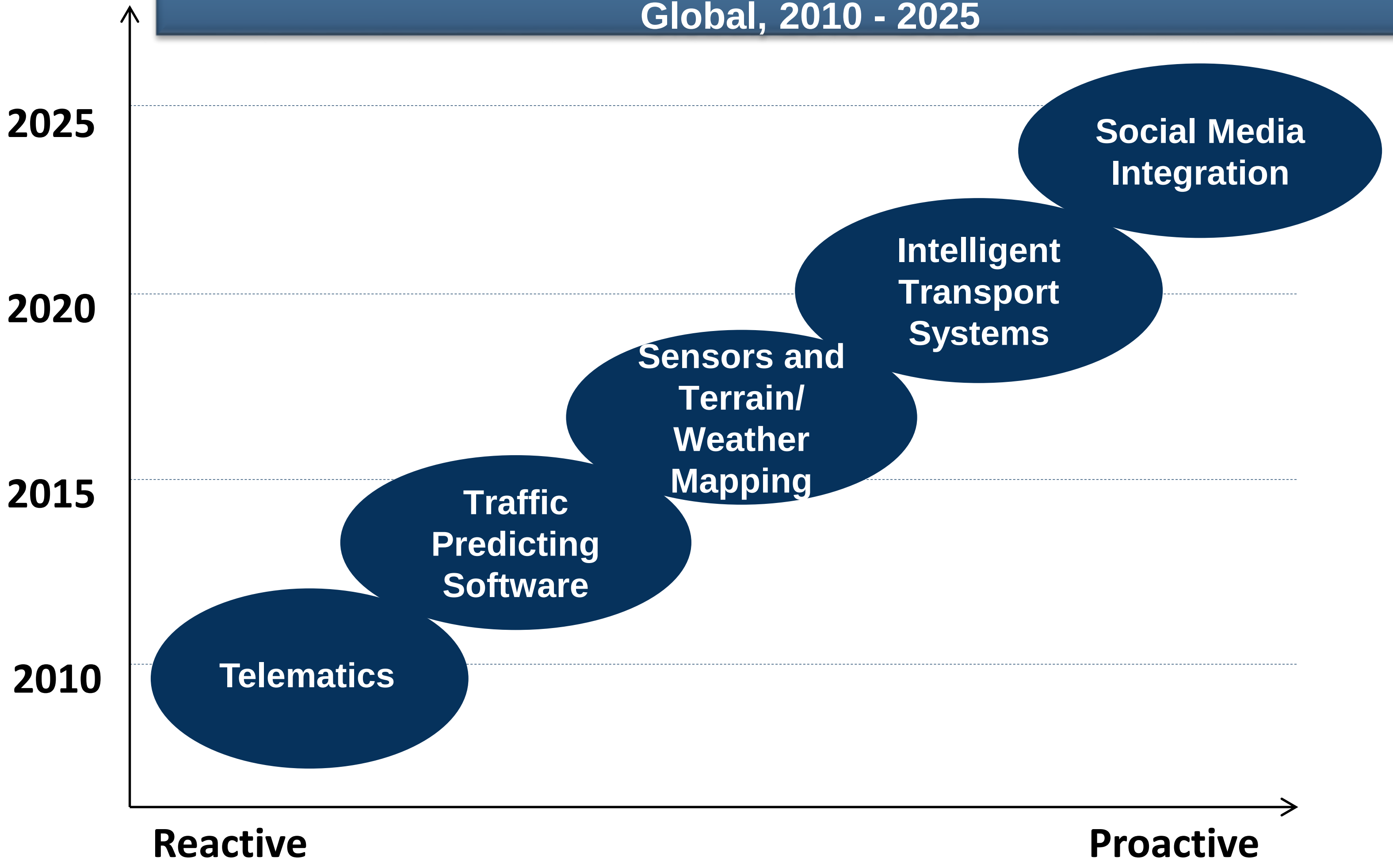
Note: No level 4 commercial vehicles are expected in 2025 globally

Ranking by government support of autonomous commercial vehicle technology

Source: Frost & Sullivan

Role of Big Data in Ushering a New Era in Trucking

Connectivity and Urban Logistics: Evolution of Technology Platforms, Global, 2010 - 2025



Big Data Catalysis

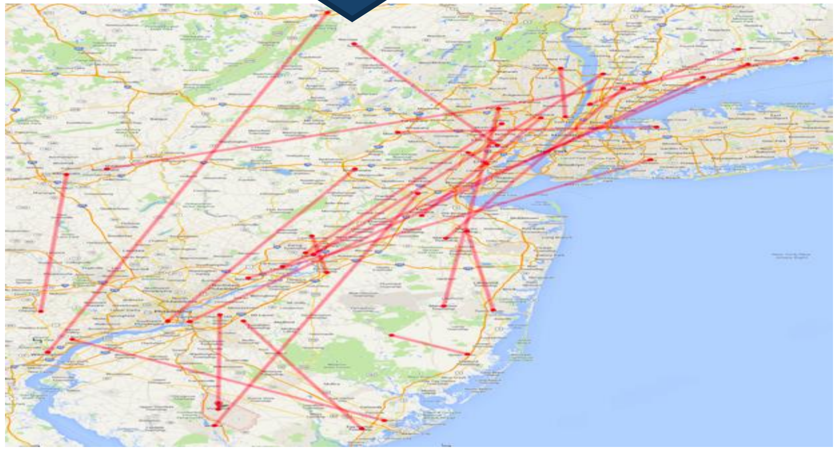
- Fleets to obtain both **panoramic and granular view** of operating parameters
- **Proactive decision making** enabled by big data analytics
- **Fuel, freight, driver, equipment efficiencies** will be elevated
- New technologies and concepts will emerge- **Automated mobility, Uber for trucks, prognostics, maintenance on the fly, innovative insurance models**

Source: Frost & Sullivan analysis.

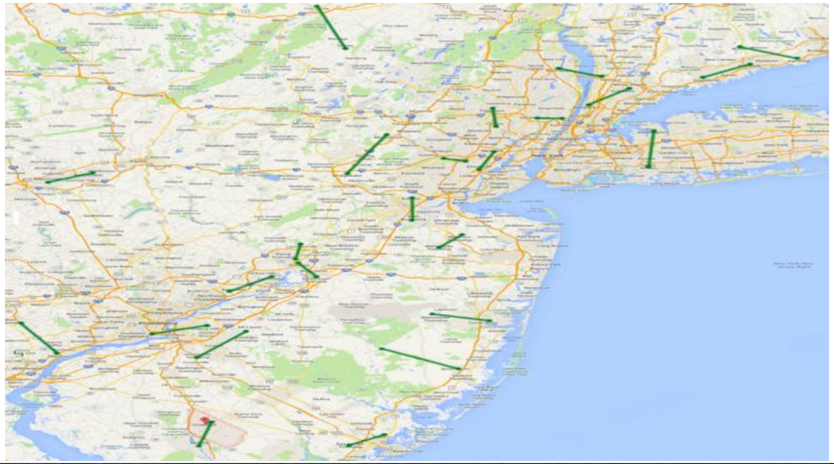
Uber for Trucks is Here- By 2025 $26.4 Billion in Freight Transactions to Occur Through This Platform

25 Trucks, 25 Loads, One Day= 1,725 Empty Miles, Driver Fatigue, Traffic Congestion

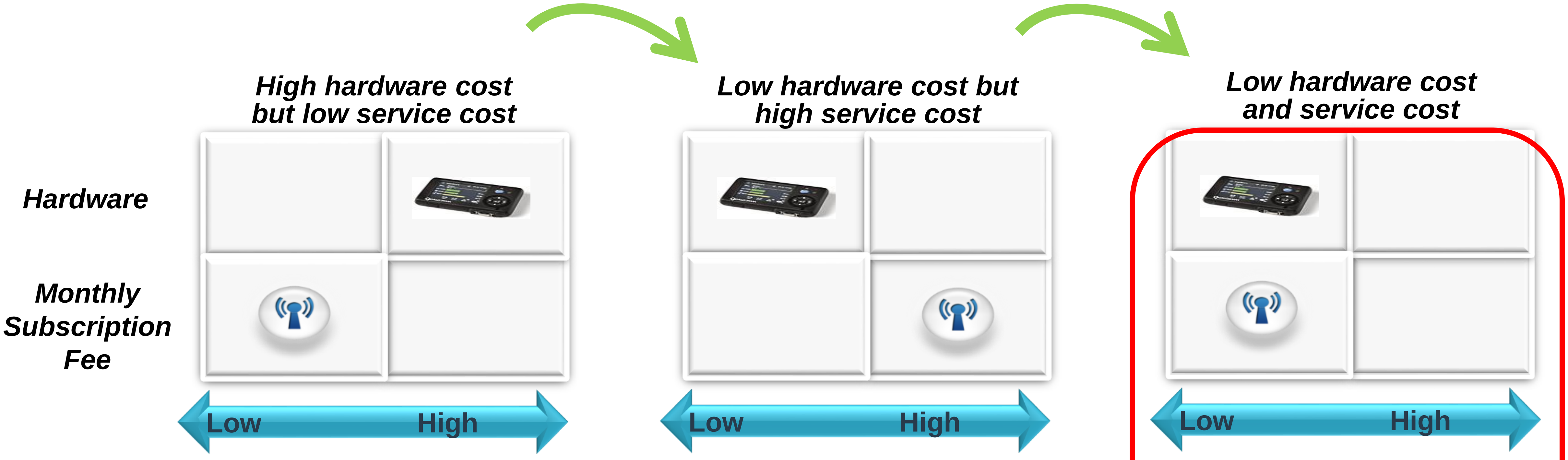
With Automated Matching System→ Empty Miles Reduced to 272, Less Tired Drivers, Less Traffic, Happy Shippers, Happy Fleets



If you scale this up to 2 Million Trucks in US that drive through US cities each day about 12 Billion Empty Miles Can be Reduced



What Does Not Meet the Eye- Impact of These Changes on Telematics and Connectivity Business

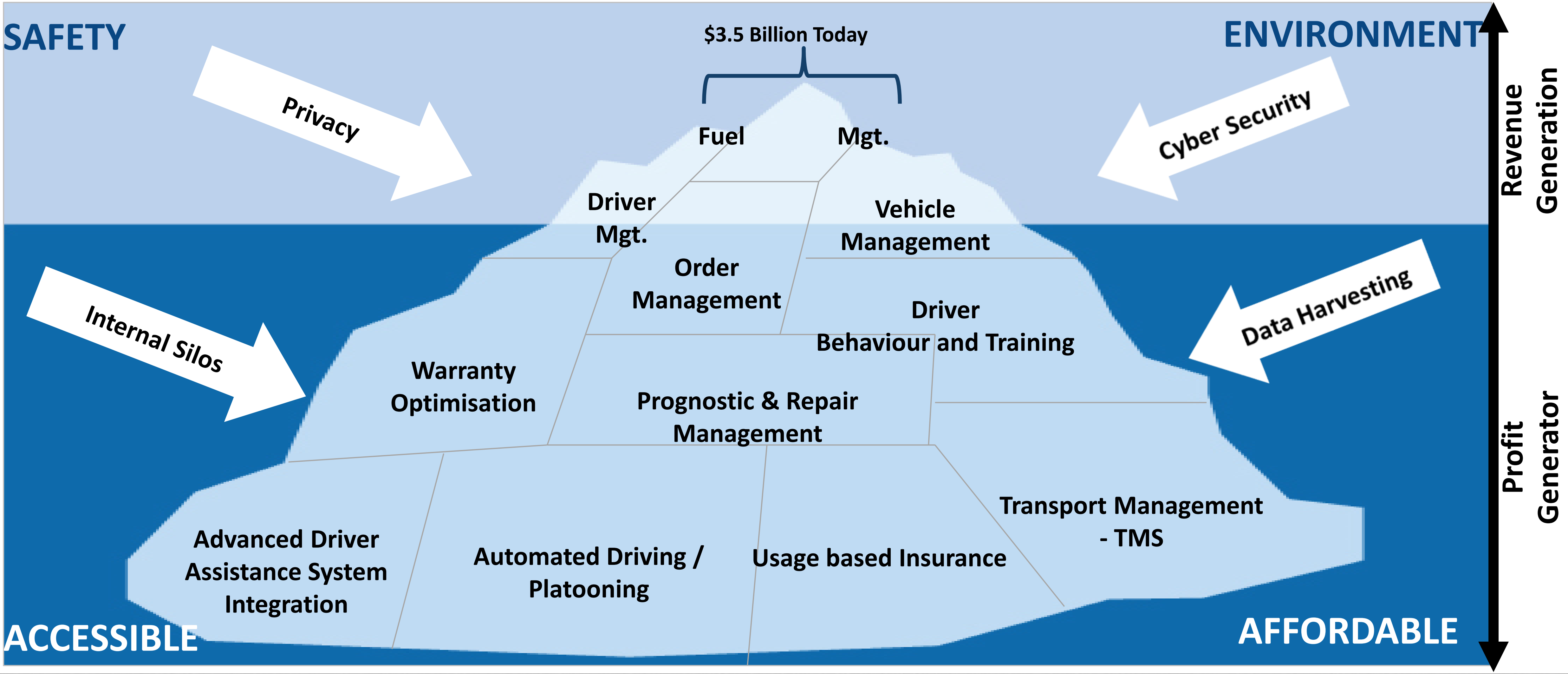


High upfront investment with low monthly service fee

No upfront investment with high monthly service fee

Profit sharing model

Talking About Things That Do Not Meet the Eye



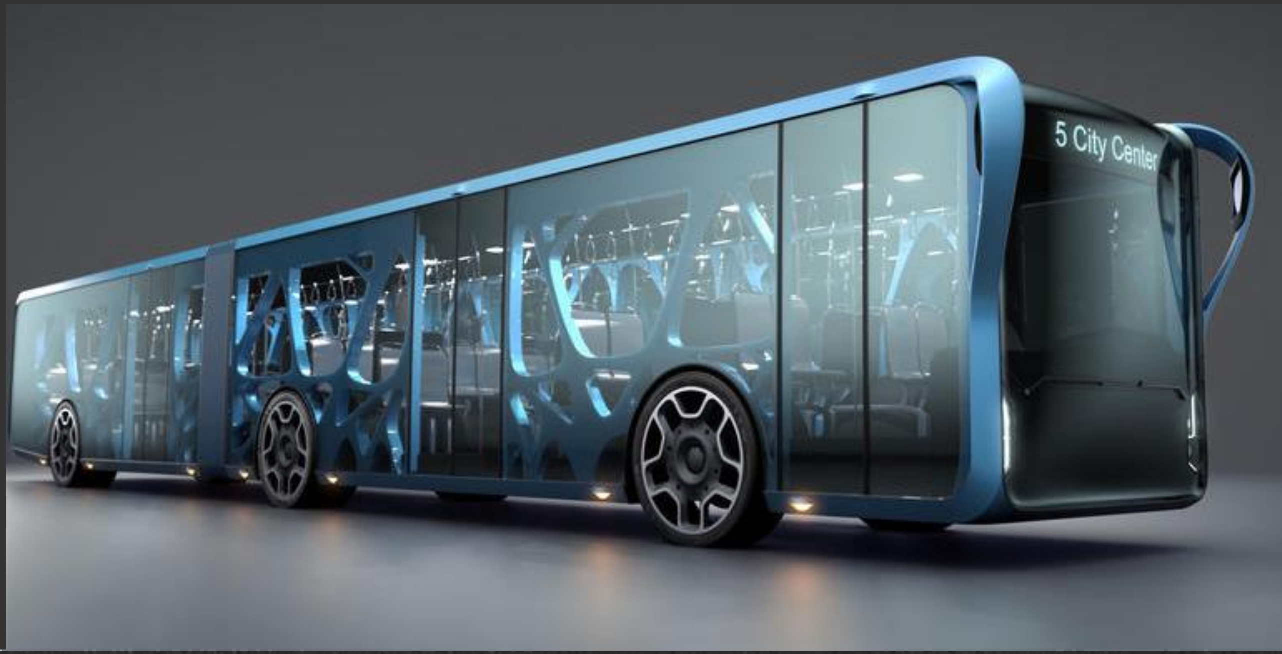
Commercial Vehicle Outlook: Truck of the Future- What Will Be Its Attributes?

Text Questions for the Speakers to:

862-781-0001

EQUIPMENT/TECHNOLOGY

COMMERCIAL VEHICLE OUTLOOK



#CVOUTLOOK

COMMERCIAL VEHICLE OUTLOOK

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HDMA

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