# TuSimple 2022 Investor Day

## May 11, 2022

# Disclaimer

This presentation and any accompanying oral statements (together, this "Presentation") contain forward-looking statements. All statements other than statements of historical fact contained in this letter, including statements as to future results of operations and financial position of TuSimple Holdings Inc. and its subsidiaries (the "Company"), planned products and services by the Company or any of its subsidiaries, business strategy and plans of the Company or any of its subsidiaries, launch dates of products or services in the United States or in any other territory, the commencement date of the Company's Driver Out Pilot Program, expected safety benefits of the Company's autonomous semi-trucks, objectives of management for future operations of the Company, market size and growth opportunities in various global territories, competitive position and technological and market trends in various global territories, statements regarding a transaction at a subsidiary level for the Company's Asia-Pacific-focused business, are forward-looking statements. Forward-looking statements are inherently subject to risks and uncertainties, some of which cannot be predicted or quantified. In some cases, you can identify forward-looking statements by terms such as "will", "expect," "plan," "anticipate," "intend," "target," "project," "predict," "potential," "explore" or "continue" or the negative of these terms or other similar words. The Company has based these forward-looking statements largely on its current expectations and assumptions and on information available as of the date of this letter. The Company assumes no obligation to update any forward-looking statements after the date of this letter, except as required by law.

The forward-looking statements contained in this Presentation are subject to known and unknown risks, uncertainties, assumptions and other factors that may cause actual results or outcomes to be materially different from any future results or outcomes expressed or implied by the forward-looking statements. These risks, uncertainties, assumptions and other factors include, but are not limited to, those related to autonomous driving being an emerging technology, the Company's limited operating history in a new market, the regulations governing autonomous vehicles, the Company's dependence on its senior management team, reliance on third-party suppliers, potential product liability or warranty claims and the protection of the Company's intellectual property, which may be more difficult to protect in China than in the U.S. Moreover, the Company operates in a competitive and rapidly changing environment, and new risks may emerge from time to time. You should not put undue reliance on any forward-looking statements. Forward-looking statements should not be read as a guarantee of future performance or results and will not necessarily be accurate indications of the times at, or by, which such performance or results will be achieved, if at all. It is not possible for the Company to predict all risks, nor can the Company assess the impact of all factors on its business or the markets in which it operates or the extent to which any factor, or combination of factors, may cause actual results or outcomes to differ materially from those contained in any forward-looking statements the Company may make.

You should carefully consider the foregoing factors and the other risks and uncertainties described under the caption "Risk Factors" in the Quarterly Report on Form 10-Q for the quarter ended March 31, 2022, filed with the Securities and Exchange Commission (the "SEC") on May 4, 2022, and the Company's other filings with the SEC. These SEC filings identify and address other important risks and uncertainties that could cause actual events and results to differ materially from those contained in the forward-looking statements. This Presentation also contains estimates, forecasts and other statistical data relating to market size and growth and other industry data. These data involve several assumptions and limitations, and you are cautioned not to give undue weight to such estimates. The Company has not independently verified the statistical and other industry data generated by independent parties and contained in this Presentation and, accordingly, it cannot guarantee their accuracy or completeness. In addition, assumptions and estimates of the Company's future performance and the future performance of the markets in which the Company competes are necessarily subject to a high degree of uncertainty and risk due to a variety of factors. These and other factors could cause results or outcomes to differ materially from those expressed in the estimates. The Company has not reconciled its expectations for non-GAAP adjusted R&D expense, non-GAAP adjusted SG&A expense, and non-GAAP adjusted EBITDA, because the stock-based compensation expense excluded from such items cannot be reasonably calculated or predicated at this time. The effect of the excluded stock-based compensation may be significant.

The Company believes these non-GAAP measures provide meaningful information to assist investors in understanding financial results and assessing prospects for future performance as they provide a better baseline for analyzing the ongoing performance of its business by excluding items that may not be indicative of core operating results. Because non-GAAP financial measures are not standardized, it may not be possible to compare these measures with other companies' non-GAAP measures having the same or similar names. Thus, the Company's non-GAAP measures should be considered in addition to, not as a substitute for, or in isolation from, the company's GAAP results.

The Company encourages investors and others to review its financial information in its entirety, not to rely on any single financial measure, and to view its non-GAAP measures in conjunction with GAAP financial measures

# Agenda

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Xiaodi Hou

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and Adrian Thompson

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Pat Dillon

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Xiaodi Hou, Pat Dillon

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Pat Dillon

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Xiaodi Hou

# Welcome

Welcome to the 2022 Investor Day:
## Click here or below to play video

# Welcome & Strategy Update

## Xiaodi Hou
Co-Founder and CEO

Through our Autonomous Freight Network (AFN), TuSimple is committed to bringing **safe**, **fuel-efficient** & **low-cost freight capacity** to market combining the best L4 autonomous technology, hardware and go-to-market strategy.

tu simple
A BETTER PATH FORWARD

# Our Progress Thus Far

**Founded by Dr. Xiaodi Hou and Mo Chen**

**Received strategic investment from NVIDIA**

**Began autonomous freight operations with UPS and USPS**

**Launched Autonomous Freight Network**

**Announced global partnership to develop autonomous trucks with TRATON**

**Completed over 160,000 autonomous miles for UPS[1]**

**Autonomous Domain Controller partnership with NVIDIA**

| 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 |

**Broke 10 world records as computer vision world champions**

**First** to demonstrate fully autonomous truck runs on surface streets and highways

**Demonstrated ~70 miles, 0 disengagement terminal-to-terminal run on CBS 60 minutes**

**First** to announce partnership to co-develop autonomous trucks with Navistar

**First** publicly listed autonomous trucking company. Raised $1Bn in net proceeds in traditional IPO

**First** to demonstrate driver out fully autonomous truck runs on open public roads

**7,475** reservations from blue chip partners across entire freight ecosystem[2]

1. UPS North American Air Freight (NAAF).
2. As of March 31, 2022.

# Market Leading Development

Our Autonomous Trucking Progress Thus Far:
[Click here or below to play video]
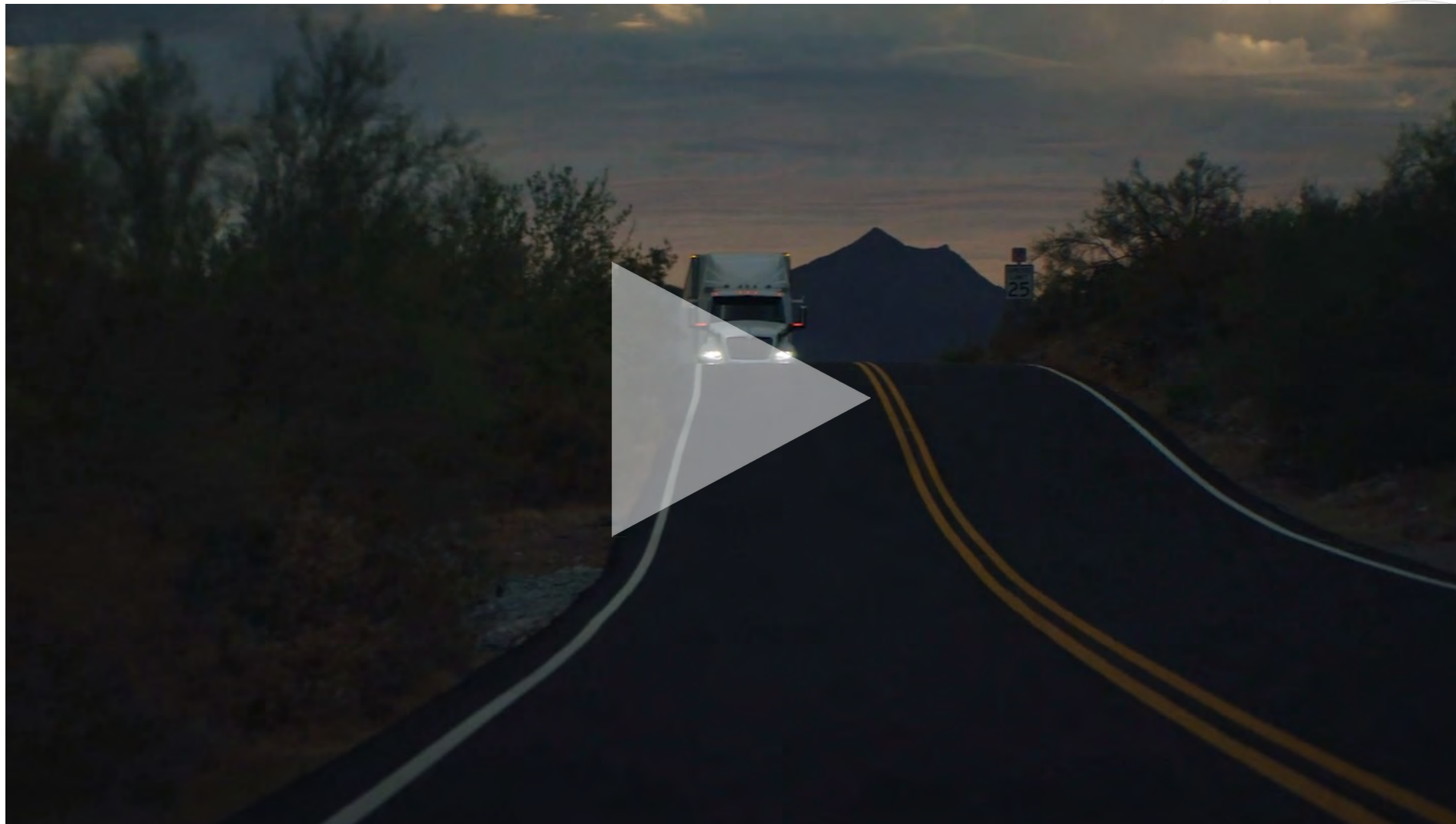
# Massive TAM Opportunity With Secular Growth Drivers

Global Truck Freight Market: $4tn

Global E-Commerce: $3.5tn

Global Automotive: $2.8tn

## $800bn
U.S. Truck Freight Market[1]

- ~80% of total U.S. freight market
- 3% CAGR from 1990-2018
- ~2.3mm Class 8 semi-trucks
- ~175bn miles driven, annually

1. American Trucking Association (ATA).

# Massive TAM Opportunity With Secular Growth Drivers

Truck freight volumes in the U.S. are concentrated along a small number of corridors. Nearly **80%** of truck freight goods hauled in the U.S. are moved via **10%** of the nation's trade corridors.

Our current **AFN** routes alone have an estimated **~$10-13bn of potential freight revenue**.

▶ **Dallas-Houston ~ $3-4bn**
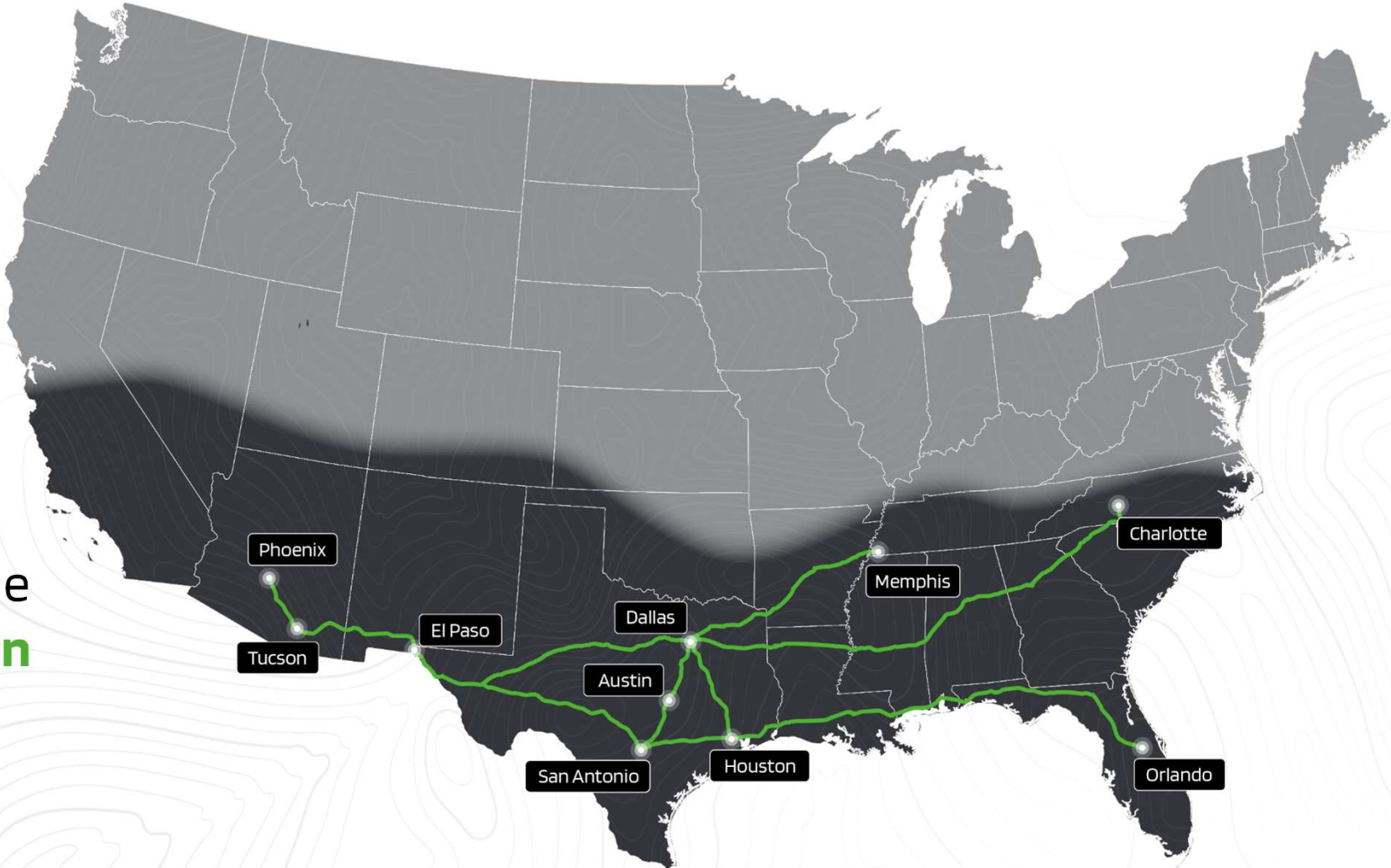
Note: Analysis based on data from FHWA and ATA.

# Industry Challenges Today Accelerates Adoption

## Safety

94% of all accidents are due to human error[1]
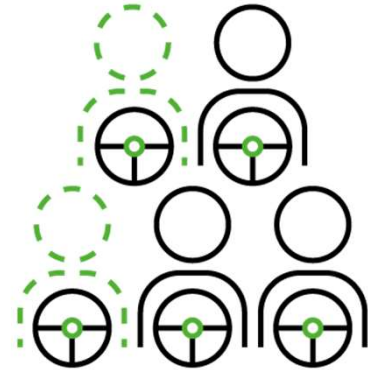
## Driver Shortage

Current driver shortage of 80,000; expected to double by 2030[2]
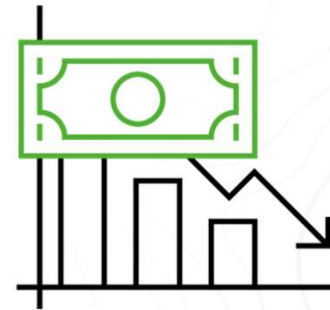
## Cost

Driver costs account for ~45% of per-mile operating costs[3]

## Environment

Medium and heavy-duty trucks contribute to 24% of annual US transportation greenhouse gas emissions[4]

1. National Highway Traffic Safety Administration.
2. American Trucking Association.
3. American Transportation Research Institute, as of November 2021.
4. U.S. Environmental Protection Agency.

# The Elements of AV Trucking Commercialization

**Safety**

*Driver Out Capability*

**Efficiency**

*Improved Unit Economics*
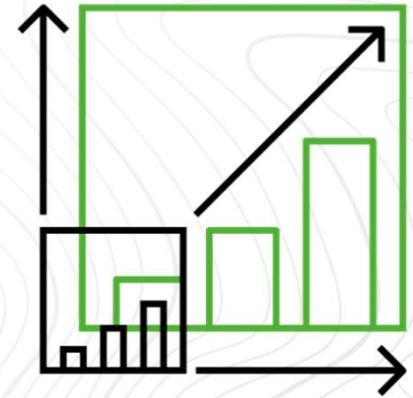
**Scale**

*Mass Production & Deployment*

# Clear Global Leader in Autonomous Trucking Technology

**First and only fully autonomous driver out semi-truck runs on open public roads**

- Highest number of road miles across autonomous trucking players

**We believe we have the most advanced L4 production semi-truck program**

- Longest standing global OEM partnerships with TRATON and Navistar since 2020

**Comprehensive Autonomous Freight Network**

- Broadest and deepest integration of autonomous technology with blue chip partners

# Best-In-Class Hardware Partnerships



**Steering**
ZF

**Powertrain**
Cummins  TRATON

**Brakes**
KNORR BREMSE

NAVISTAR  TRATON
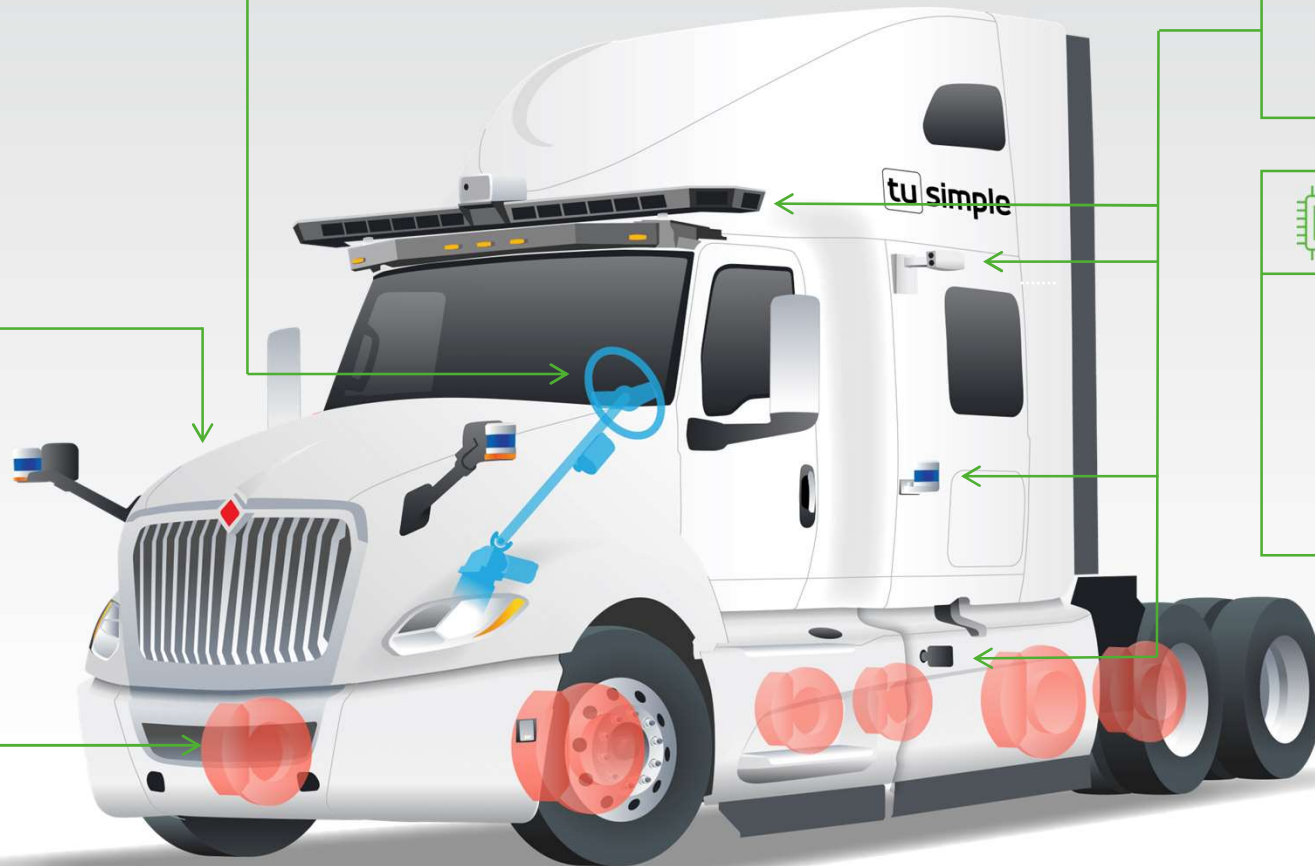
**Sensors**
ZF  SONY

**Co-development of the Autonomous Domain Controller (ADC)**
NVIDIA

**One Stop Solution**
- Automotive-grade sensor interface
- High Performance Computing
- Redundant and Diagnostic Functions

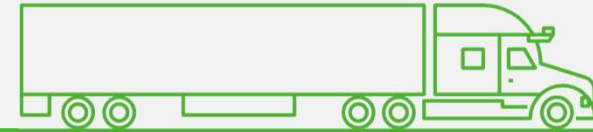**Tires**
GOOD YEAR

# Two Complementary Business Models
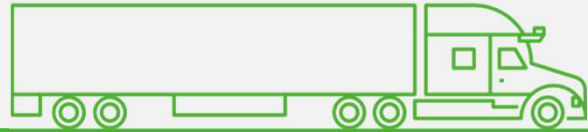
## TuSimple Capacity

- Use purpose-built L4 autonomous semi-trucks operated by TuSimple to access AFN
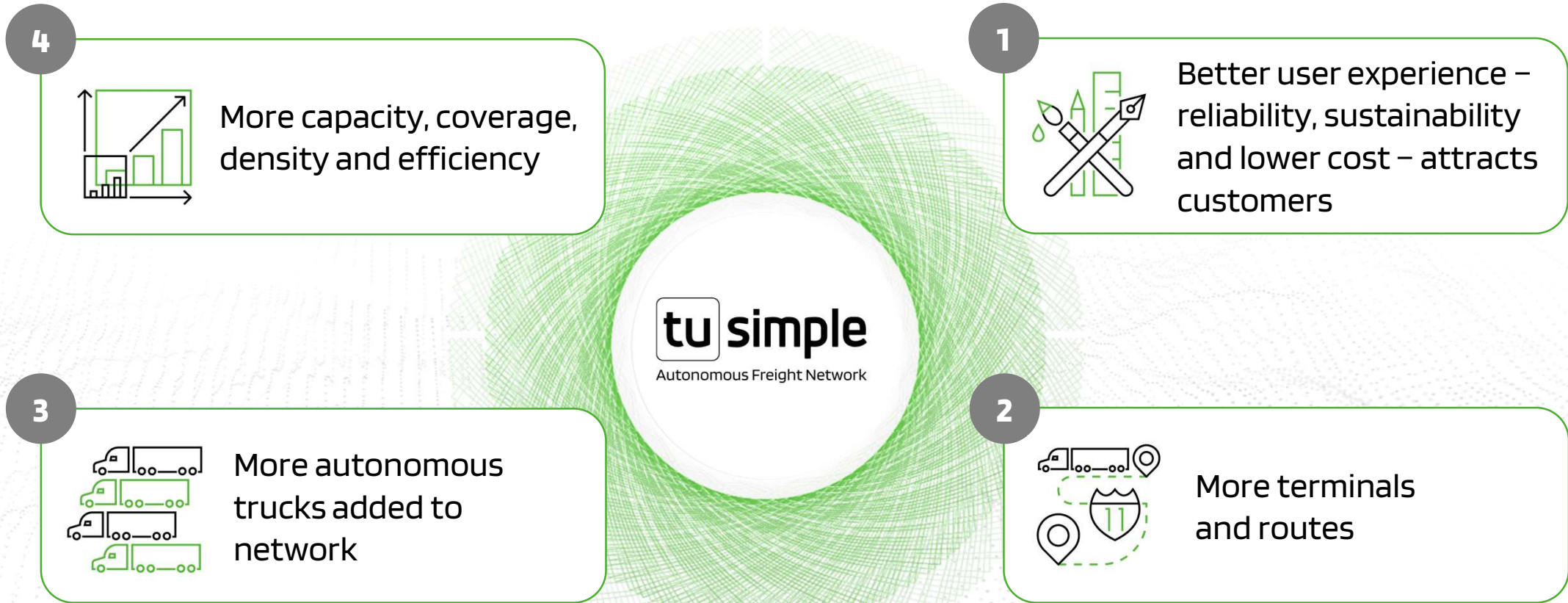
**Freight Users**

## Carrier-Owned Capacity

- Purchase purpose-built L4 autonomous semi-trucks through OEM and subscribe to TuSimple Path to access AFN

**$ / mile Freight Rate**

Capital Light Method
Uses Shared Capacity
Leverages Shared AFN Terminals

**Customer Value Prop.**

**$ / mile Subscription Fee**

Upfront Investment with Payback Period < 1 year
Controls Own Capacity
Uses Own Terminals

**Customers have Flexibility to Select Different Business Models and Benefit from Lower Overall Freight Cost**

# Network-Based Approach Designed to Accelerate Flywheel Effect

**4** More capacity, coverage, density and efficiency

**1** Better user experience – reliability, sustainability and lower cost – attracts customers

**tu simple**
Autonomous Freight Network

**3** More autonomous trucks added to network

**2** More terminals and routes

Speed to Market and Scalable AFN Infrastructure Builds an Attractive and Defensible Business Model

# TuSimple's Technology and Mission are Highly Aligned with ESG Principles

## Environmental

### Studies and Recognition

**13% fuel savings**

**10% increased fuel efficiency**

**2021 SmartWay High Performer**

## Social

### Workforce Diversity (U.S.)

**66%**
**Ethnic Minority[1]**

**22%**
**Female[1]**

### Safety

Developed safety framework for Driver Out
Significant safety advantages uncovered through Geotab telematics study

### Community Partnerships

2 workforce training programs developed
More than 2.7 million meals donated to date
1st AT sponsor for Truckers Against Trafficking

## Governance

### Board of Directors[2]

**80%**
**Independent**
80.0% of Russell 3000 directors are independent[3]

**20%**
**Ethnic Minority**
21.0% of Russell 3000 directors are ethnic minorities[4]

**40%**
**Female**
24.4% of Russell 3000 directors are female[4]

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1. U.S. workforce diversity metrics as of 31 March 2022 .
2. Statistics regarding our board look to the board's nominees and assume that they are elected at our 2022 annual meeting of stockholders.
3. "Corporate Governance by the Numbers," June 30, 2020, EY Center for Board Matters.
4. "Corporate Board Practices in the Russell 3000, S&P 500, and S&P MIDCAP 400 | 2021 Edition," Esgauge Intangibles AI & The Conference Board.

# Strong Management Team Across All Functions

**Dr. Xiaodi Hou**
Co-Founder & CEO

**Jim Mullen**
Chief Administrative and Legal Officer

**Pat Dillon**
Chief Financial Officer

**Isabella Zhou**
Chief Human Resources Officer

**Jing Zhu**
SVP, Software

**Ersin Yumer**
VP, Algorithm

**Adrian Thompson**
VP, Systems & Safety Engineering

**Ruilang Zhang**
VP, Software Engineering

**Vince Verna**
VP, Hardware

**Robert Rossi**
VP, Mapping

**Lei Wang**
VP, Planning & Control

**Lee White**
VP, Strategy

**Eric Tapia**
VP, Global Controller

# Experienced and Diverse Board

**Dr. Xiaodi Hou**
Chair of the Board

tu Caltech

**Brad Buss**
Lead Independent Director
Chair of Audit Committee

QuantumScape  MARVELL  AECOM

TESLA  SolarCity  Advance Auto Parts

**Karen C. Francis**
Independent Director

VONTIER  METAWAVE

nauto  Ford  gm

**Michelle Sterling**
Chair of Compensation Committee

digital turbine  Qualcomm

**Reed Werner**
Chair of Government Security
Committee

VIPKID

Goldman Sachs  Columbia Business School

## 80%
**Independent**
80% of Russell 3000
directors are independent[1]

## 20%
**Ethnic Minority**
21% of Russell 3000 directors
are ethnic minorities[2]

## 40%
**Female**
24% of Russell 3000
directors are female[2]

Note: Board of directors and statistics regarding our board look to the board's nominees and assume that they are elected at our 2022 annual meeting of stockholders.
1. "Corporate Governance by the Numbers," June 30, 2020, EY Center for Board Matters.
2. "Corporate Board Practices in the Russell 3000, S&P 500, and S&P MIDCAP 400 | 2021 Edition," Esgauge Intangibles AI & The Conference Board.

# Autonomous Freight Network & Regulatory Update

## Jim Mullen
Chief Administrative & Legal Officer

# Our Autonomous Freight Network Ecosystem



**Upstream**

Terminals
Ryder
HILLWOOD A PEROT COMPANY

Tires
GOODYEAR

Roadside Assistance
WERNER ENTERPRISES

Insurance
Liberty Mutual INSURANCE

Telematics
GEOTAB

**TuSimple AFN**

**Downstream**

Carriers & 3PL
WERNER ENTERPRISES
LOADSMITH
U.S. XPRESS
SCHNEIDER

Shipper/Parcel
UPS
DHL
Giumarra
McLANE

Rail
CN
UNION PACIFIC

Commercial Rental
PENSKE
Ryder

# Building Deep Relationships with Our Partners

We are focused on long-term lane adoption and deployment planning to allow for rapid scaling once implemented.

## Parcel

Completed over 200,000 autonomous miles of paid freight haulage over the past three years for UPS NAFF

## Carrier

Integrated with Werner roadside assistance services to prepare for driverless operations

## Rail

Expanding our ODD to incorporate intermodal containers & chassis

## Shipper

Delivered watermelons from AZ to OK, illustrating AV trucking's ability to deliver fresher food faster

## 3PL

Loadsmith reserved 350 trucks, a strategic component of their mission to address the driver shortage in the US

**Building substantial relationships and true partnerships centered on adoption, integration, and scaling** AV trucks in our customer's fleets

**Pulling forward hurdles** that need to be addressed before AV trucks can be operationalized on their network
- Launching and landing pads
- Roadside assist service options
- Fleet management integration for remote monitoring
- Tender loads directly through web services
- Terminal/yard management automation

# AFN Expansion: Growing our Terminal Footprint

**In preparation for our new driverless lanes and expansion of AV testing we are growing our terminal footprint**
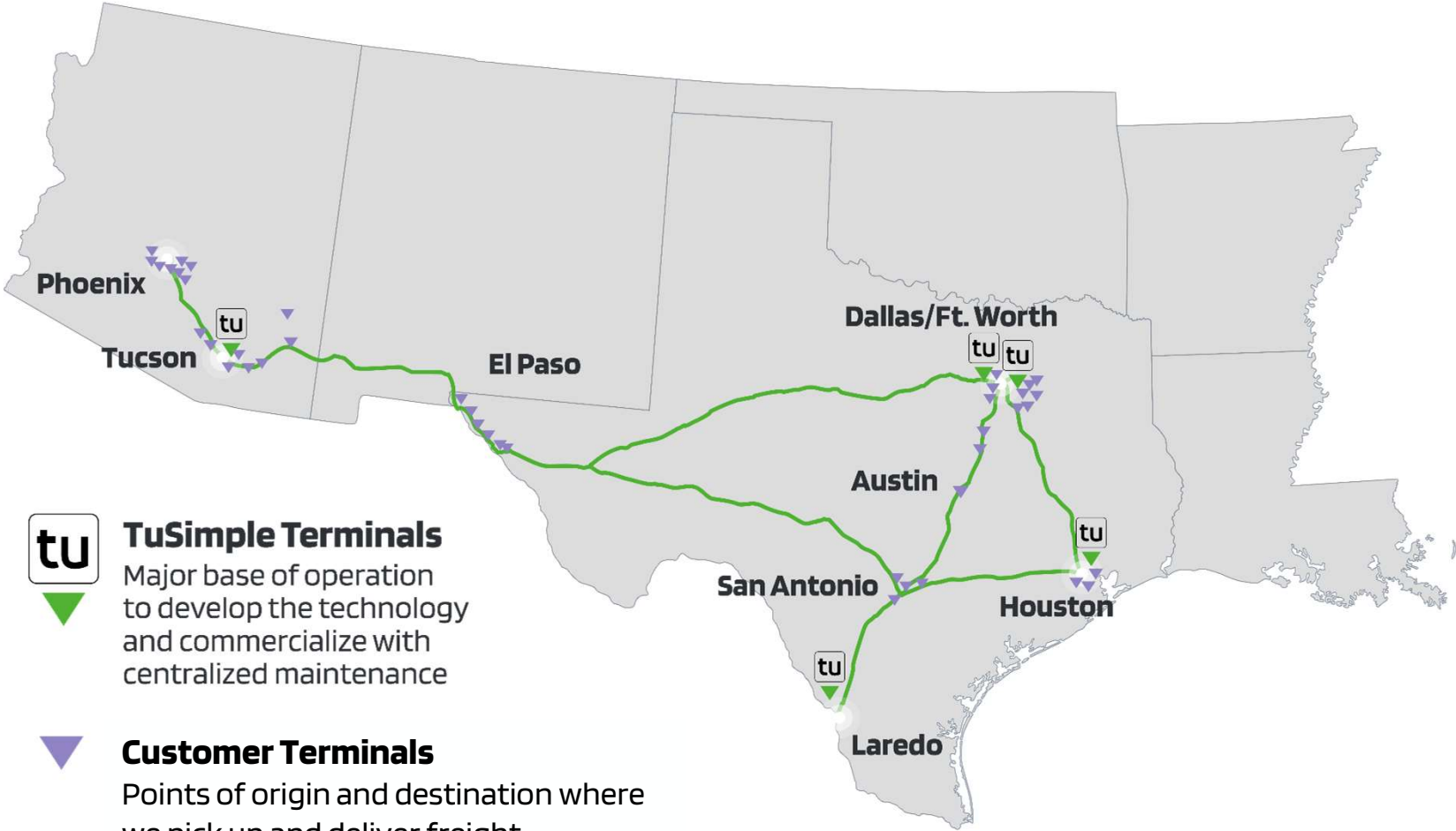


**tu** **TuSimple Terminals**
Major base of operation to develop the technology and commercialize with centralized maintenance

▼ **Customer Terminals**
Points of origin and destination where we pick up and deliver freight

"What we're doing is automating the repetitive task of the middle mile and creating more first- and last-mile jobs so that drivers can be home nightly and be present in their families' lives but still go out and do very well for themselves financially without having to be an irregular route, over-the-road trucker."

– Brett Suma, CEO **LOADSMITH**

# 26 States Explicitly Allow Driver Out AV Operations

## There is No State or Federal Rule Prohibiting Driver Out AV



**44** states
Allow Driver In AV

**26** states
Allow Driver Out AV

**50** states
Cohesive AV operations framework laid out in US DOT 4.0 AV Regulations

**Regulatory Landscape**

Allow Driver Out AV

Allow Driver In AV

In Progress

**AFN Network Expansion Plans[1]**

———— Current Freight Routes

———— Future Expansion Routes

1. Map represents AFN operations as of 31 March 2022.

# TuSimple is the Leader in AV Trucking
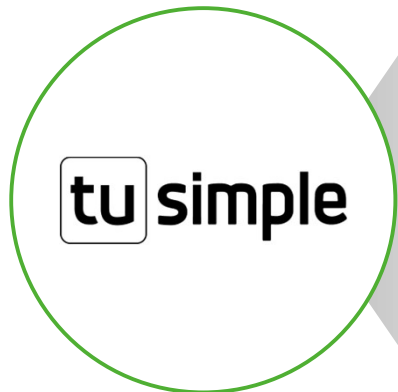
AV Trucking is a Difficult and Complex Problem and TuSimple has a **Focused and Fulsome Approach** to Solving this Problem

We Believe that **No One has Technology as Advanced as Us**, Measured by Our Achievements

Our Technological Lead De-risks our Path to Commercialization and Will **Build a Highly Attractive and Defensible Business**

# Fireside Chat: TuSimple & Werner Enterprises



**Jim Mullen**
**Chief Administrative & Legal Officer,**
**TuSimple**



**Derek Leathers**
**Chairman & CEO,**
**Werner Enterprises**

# China Market Update

## Pat Dillon

Chief Financial Officer

# TuSimple China at a Glance

**400+**

R&D professionals

**270+**

Issued Patents

**500,000+**

miles

L4 Road Test Mileage
in China

**~25**

Trucks in L4 Fleet

**1,000**

meter

Perception
Capability

**Best-in-Class Hardware Partnerships**

NVIDIA®

FOTON
福田汽车

TRATON

ZF
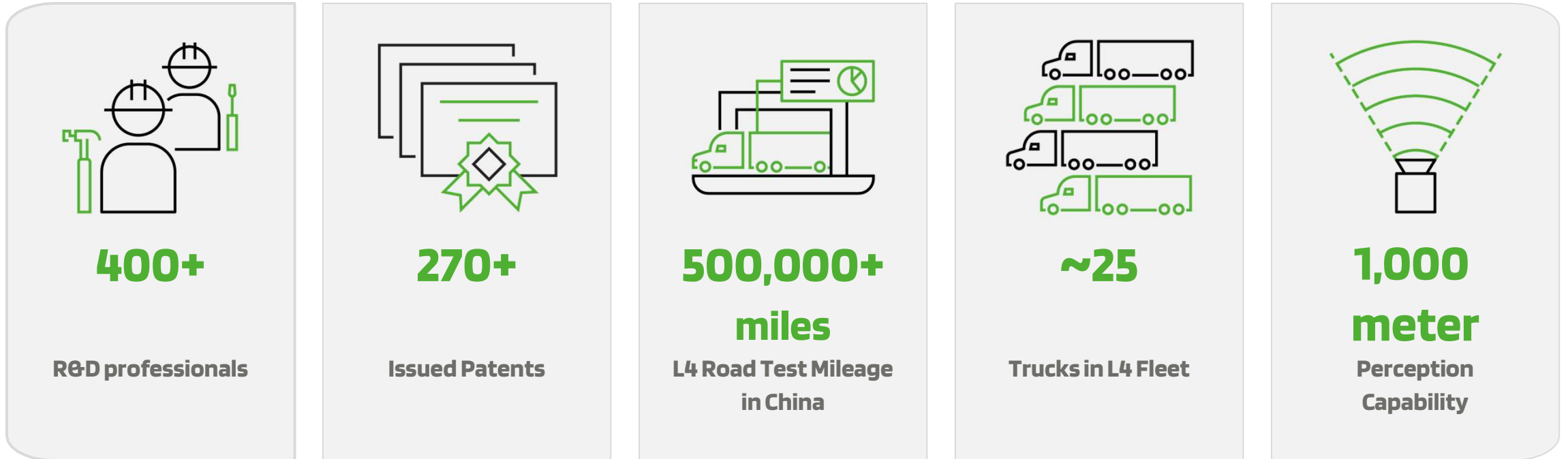
# Go-to-Market Strategy

## Massive Market Opportunity

**$1.3 Trillion**
Estimated China Road Freight Market in 2030[1]

**6% CAGR**

**$750 Billion**
China Road Freight Market in 2020[1]

## Product Offerings



**L2+ Driver-In ADAS in Collaboration with NVIDIA**

Building upon partnership with NVIDIA to provide integrated software and hardware for ADAS solutions for the China market



**L4 Autonomous Freight Network**

Build Autonomous Freight Network on the most concentrated shipping routes in China and provide autonomous freight capacity as a service

1. Industry research.

# Commercialization Roadmap

| 2022 | 2023 | 2024 | 2025 | 2025–2030 | After 2030 |
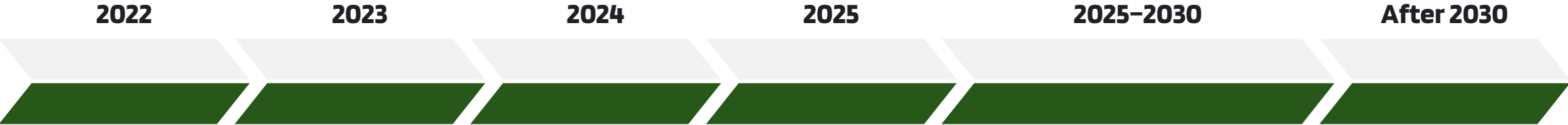
**By 2023:**

L2+ Driver-in ADAS Solution: Offer software & hardware **full-stack solutions** to OEMs

**By 2025:**

Build the first L4 autonomous truck freight route around the **"Donghai Bridge"** in Shanghai and expand the network to other core hubs

**2025–2030:**

**Expand the AFN** to Pearl River Delta and Bohai Sea economic regions

**After 2030:**

Scale up to build the **National AFN**

# Shanghai Deepwater Port Project



**LuchaogStationang Railway**
Key hub for multimodal transport

**Logistics Park**
Container customs checkpoint

**Donghai Bridge**

**Yangshan Deep-water Port**
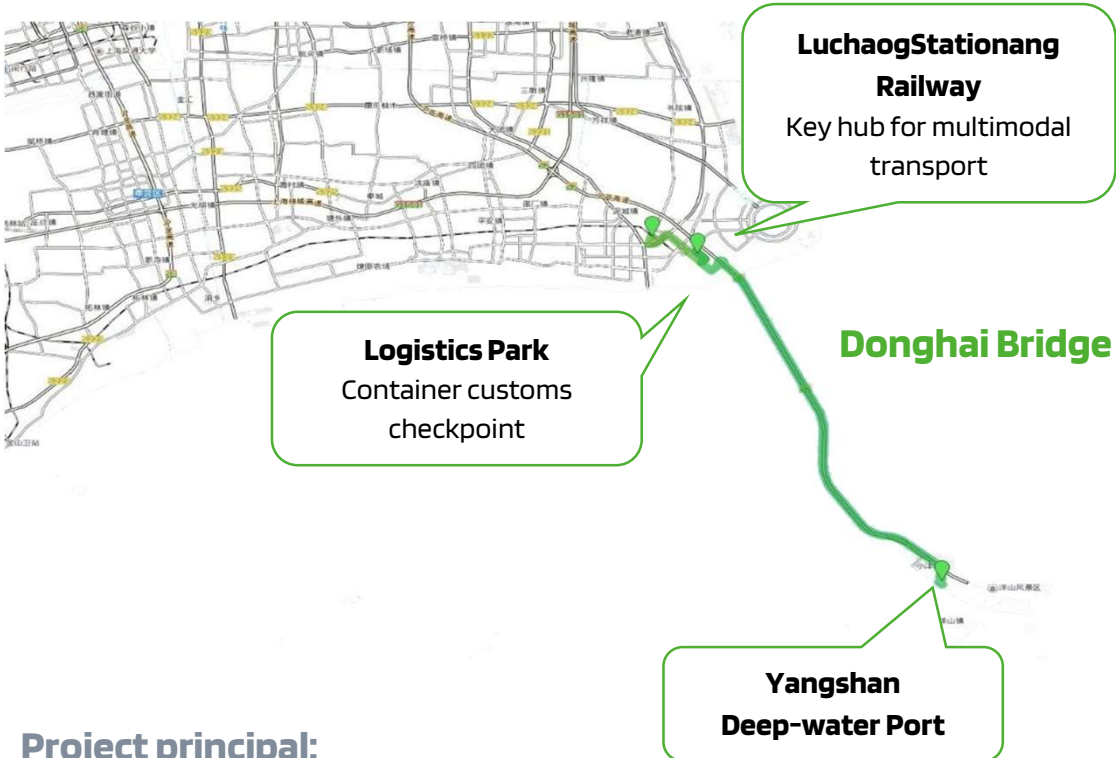
**Project principal:**

SIPG 上港集團

(Operator of public terminals in the Port of Shanghai)

## Project Overview

**World's Largest Container Port**

**20,000 Daily Freight Trips**

**Complex Port Environment**

**Only AV Company with Permits to Operate**[1]

1. Excluding state-owned entities.

# Technology Deep Dive

**Xiaodi Hou**
Co-Founder and CEO

**Vince Verna**
VP, Hardware

**Ersin Yumer**
VP, Algorithm

**Adrian Thompson**
VP, Systems & Safety Engineering

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# Autonomous Technology Tree

We strongly believe there is only one path to achieve autonomy.
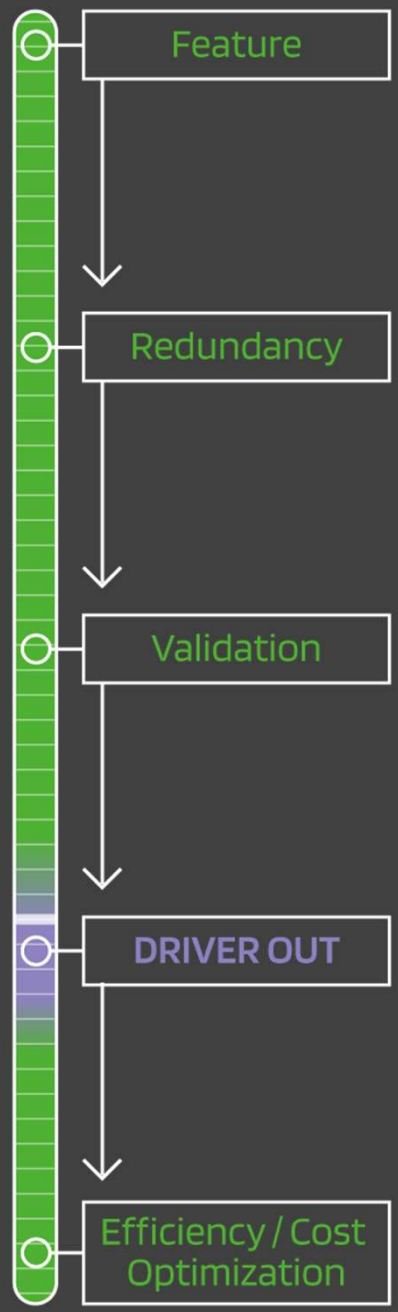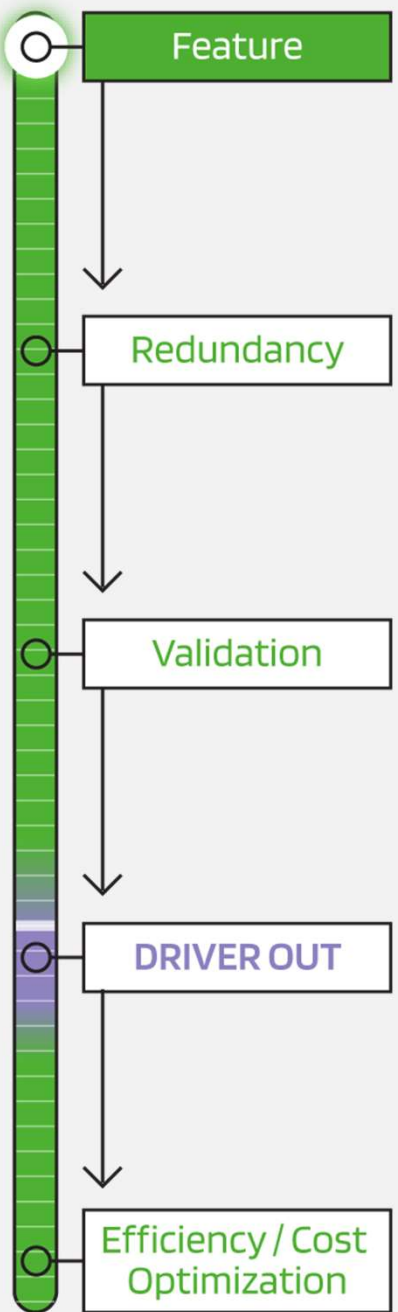
# Features

**Main Driving Capabilities of the Autonomous System**

- Easy to understand
- Richer features give the truck significant level of capability and reliability

Advanced Feature Set is **Step 1** for Driver Out
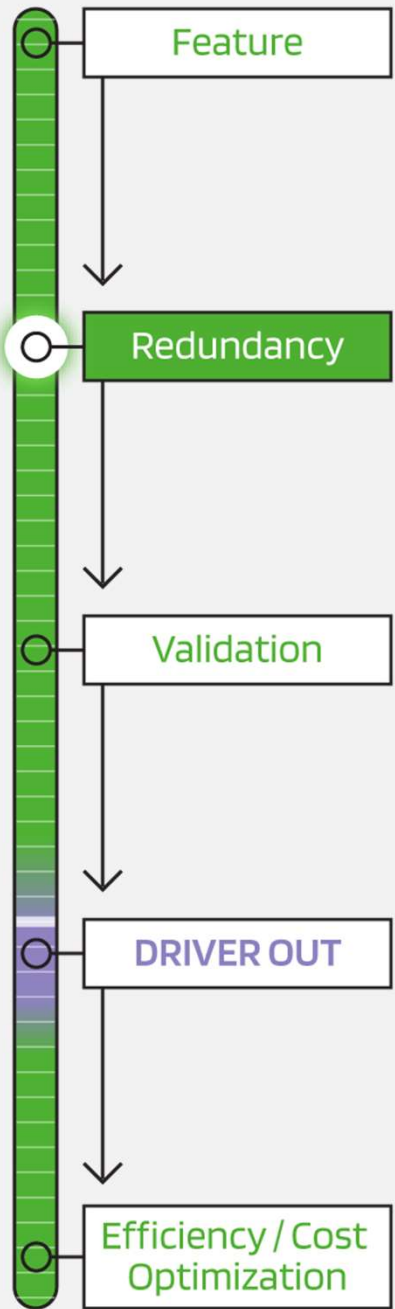
# Redundancies

**Be prepared for rare cases!**

- What if there is a failure?
    - Driver-in: disengagement!
    - Driver-out: a mitigation plan designed into the system itself
- Redundancy = Hardware + Software

Redundancy is **Step 2** for Driver Out

## Flowchart (left sidebar)

- Feature
- Redundancy
- Validation
- DRIVER OUT
- Efficiency / Cost Optimization

# Validation

**Validation is the purpose, simulation or road tests are means**

- Hypothesize possible failures of the system

- Test that the redundancy is implemented

- Validate the system:
  - Engine, steering, braking
  - Power, in-vehicle network
  - Sensor, server
  - OS, algorithm

Validation is **Step 3** for Driver Out
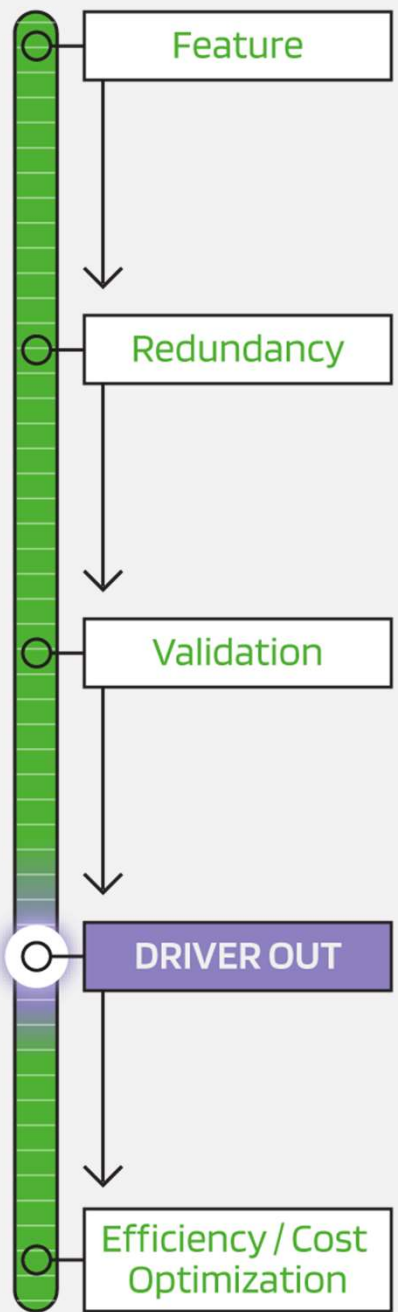
# Driver Out

**Talk is cheap, show the evidence**

- The key is to remove the reliance on human driver
  - Not every single disengagement is important, but some are
  - We will not compromise safety

- How to prove that you're ready? DRIVER OUT

Driver Out Operation Is the Key Proofpoint on the Path to Commercialization

Feature

Redundancy

Validation

DRIVER OUT

Efficiency / Cost Optimization
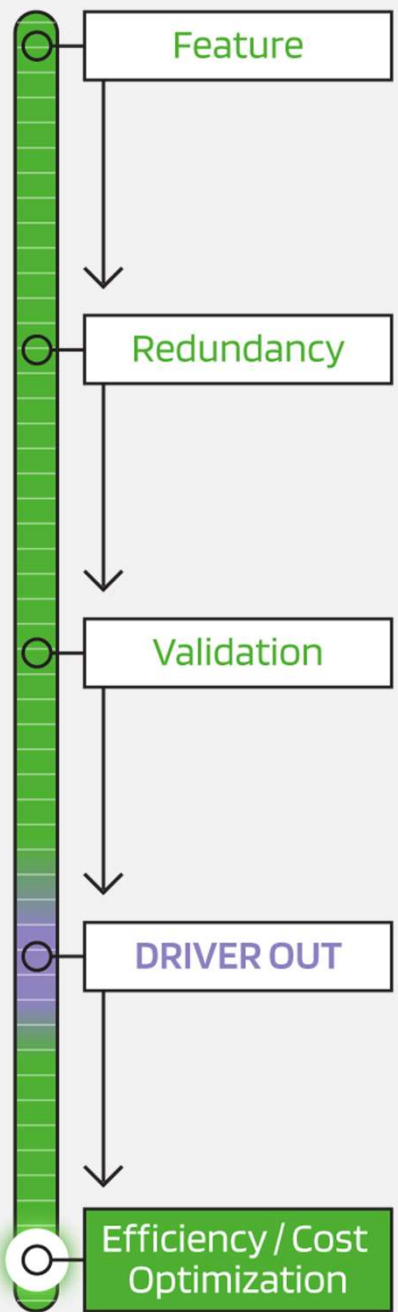
# Cost Efficiency

**Autonomy technology does not come for free**

- One-time cost

- Recurring cost

  - Equipment maintenance

  - Map update, tele-operation, etc.

Autonomy Cost Must Be Optimized to Have Market Acceptance

# Cost Efficiency

Feature → Redundancy → Validation → DRIVER OUT → Efficiency / Cost Optimization

Cost Per Mile

Current Costs

Human Driver

Time
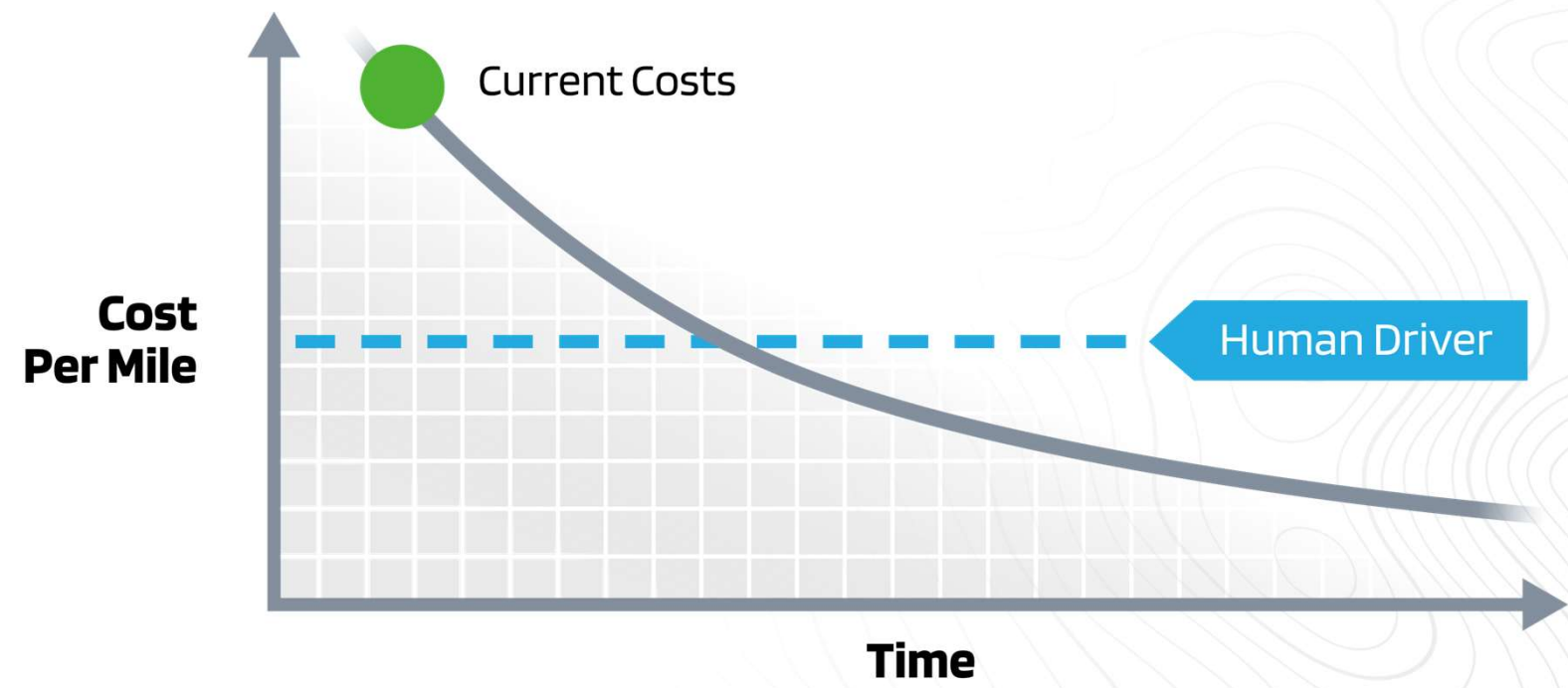
**Autonomy Cost Must Be Optimized to Have Market Acceptance**

Feature

Redundancy

Validation

DRIVER OUT

Efficiency / Cost Optimization

# Feature:
# Advanced Planning

"A superior pilot uses his superior judgment to avoid situations which require the use of his superior skill"

*– Frank Borman, Retired NASA Astronaut*
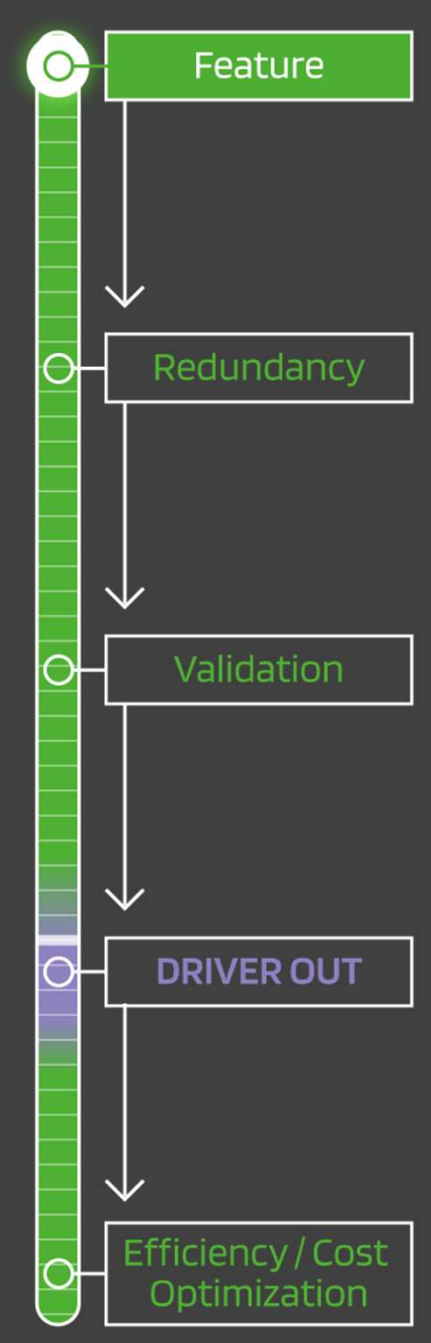
# From Maneuvers to Mini-Maneuvers

**Maneuver:**

- Braking, accelerating
- Making turns
- Lane changing and yielding

**Mini-Maneuver:**

- Defensive driving to avoid risks
- Road etiquette compliance
- Subtle driving techniques that improve efficiency

Safety Shift
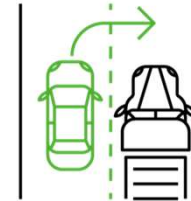
Handling Aggressive Cut-in
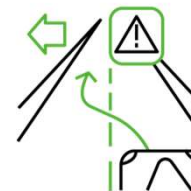
Proactive Lane Change

**Design Philosophy: Minimize High Risk Driving Scenarios**

# Safety Shift



**Scenario:** Adjacent vehicle invades our lane



Lane bias and deceleration to create space

Parallel 0.41m, 70 mph

Speed Limit 75 MPH  64.2mph

## Why Is This Hard?

- Complexity of all traffic scenarios
- Fine-grained **perception** of scene & actors
- Precise vehicle **control**

Case Study

# Safety Shift

Case Study



Lane bias and deceleration to create space
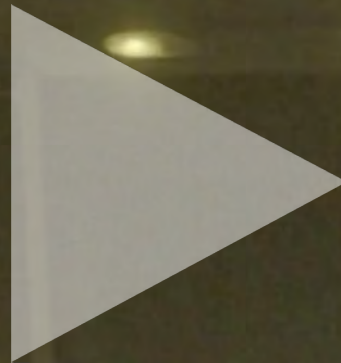
Parallel 0.31m, 69 mph

Speed Limit
**75** MPH

**64.2** mph

43

# Safety Shift

Case Study



44

# Handling Aggressive Cut-in

**Scenario: Avoid collision without overbraking**



Reducing speed to allow close cut-in by another vehicle

Parallel 0.8 m, 66mph

Front 6m 69mph

Speed Limit
**65** MPH

63.5 mph

detect car

## Why Is This Hard?

- Predicting cut-in vehicle distance

- Predicting cut-in vehicle speed

- Maintain safe distance

- No braking overreaction

Case Study



Reducing speed to allow close cut-in by another vehicle

**Parallel** 0.8 m, 66mph

**Front** 7m 69mph

Speed Limit
**65** MPH

**63.8** mph

detect car

# Handling Aggressive Cut-in

47

# Proactive Lane Change



Case Study
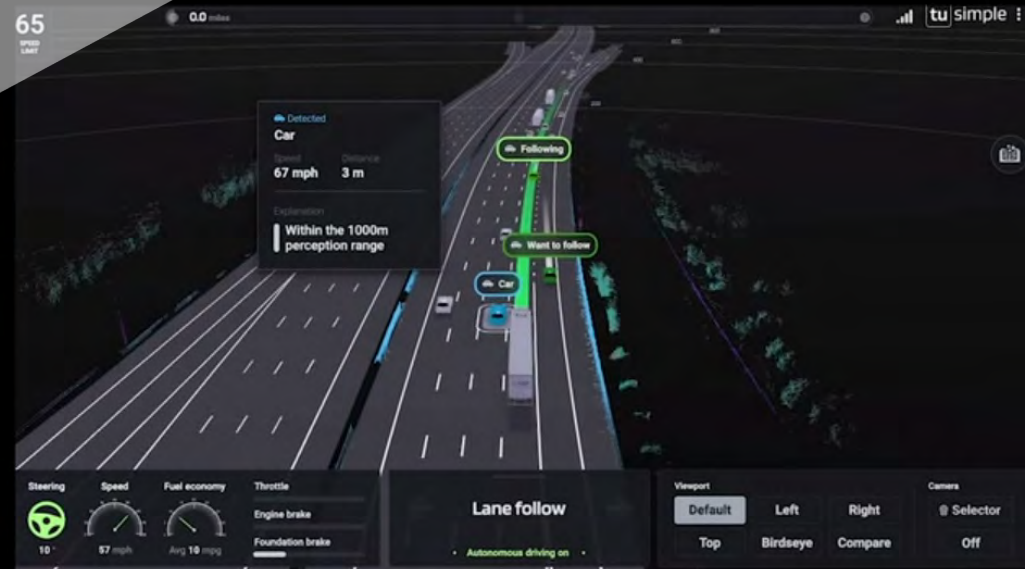
**Scenario: Proactively seek safest travel lane**



Advanced Capabilities of Driver Out Autonomous Driving System | TuSimple

Lane change to avoid dangerous merge by another vehicle

Target front  31m 66mph

Speed Limit **75** MPH | **64.4**mph | ← Left Change
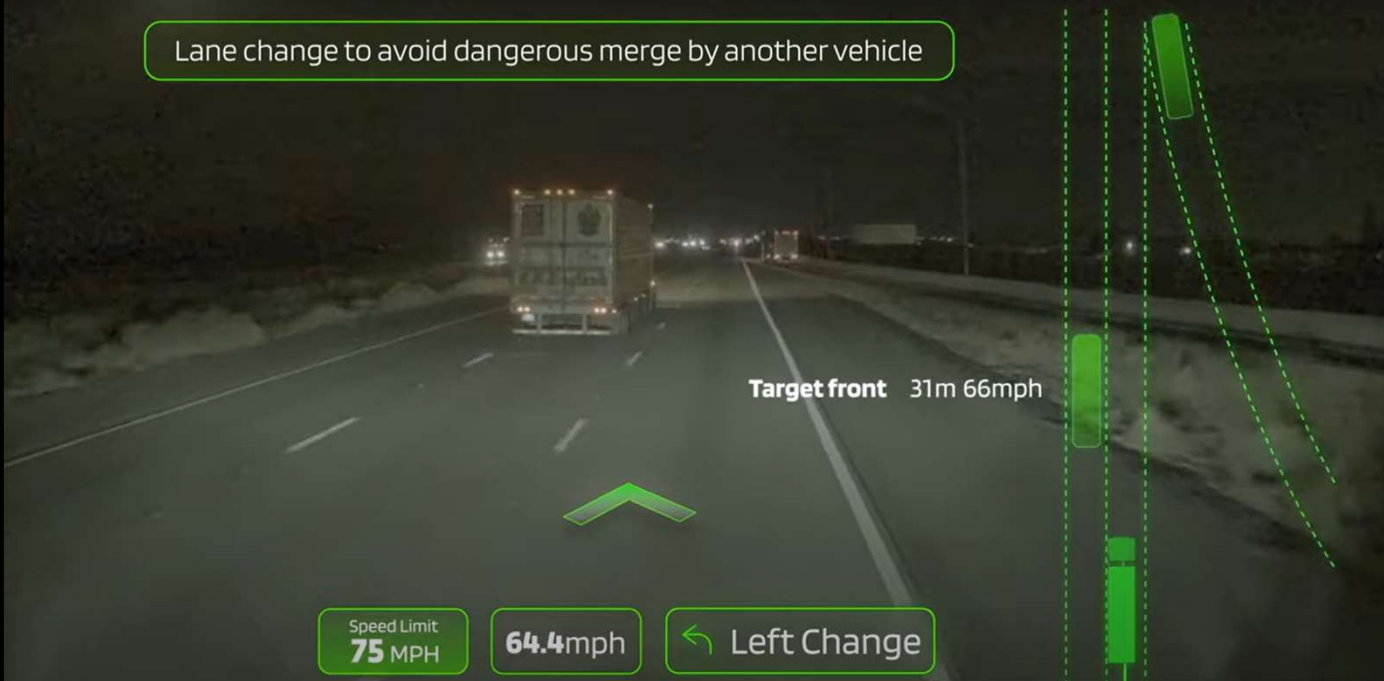
## Why Is This Hard?

- Predict future unsafe merging events by others
- Predict where opening will emerge
- Real-time decision in complex traffic
- Interactive negotiation with other vehicles

# Proactive Lane Change

Case Study



Lane change to avoid dangerous merge by another vehicle

Target front    32m 66mph

Speed Limit
75 MPH

63.9 mph

↰ Left Change

# Proactive Lane Change

Case Study



50

# Feature:
# Advanced Control

## Surpassing human level maneuvering
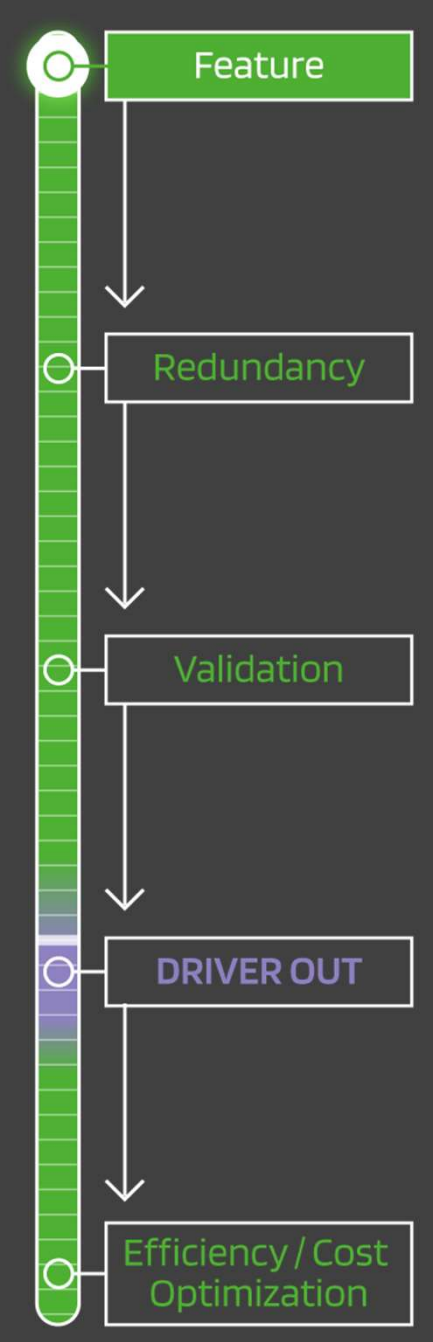
# Driving a Truck is Challenging



- Wide body

- Gear shifting latency

- Trailer weight

- Turning radius

Unique Design Challenges for Autonomous Trucking

# A Glance at TuSimple's Control Performance



**Avg. Lane Centering Accuracy**

8 inches (2.4x better than human)

**Avg. Stopping Accuracy**

8 inches

The Goal of Autonomy is to Surpass Human-level Maneuvering

Note: All data collection and analysis based on trucks with trailers containing real-world cargo.

# Competitive Advantage #1: Advanced Interfaces



**Necessary for Driver Out**

**Limited Autonomy**
- DRIVETRAIN — Basic torque control functionality
- STEERING — Limited steering redundancy
- BRAKING — Low performance autonomous braking

**STATUS:** RELEASED

**Driver-Out Capable**
- DRIVETRAIN — Fully-integrated torque control ★
- STEERING — Fully integrated redundancy ★
- BRAKING — Smooth, precise, and redundant ★

**STATUS:** RELEASED

**Advanced Features**
- DRIVETRAIN — Remote reverse, neutral, drive
- STEERING — Precise real-time diagnostics ★
- BRAKING — Cooperative redundancy ★

**STATUS:** TESTING

**Advanced Autonomy**
- DRIVETRAIN — Fuel optimization
- STEERING — High reliability drive-by-wire
- BRAKING — ASIL D certified

**STATUS:** DEVELOPMENT

| 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 | 2024 | 2025 | 2026 | Future > |

**Release Dates**

★ A TuSimple innovation that's now an industry standard

tu Current TuSimple Engagement

**TuSimple is Paving the Way with Tier 1 Suppliers**

# Competitive Advantage #2: Algorithm Breakthrough
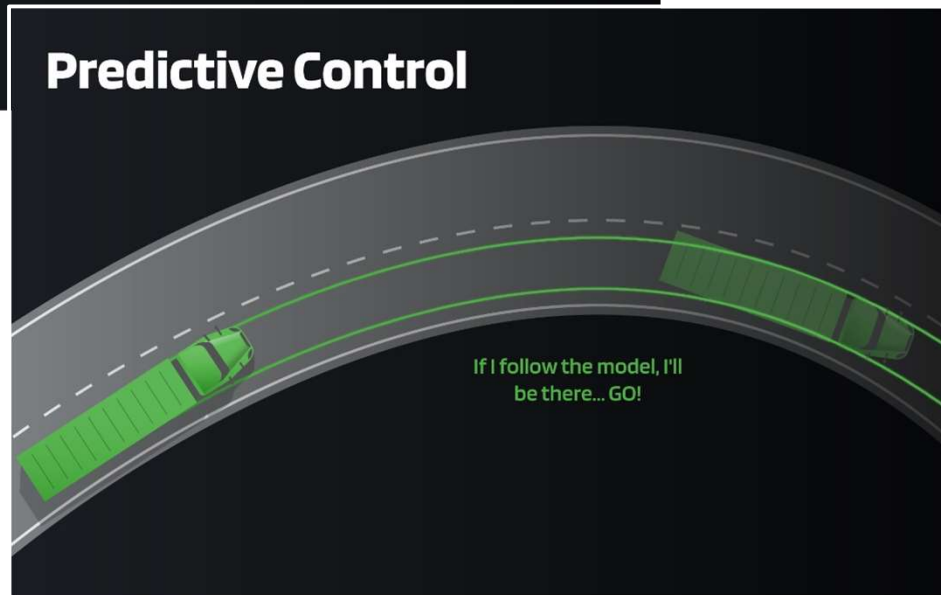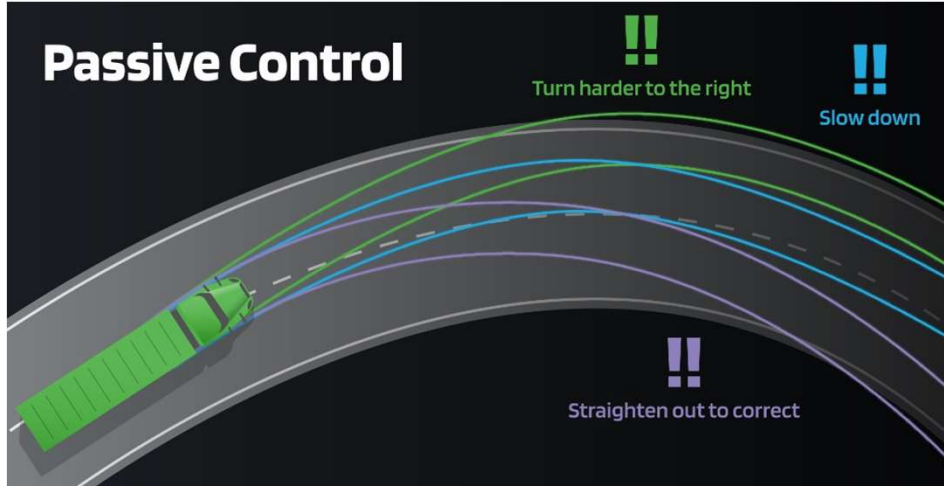


## From Passive To Predictive Control

Predictive Control

- Massive control dynamics modeling

- TuSimple's autonomous driver → vehicle handling "intuition"

- Improved safety and fuel efficiency

# Fuel Efficiency

Case Study

**Advanced driving technique to improve fuel economy without compromising safety**

Target Speed: 65 mph

Momentum is captured while driving downhill

Increased momentum assists upcoming hill climb

Speed is allowed to fall below target before the crest of the hill, with the knowledge that momentum will be captured again on the next downhill

Speed limit and traffic laws are adhered to

# Feature:
# Advanced Perception

Feature

Redundancy

Validation

DRIVER OUT

Efficiency / Cost Optimization
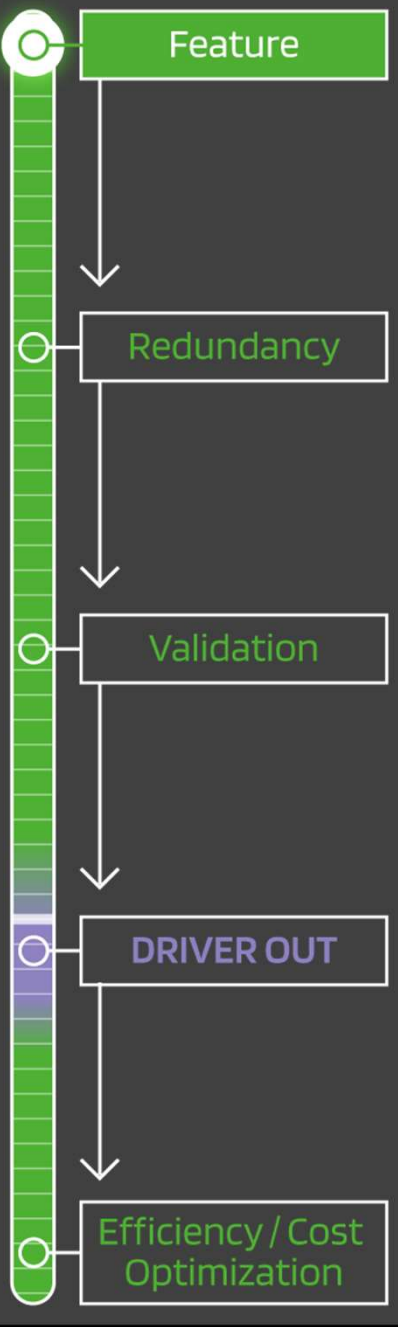
# Sensors



**Camera**

**LiDAR**

**Radar**

# Understanding Perception

## How does the truck "see"?

- Cameras, LiDARs, and radars
- Deep learning perception algorithms
- Both powerful & robust

# Multi-Level Perception: Pixels

Case Study
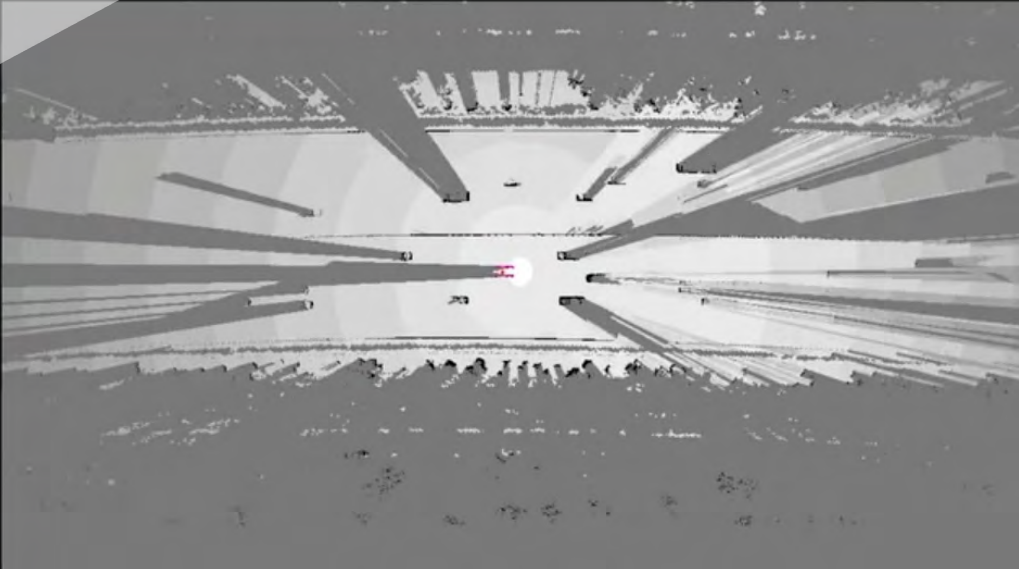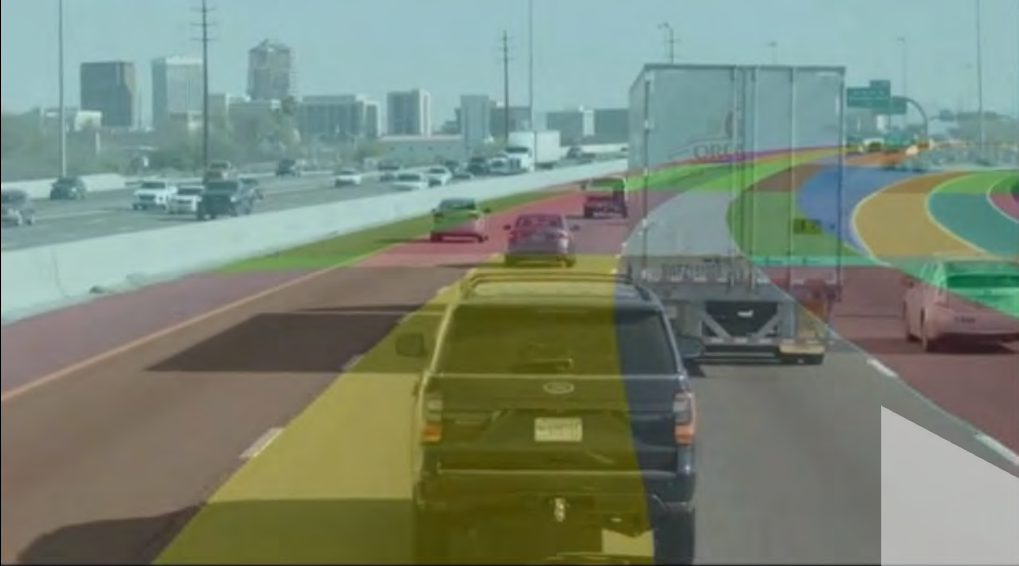


61
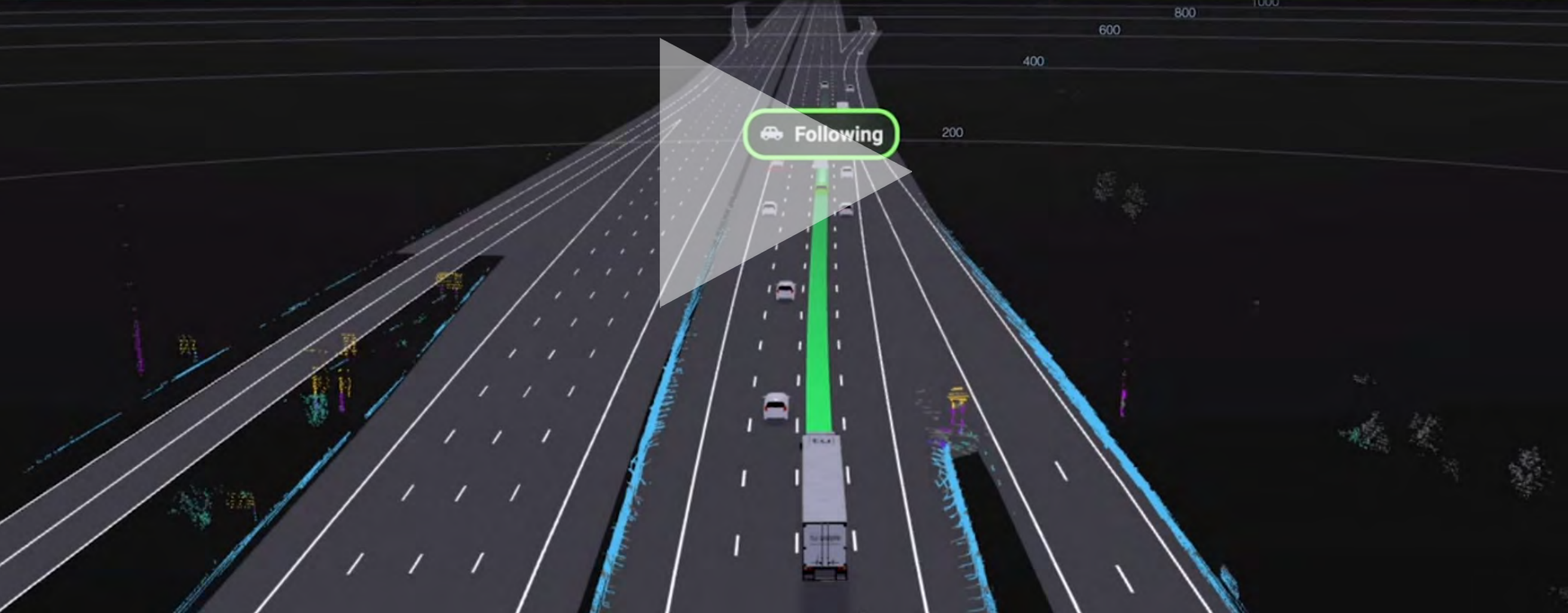
# Multi-Level Perception: Scenes

Case Study
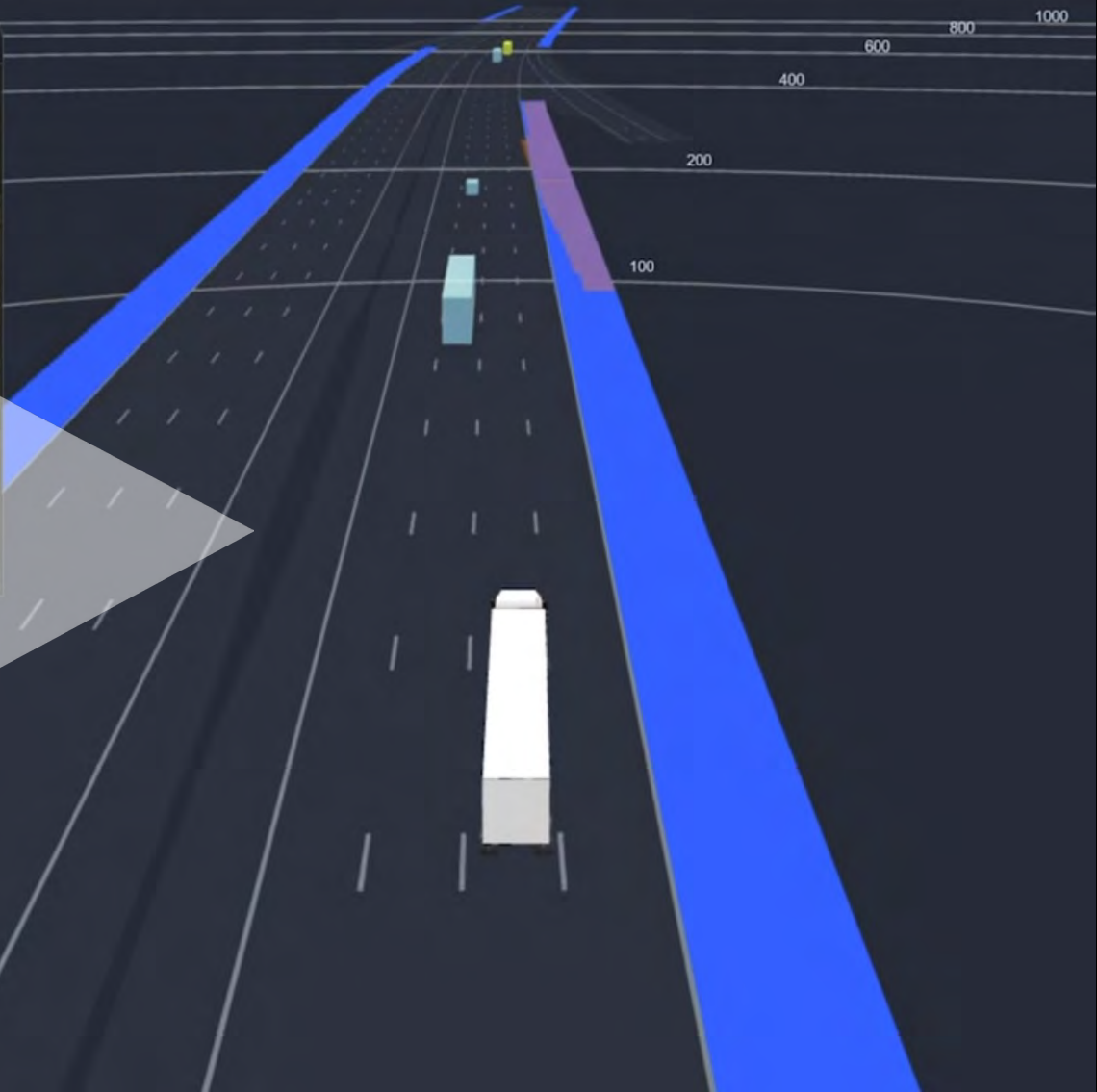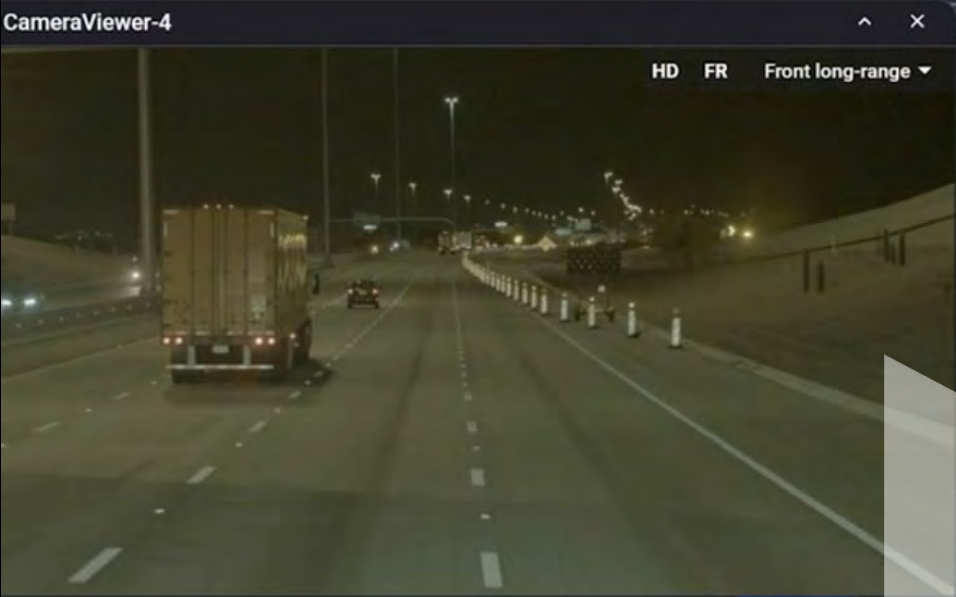
Case Study: Detecting Pedestrians on the Road
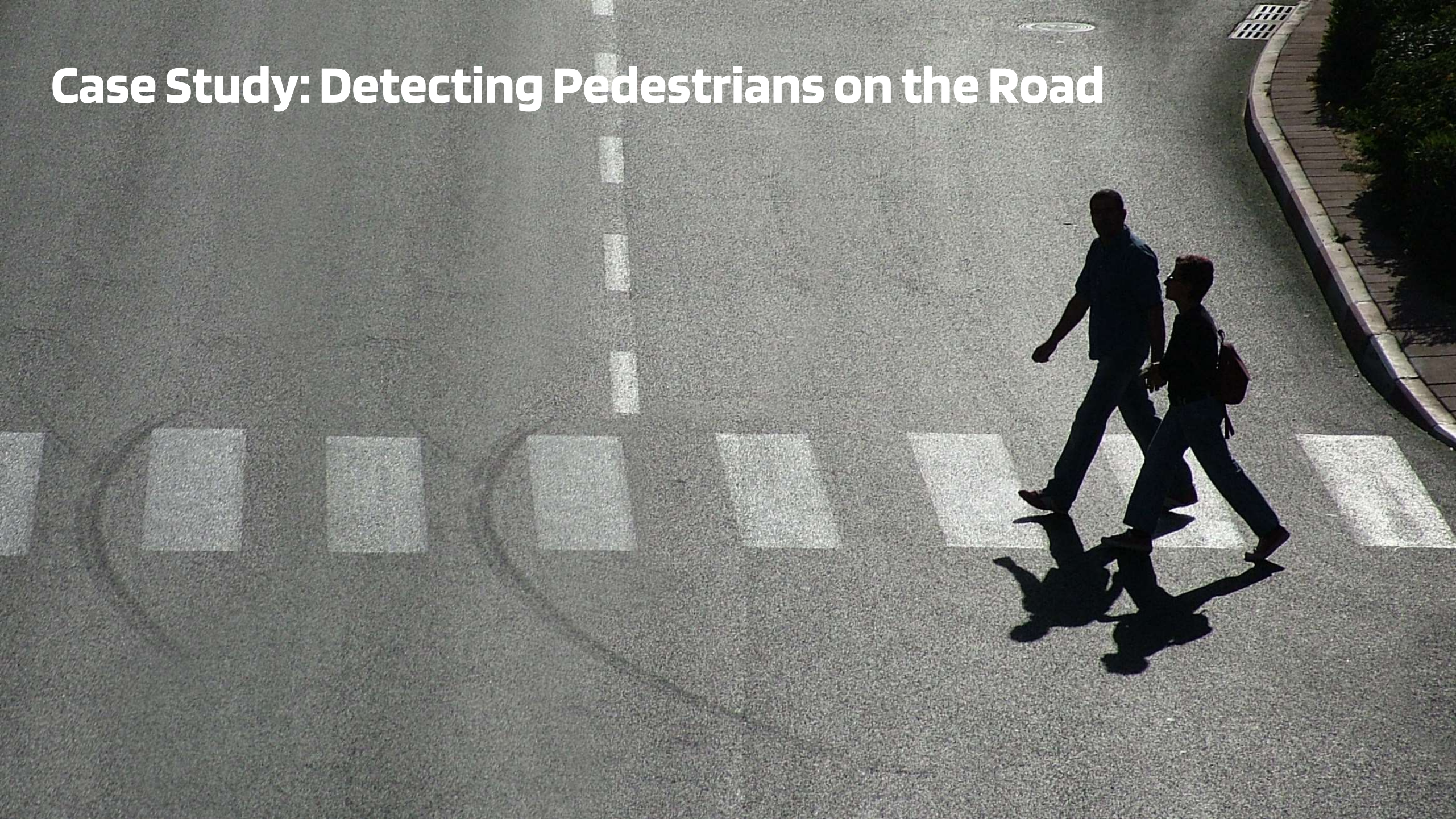
# Camera Perception

# Unknown Objects

Case Study

Target_front: 448m, 65mph

# Occupancy Grids

Case Study

Target_front: 448m, 65mph
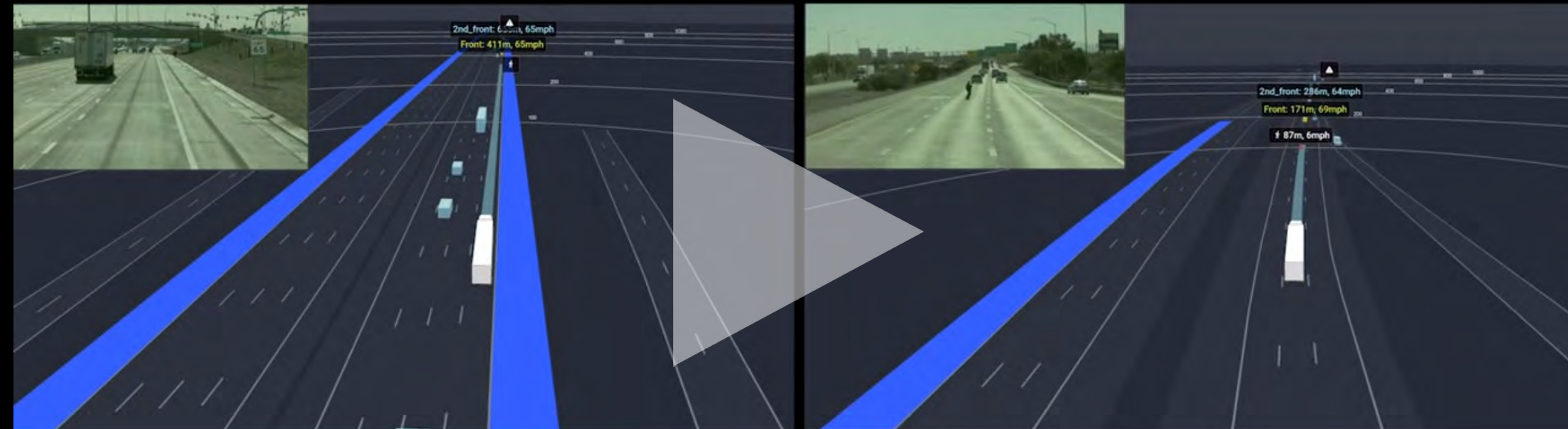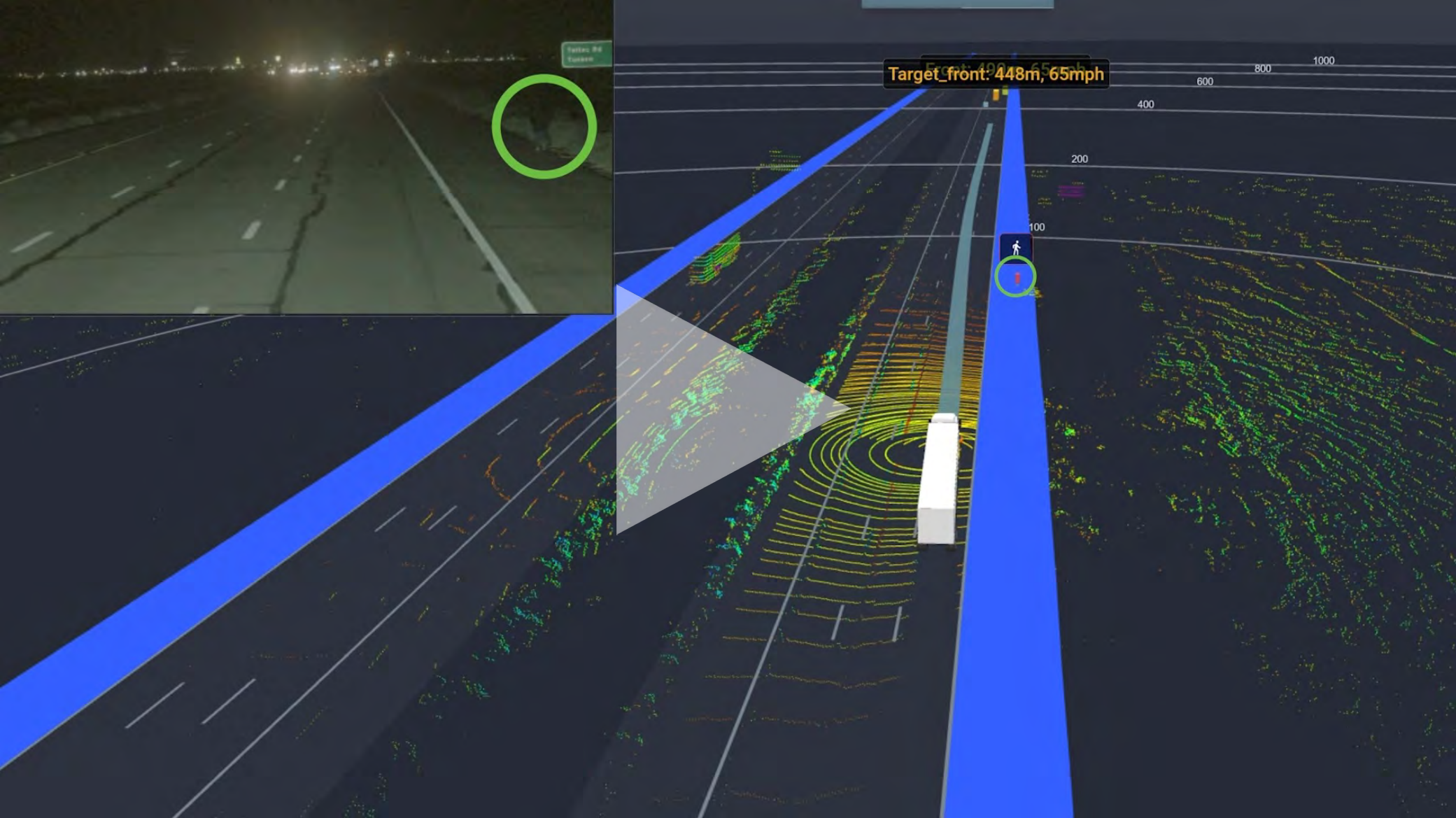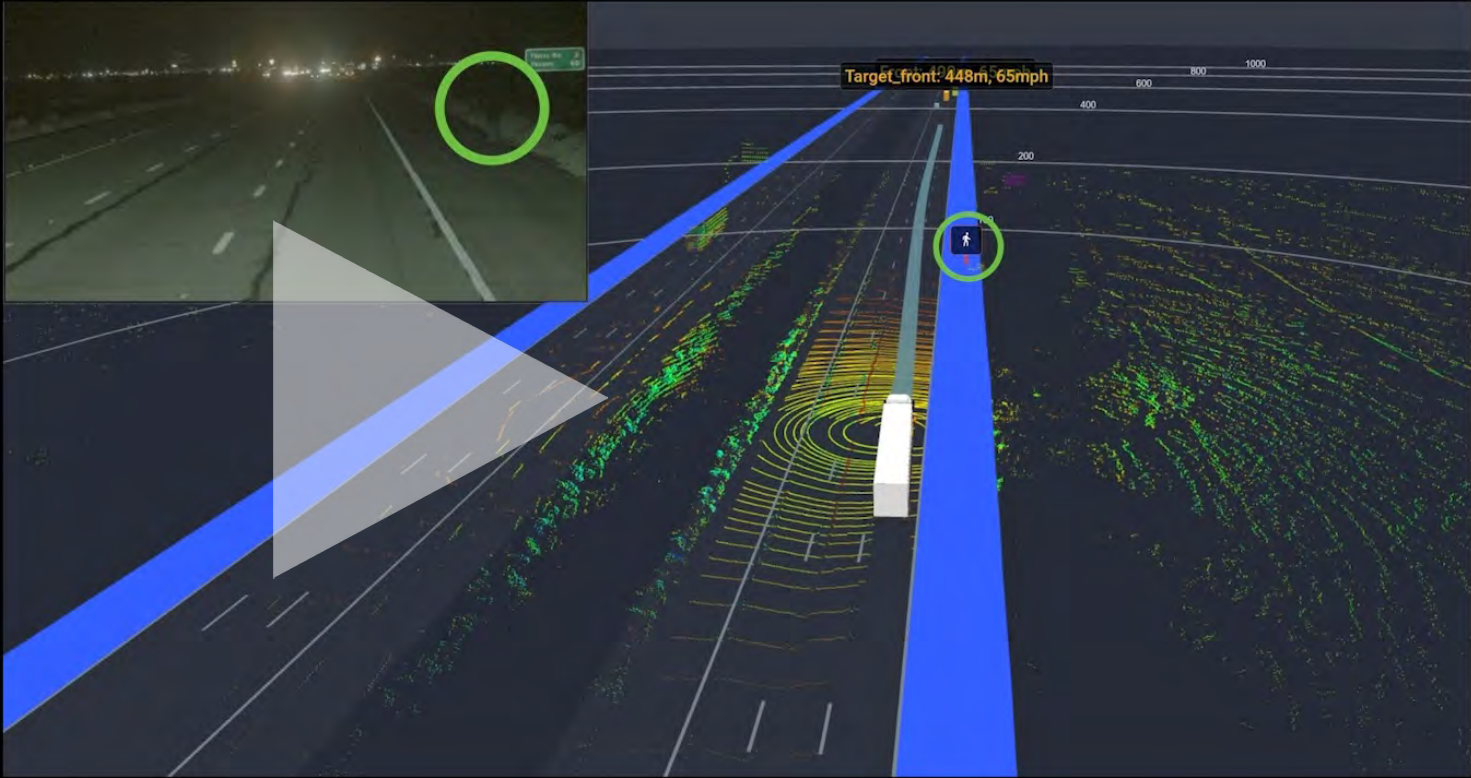
# Generalization: Roadside Cars

Case Study
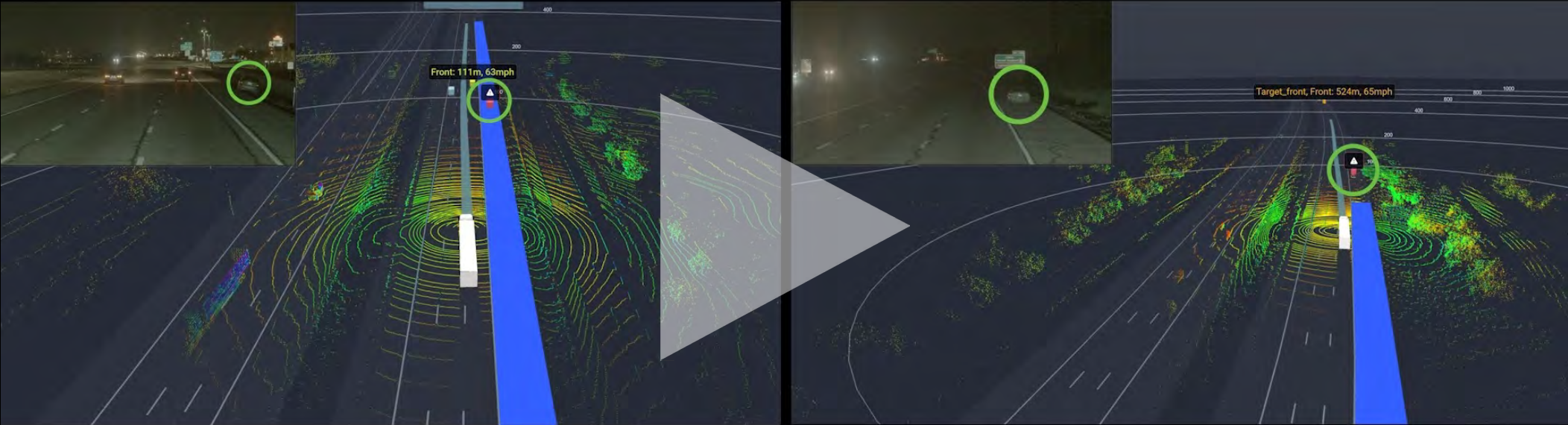
# Redundancy:
# Hardware Ruggedization

## Vince Verna

VP, Hardware

Feature

Redundancy

Validation

DRIVER OUT

Efficiency / Cost Optimization
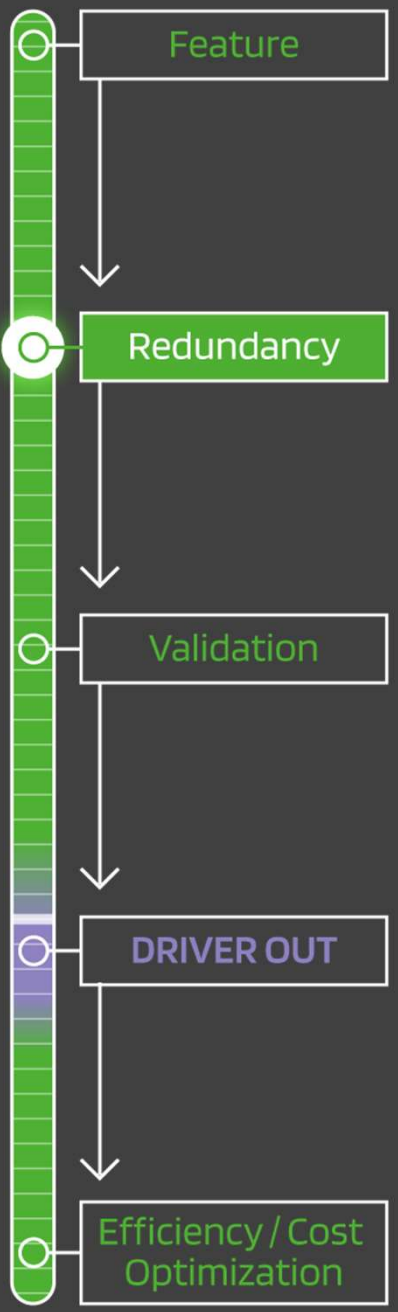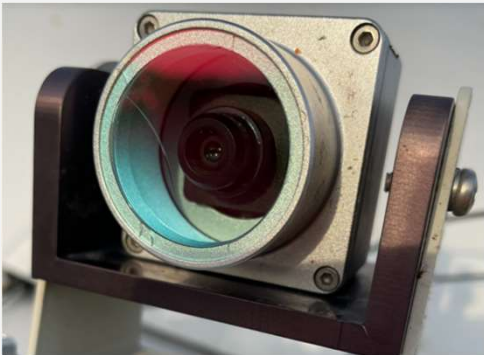
# Driver Out Requires Hardware Ruggedization

## Standard OEM Truck Platform Hardware Failures
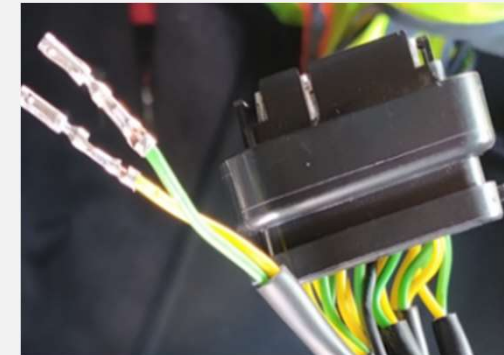
**Autonomy Hardware**



Cameras, LiDARs, Radars
Compute Unit

**Chassis Components**



Steering, Braking

**Electrical**



Power, Networks, Signals

Standard OEM Platform Hardware is Not Driver Out Ready

# Improving the OEM Truck Platform

## Hardware Engineering: Systematically improving a platform truck's capability

| Mechanical Engineering | Electrical Engineering | Testing |
|:---:|:---:|:---:|
|  |  |  |
| Perception Housing | Electronic Control Units | Vibration Table |
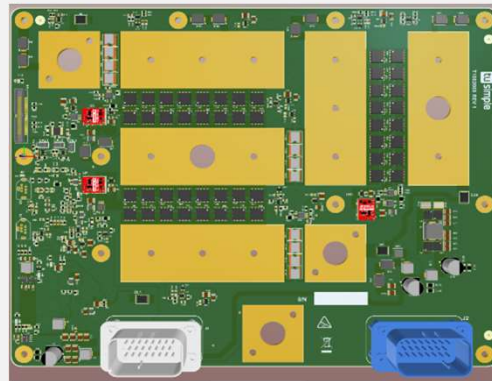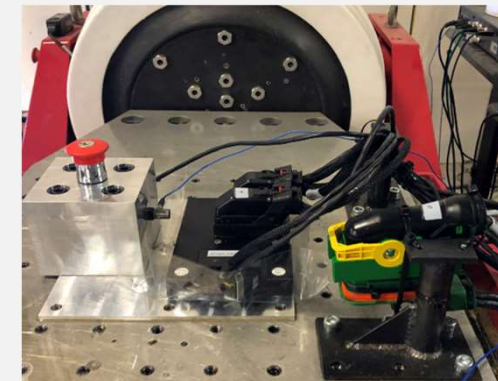
TuSimple's Hardware Team Apply Their Automotive Expertise to Improving Our Partners' Truck Platforms

# Network Communication "CAN Bus" Ruggedization

The CAN Bus can be subject to failures like:

- Short circuits
- Broken wires
- Corrupted data

Example of a CAN fault
to the brake controller
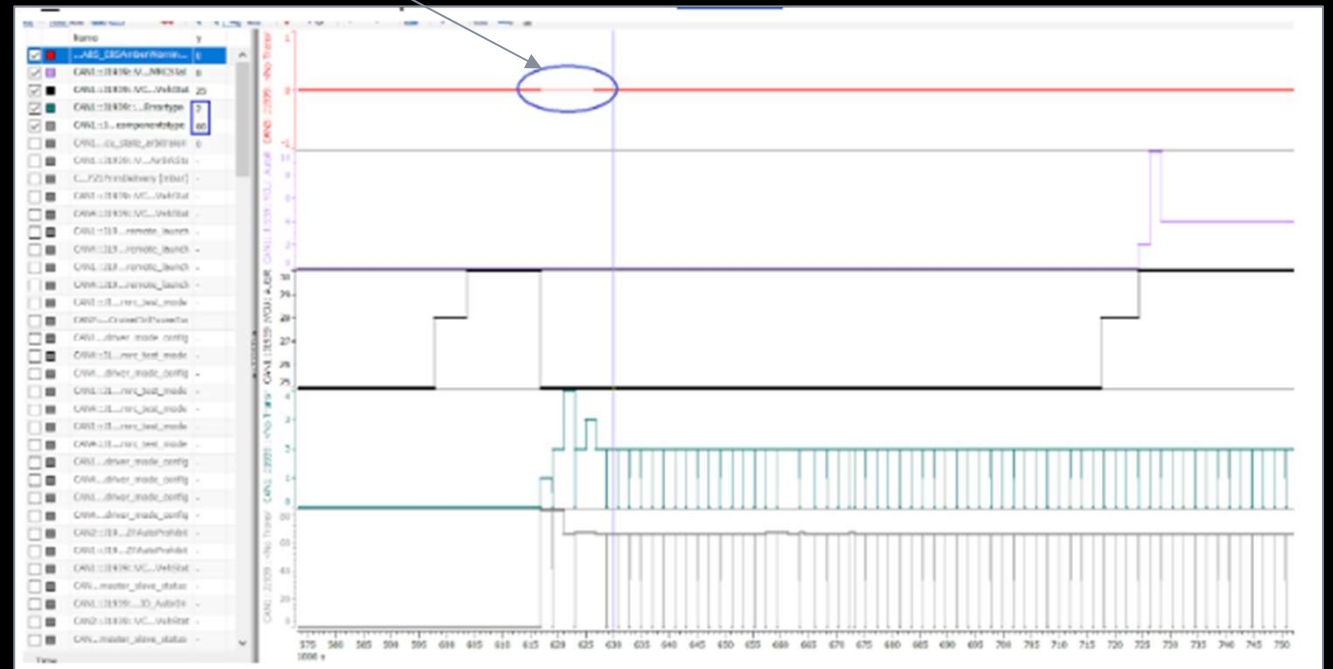


**TuSimple Identified CAN Improved Reliability Requirements**

# CAN Bus Ruggedization (cont.)

## TuSimple's solution

**CAN Bus Distribution Board**



Robust board-to-board connectors
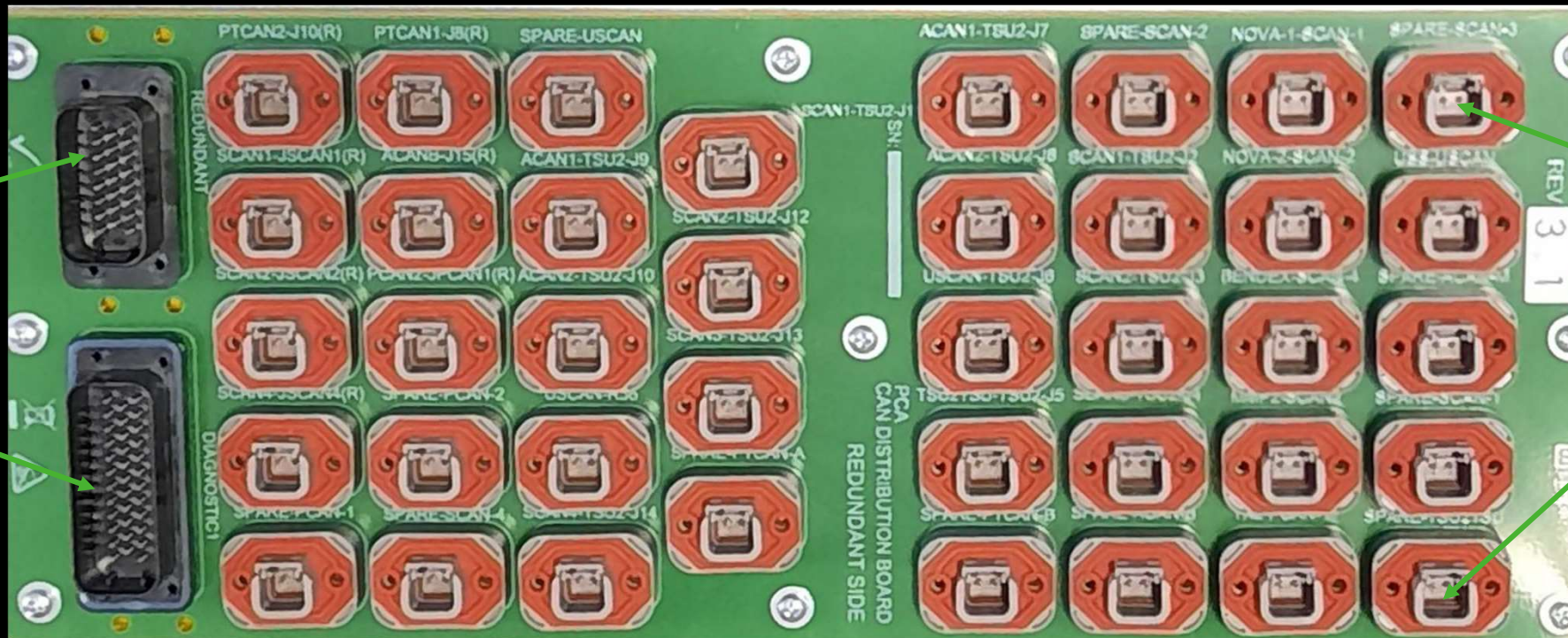
Spare CAN connections for testing and R&D

**Improved Hardware Integrity Reduces CAN Faults and Improves System Diagnostics**

# Power Ruggedization

Power Loss is a severe fault

- Preventing power loss prevents system shut down



Loose cable

**Standard OEM Architectures Lack the Redundancy and Safety Required for AV Systems**

# Power Ruggedization (cont.)



**Case Study**

## TuSimple's solution

In-house designed power electronics



Without TuSimple Power Electronics

With TuSimple Power Electronics
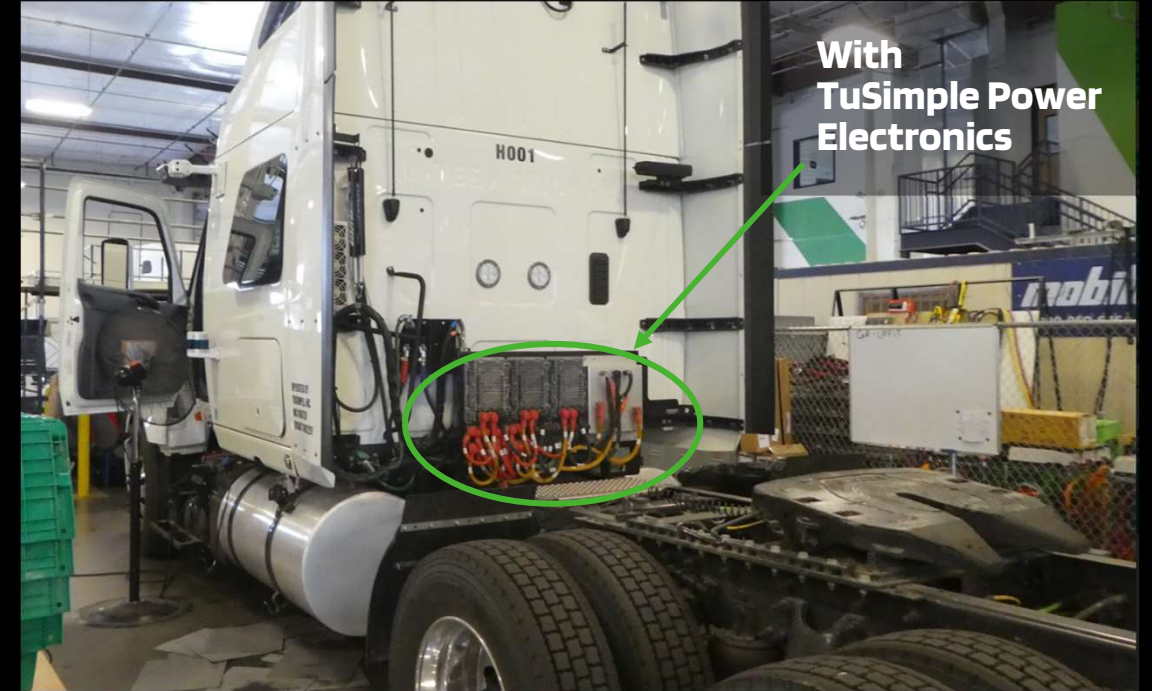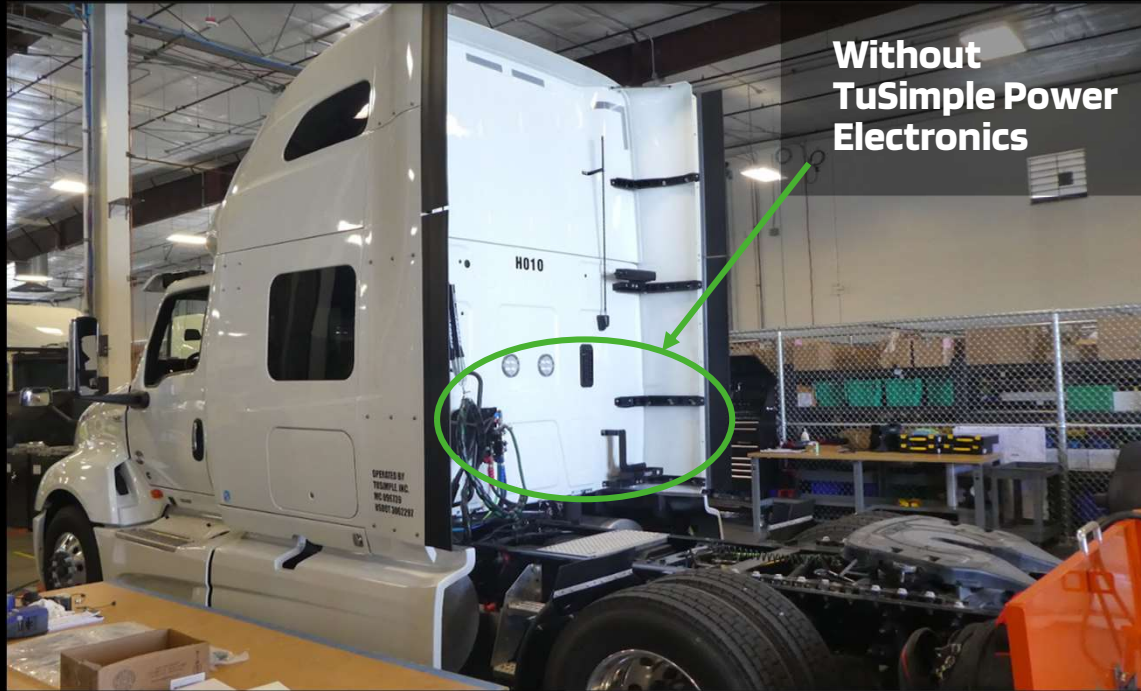
**TuSimple's Proprietary Power Electronics Protect Against Power Loss**

# Hardware Validation

## Design verification of components before they are installed on trucks

Components must pass vehicle testing standards before install

- CISPR 12
- CISPR 25
- ISO 11451-2
- ISO 12103-1
- ISO 22241-1
- ISO 26262
- SAE J1455
- DR100159-05
- ISO16750-1
- ...

### V-Development process

Increases our confidence in components at every step before they are put on the truck

Vehicle Testing

System Testing

Subsystem Testing
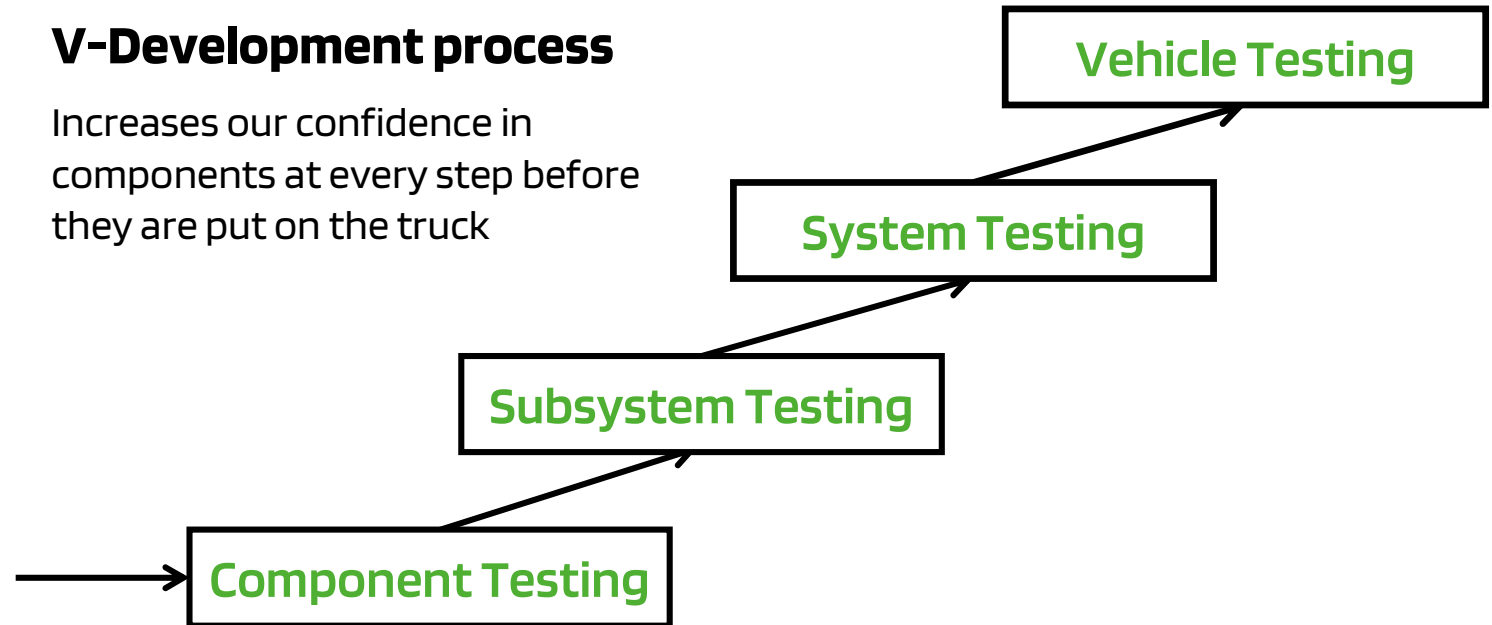
Component Testing

Hardware is Validated to Rigorous Automotive and Commercial Vehicle Standards

# Hardware Validation of the Power Bridge (PBR)

**Progressive testing sequence**

| Component Testing |
| --- |





Each Level of Testing Must Be Passed Before Progressing to the Next Higher Level

# Hardware Validation of the Power Bridge (PBR)

**Progressive testing sequence**

| Component Testing | → | Subsystem Testing |



Each Level of Testing Must Be Passed Before Progressing to the Next Higher Level

# Hardware Validation of the Power Bridge (PBR)

**Progressive testing sequence**

| Component Testing | → | Subsystem Testing | → | System Testing |
|---|---|---|---|---|



Each Level of Testing Must Be Passed Before Progressing to the Next Higher Level

# Hardware Validation of the Power Bridge (PBR)
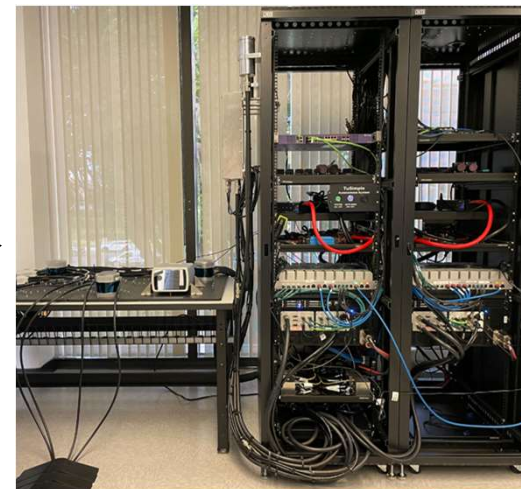
**Progressive testing sequence**

| Component Testing | → | Subsystem Testing | → | System Testing | → | Vehicle Testing |



**Each Level of Testing Must Be Passed Before Progressing to the Next Higher Level**

# Hardware Validation - Vehicle Testing Examples

## Data driven validation

**Process**

**Example 1**

| Issue Triage |
| :---: |

↓

| Problem Solving |
| :---: |

↓

| Change Control |
| :---: |

↓

( Current Hardware Cost Per Mile )

**CAN Network Communication Errors:**
Caused disengagements

↓

**Root Cause:**
Resistor termination

↓

**Change Control:**
Electrical parts re-designed & released for future builds

↓

( **Current Hardware Cost Per Mile**
**2% Hardware Cost Per Mile Reduction** )

**Robust Issue Tracking and Problem Resolution Leads to Increased Reliability and Lower Cost Per Mile**

# Hardware Validation - Vehicle Testing Examples

## Data driven validation

| Process | Example 1 | Example 2 |
|---|---|---|

**Issue Triage**

**CAN Network Communication Errors:**
Caused disengagements

**LiDAR Arm Weld Failure**

↓

**Problem Solving**

**Root Cause:**
Resistor termination

**Root Cause:**
Incomplete weld penetration

↓

**Change Control**

**Change Control:**
Electrical parts re-designed & released for future builds

**Change Control:**
New weldment process, parts & supplier

↓

**Current Hardware Cost Per Mile**

**Current Hardware Cost Per Mile**
**2% Hardware Cost Per Mile Reduction**

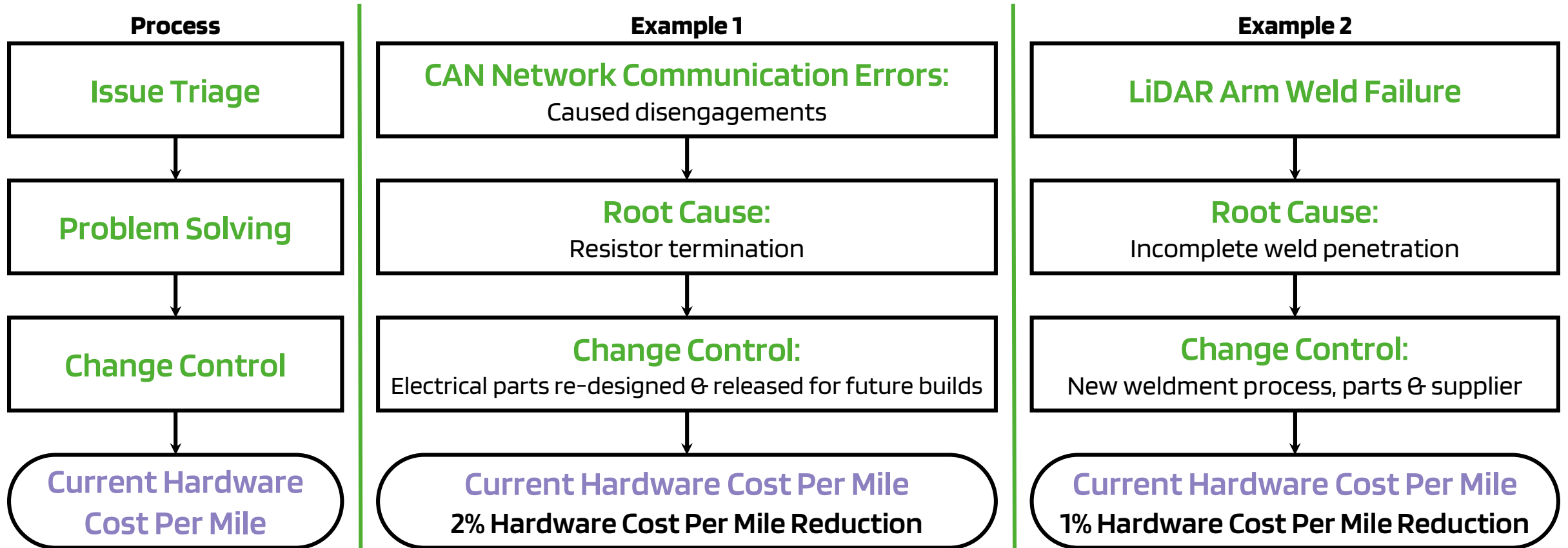**Current Hardware Cost Per Mile**
**1% Hardware Cost Per Mile Reduction**

**Robust Issue Tracking and Problem Resolution Leads to Increased Reliability and Lower Cost Per Mile**
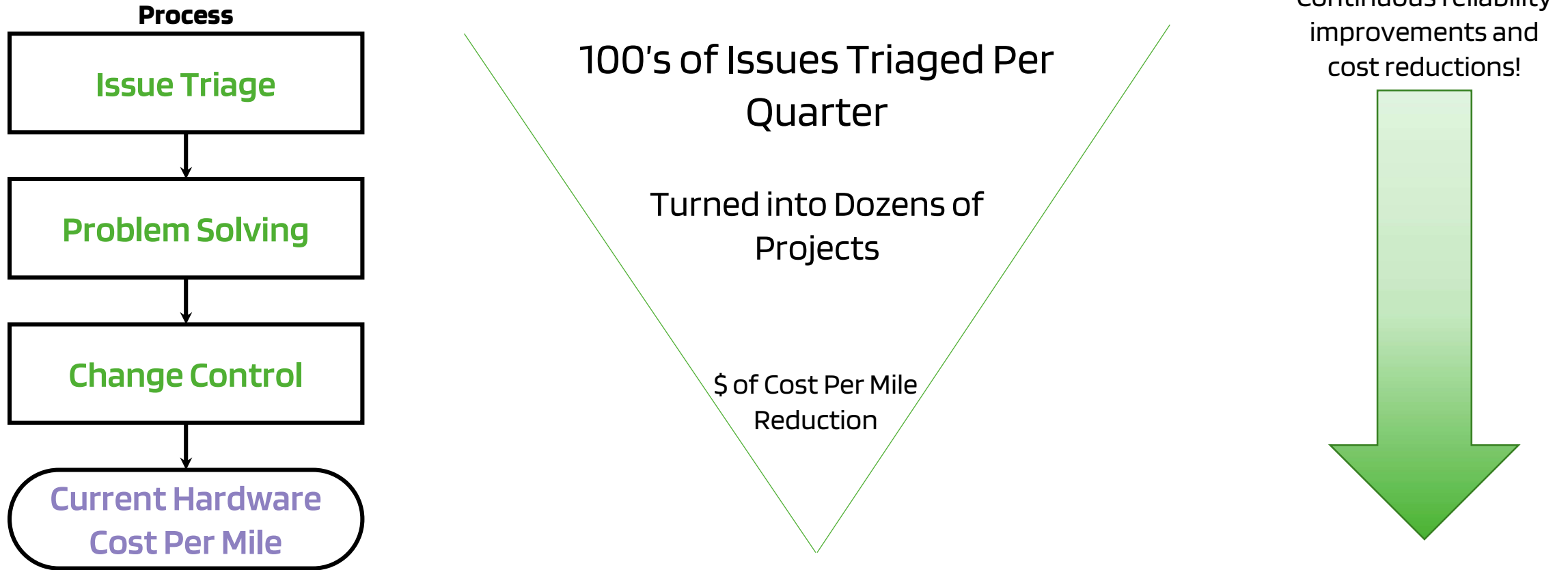
# Hardware Validation - Vehicle Testing Examples

**Data driven validation**

**Process**

Issue Triage

Problem Solving

Change Control

Current Hardware Cost Per Mile

100's of Issues Triaged Per Quarter

Turned into Dozens of Projects

$ of Cost Per Mile Reduction

Continuous reliability improvements and cost reductions!

Robust Issue Tracking and Problem Resolution Leads to Increased Reliability and Lower Cost Per Mile

# Knowledge Transfer from Retrofit to Production Truck

**Ruggedization**

- Autonomy Hardware
- Chassis Components
- Electrical
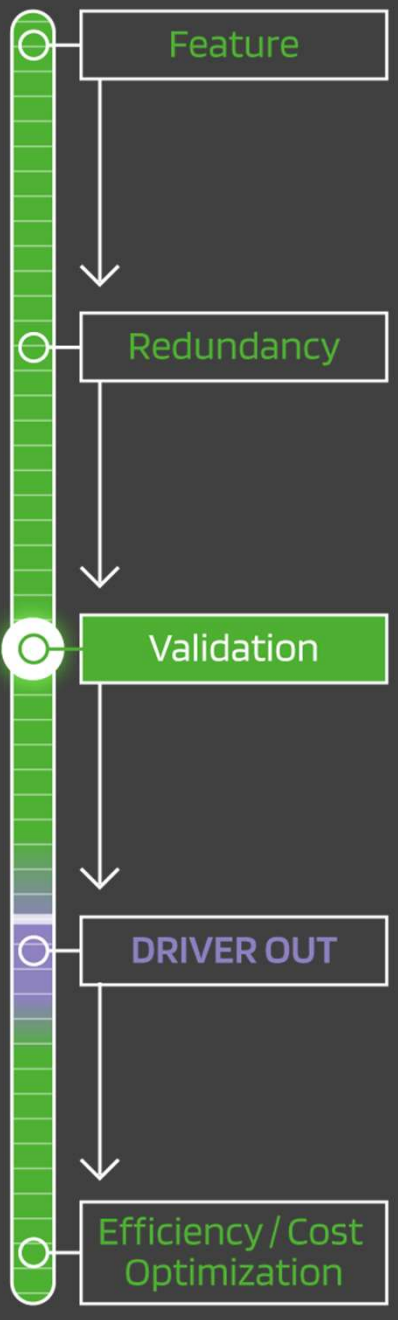
TuSimple Provides All Key Learning and Ruggedization to Our OEM Partners

# Validation:
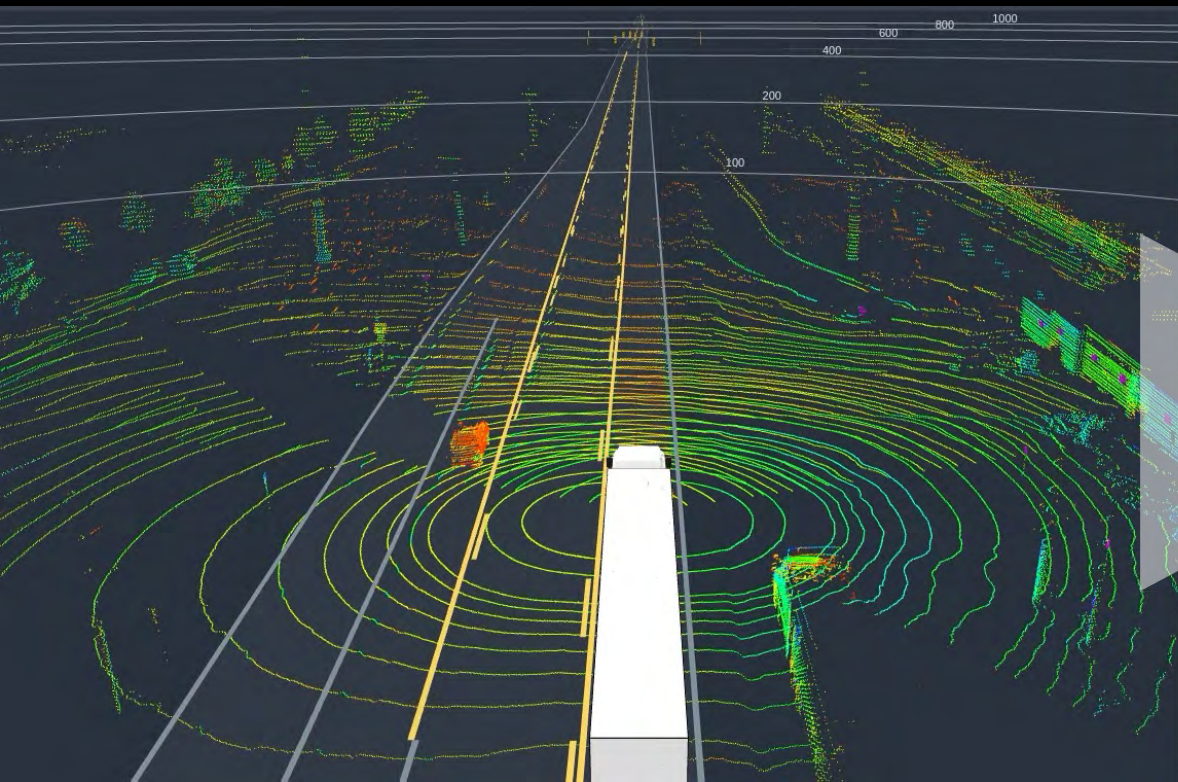# Simulation

## Ersin Yumer

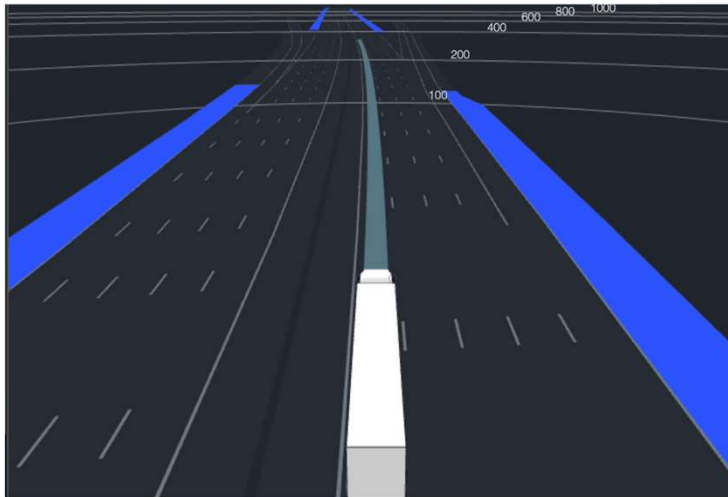VP, Algorithm

# 1,000

**simulation miles for 1 road test mile***

**\*average for year 2022**

# Let's Watch a Truck Drive…

# Not Every Mile Driven is the Same

## Boring miles

- No dynamic objects

- No interactions

- Only minor steering/control action is needed

- Driving on a straight line



## Interesting miles

- Other dynamic objects
  - Vehicles
  - Vulnerable road users (pedestrians, bikes, ...)

- Precise steering and control needs (lane change, merge, ...)

- Driving on curved roads, through intersections, ...
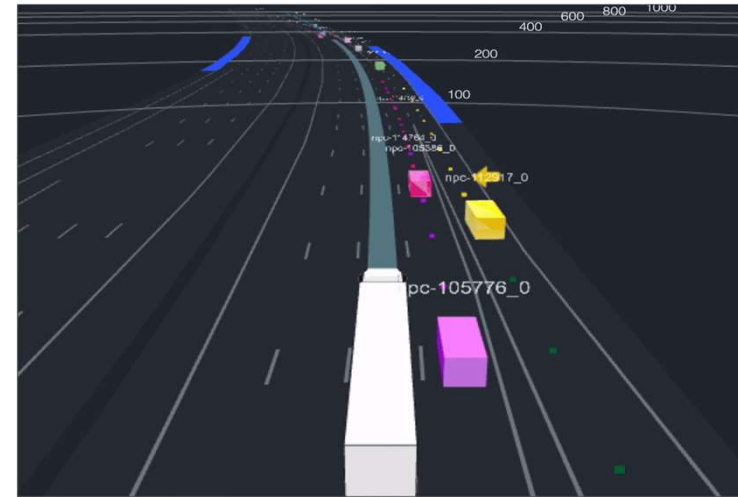


At TuSimple, we Focus our Simulation Efforts on Leveraging "**Interesting Miles**"

# 1,000

**simulation miles for 1 road test mile***

*average for year 2022

# TuSimple Simulation Ecosystem

# TuSimple Simulation Ecosystem
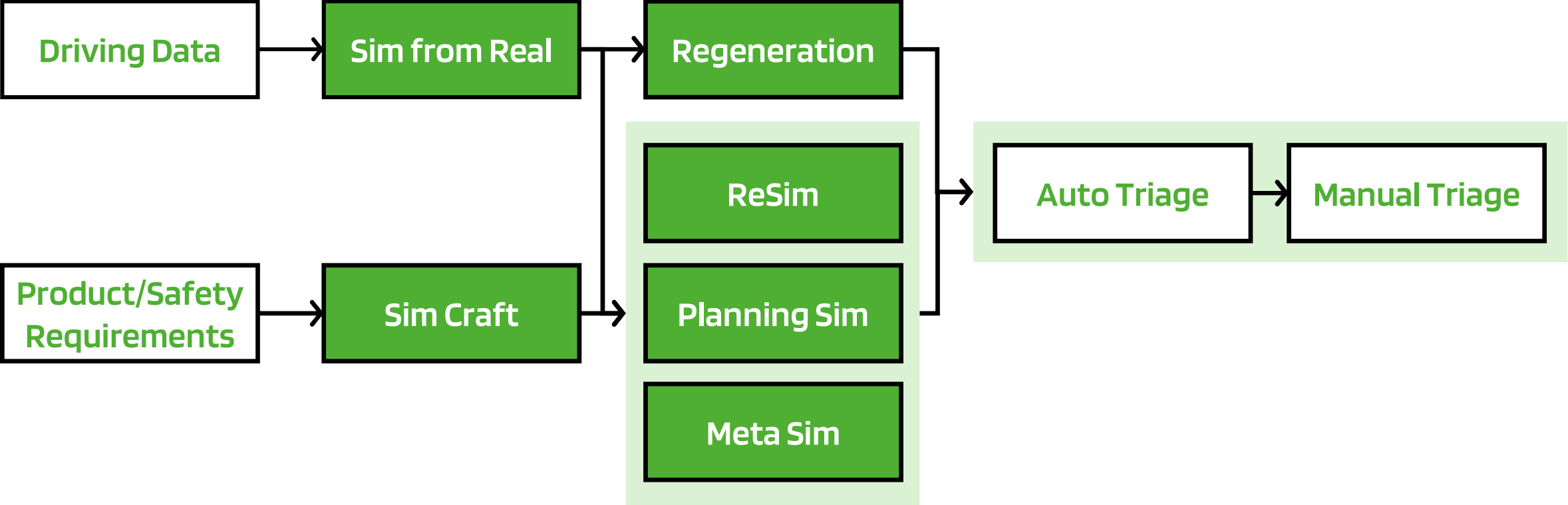
# TuSimple Simulation Ecosystem
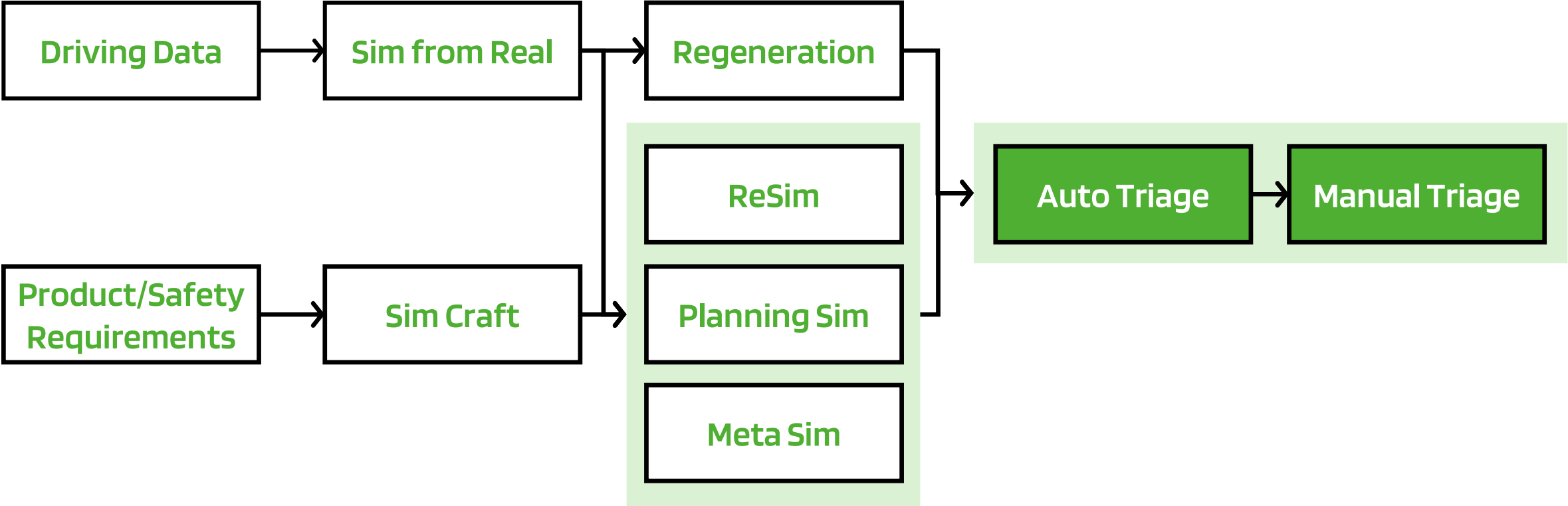
# TuSimple Simulation Ecosystem
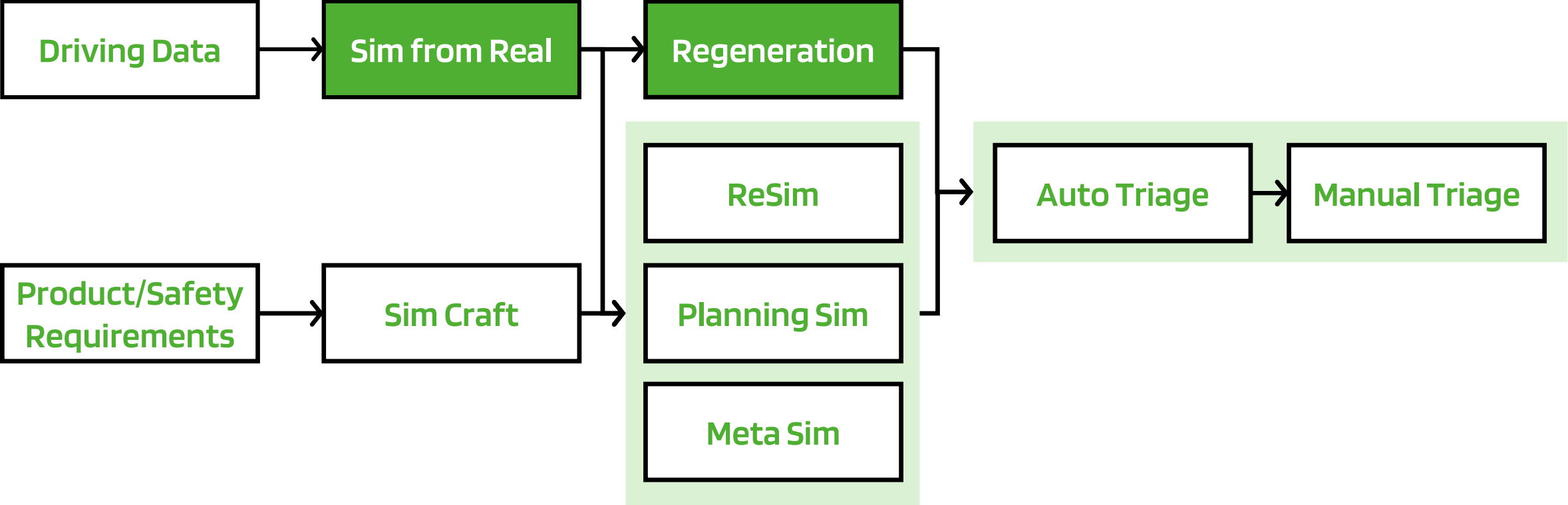
# Regeneration:Before

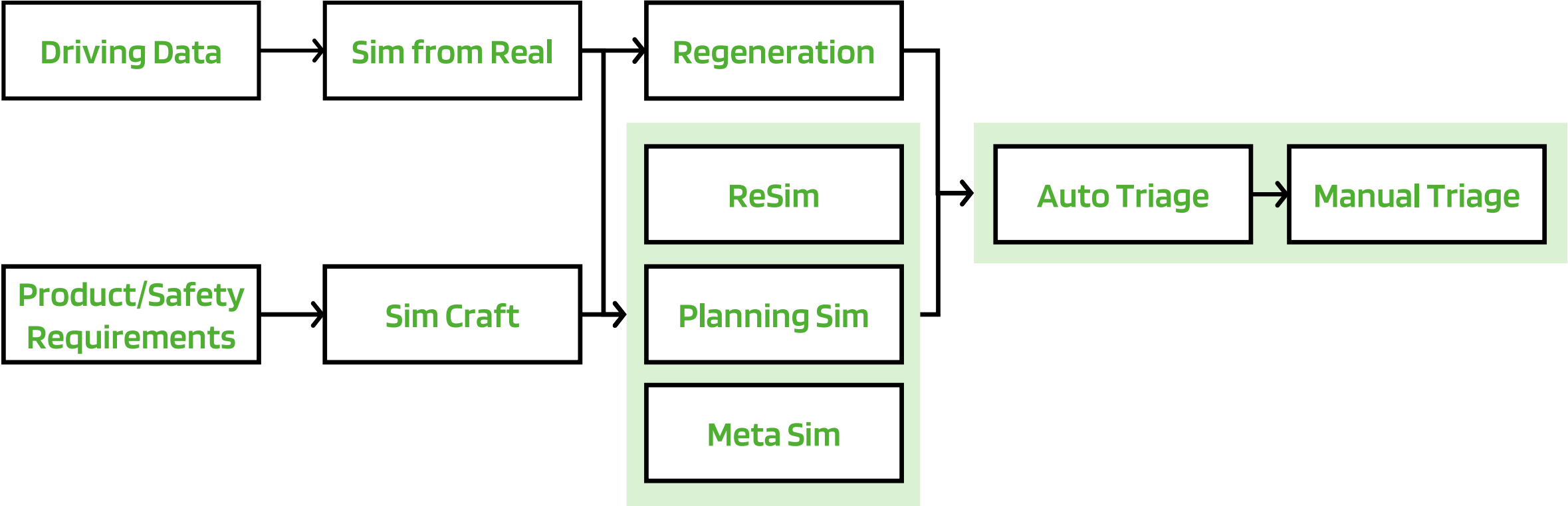**tu simple** | Investor Day 2022
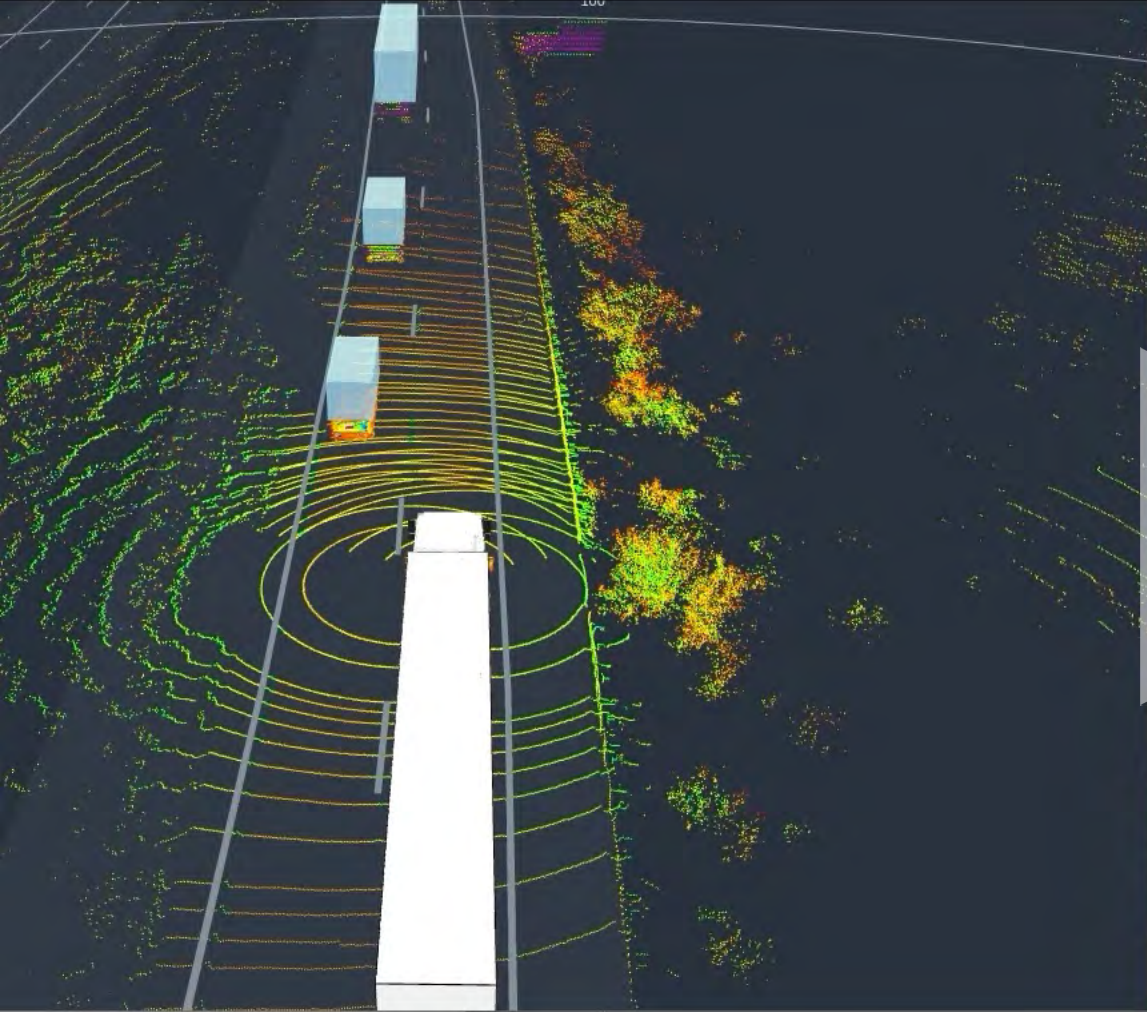
Before
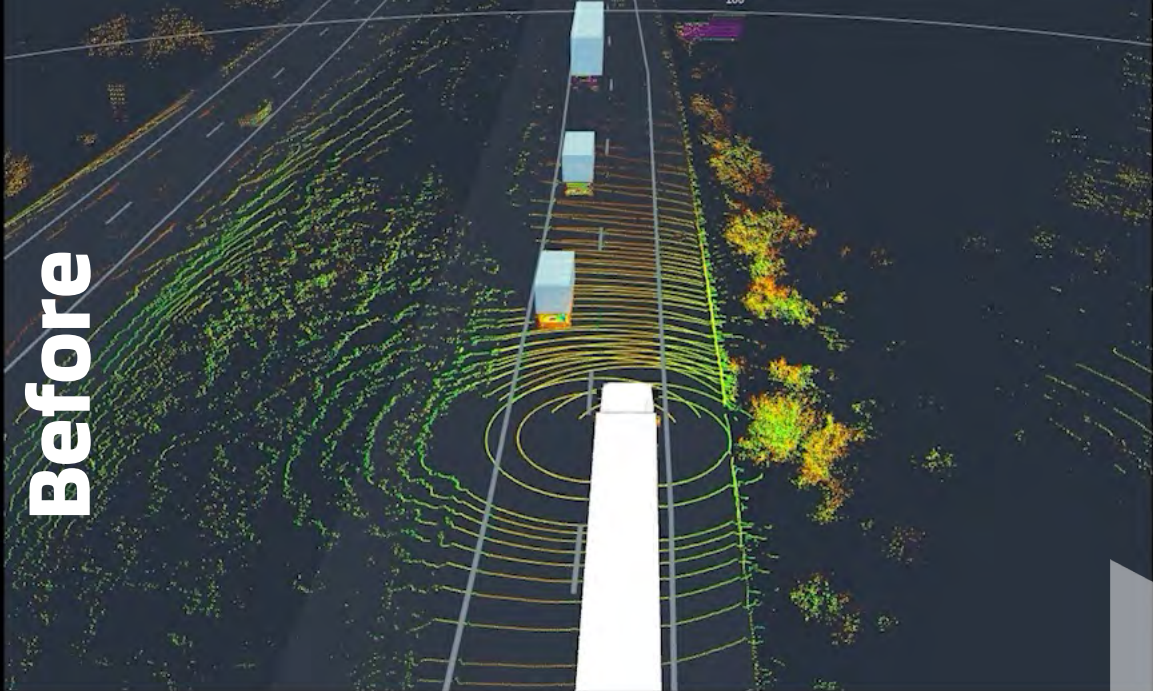
After
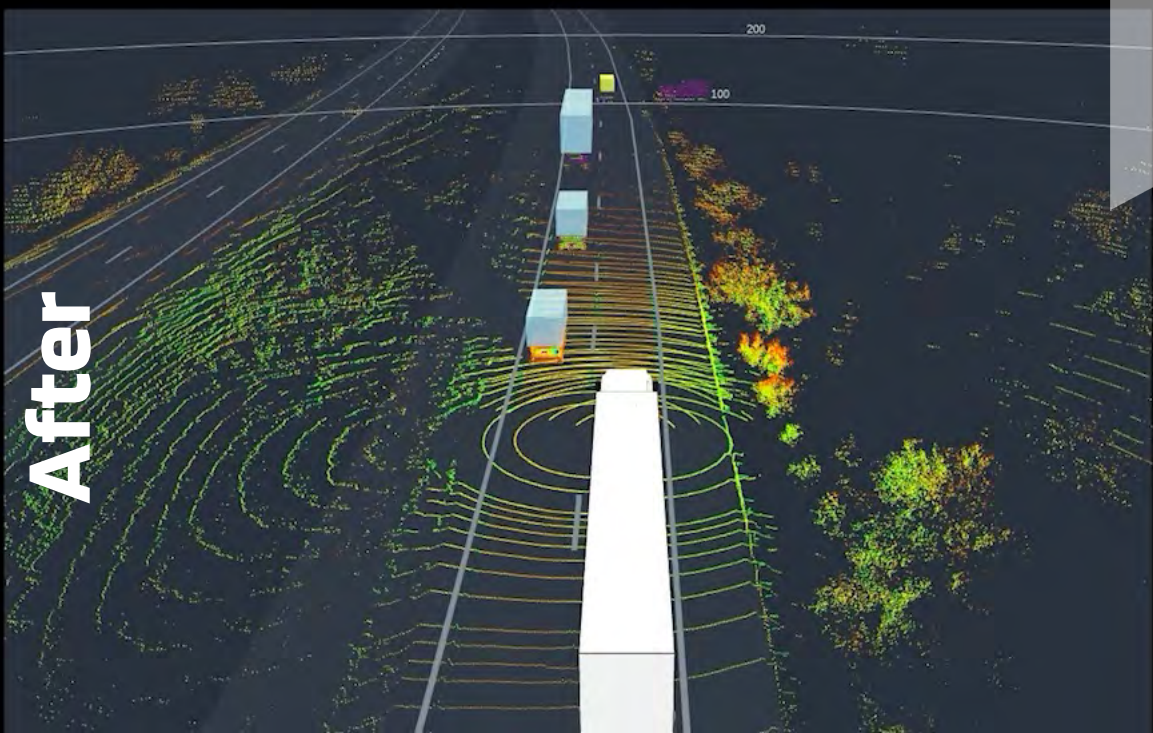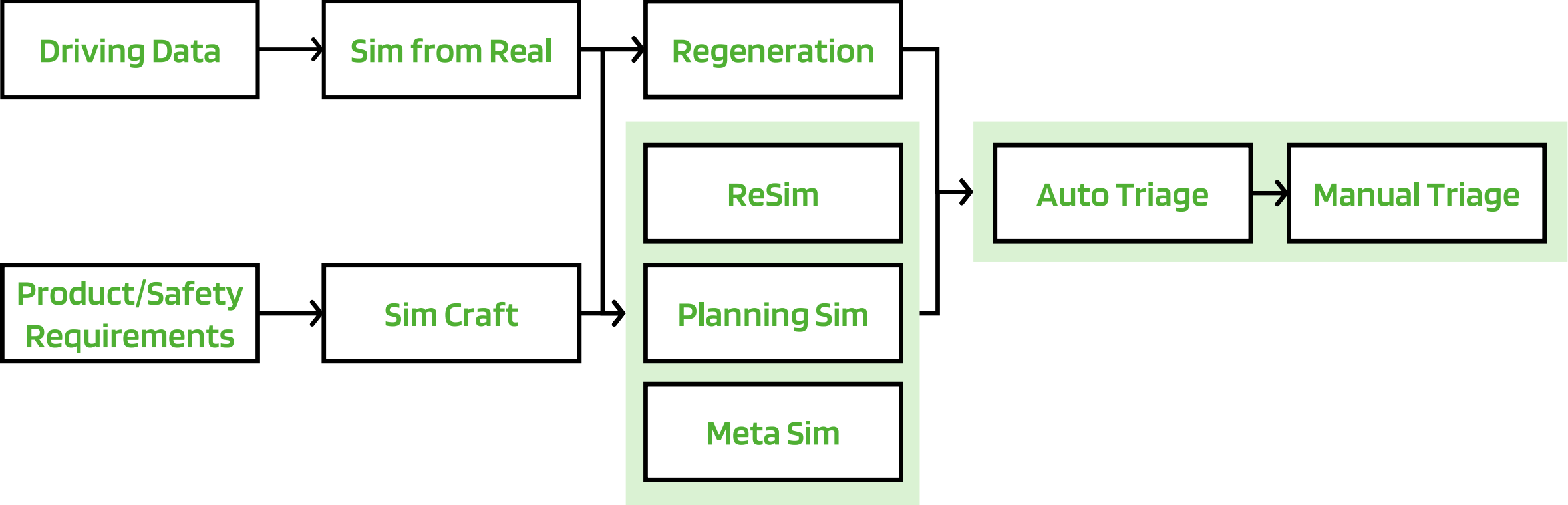
# Case Study: A Typical Merge Example

# TuSimple Simulation Ecosystem

```
Driving Data ──────▶ Sim from Real ──────▶ Regeneration ──────┐
                                                               │
                                            ┌─────────────┐    │
                                            │    ReSim    │    ├──▶ Auto Triage ──▶ Manual Triage
Product/Safety ─────▶ Sim Craft ──────▶    │ Planning Sim│────┘
Requirements                                │   Meta Sim  │
                                            └─────────────┘
```
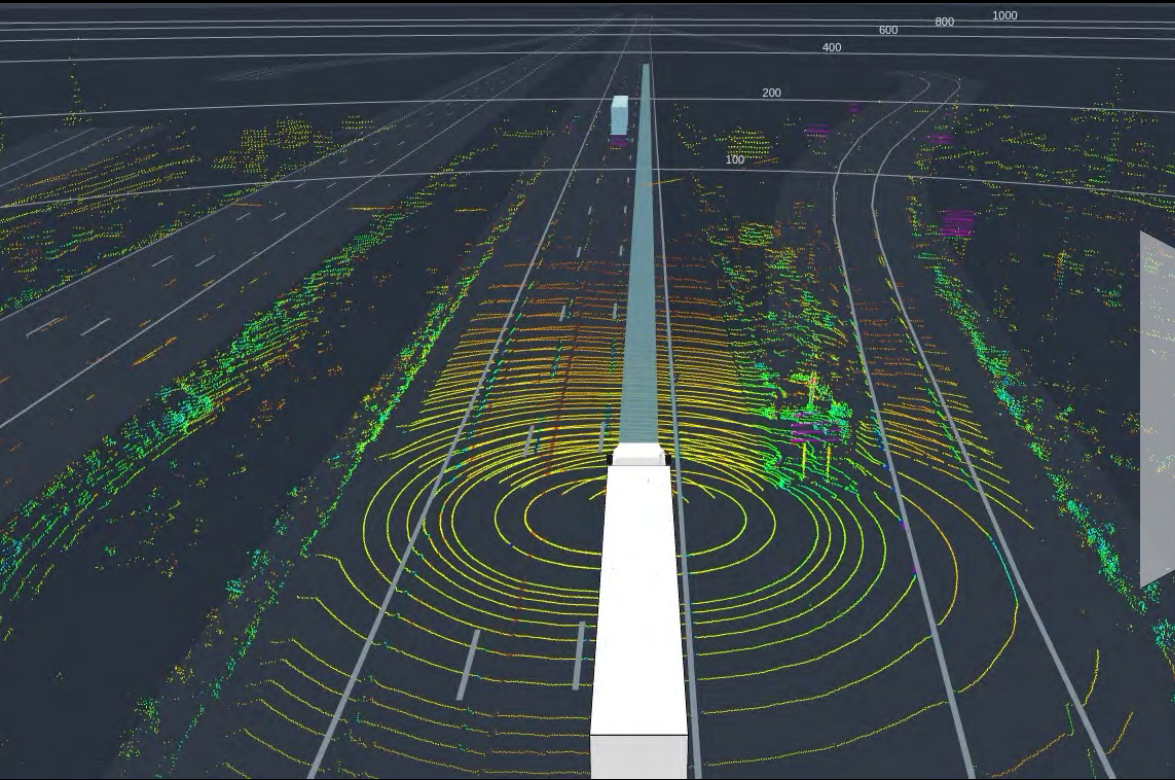
# TuSimple Simulation Ecosystem

# Resim: Step 1 – Regeneration (New Perception Results)
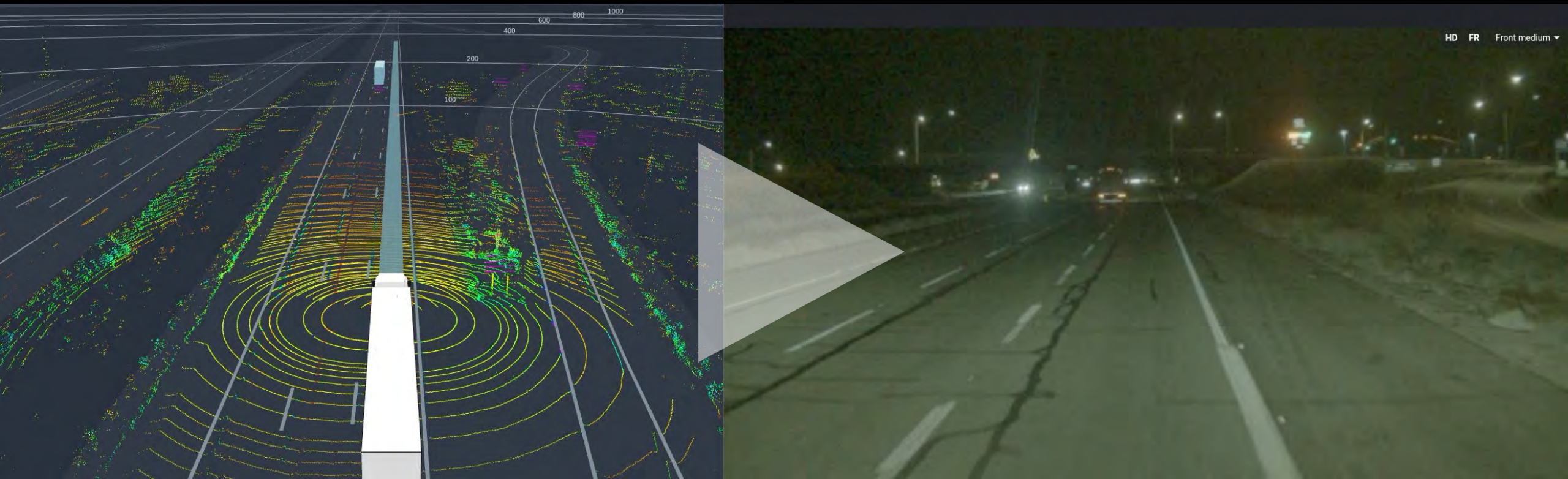


Resim Step 1: Regeneration:
Click here or above to play video

# Resim: Step 2 – Simulation with New Perception Results
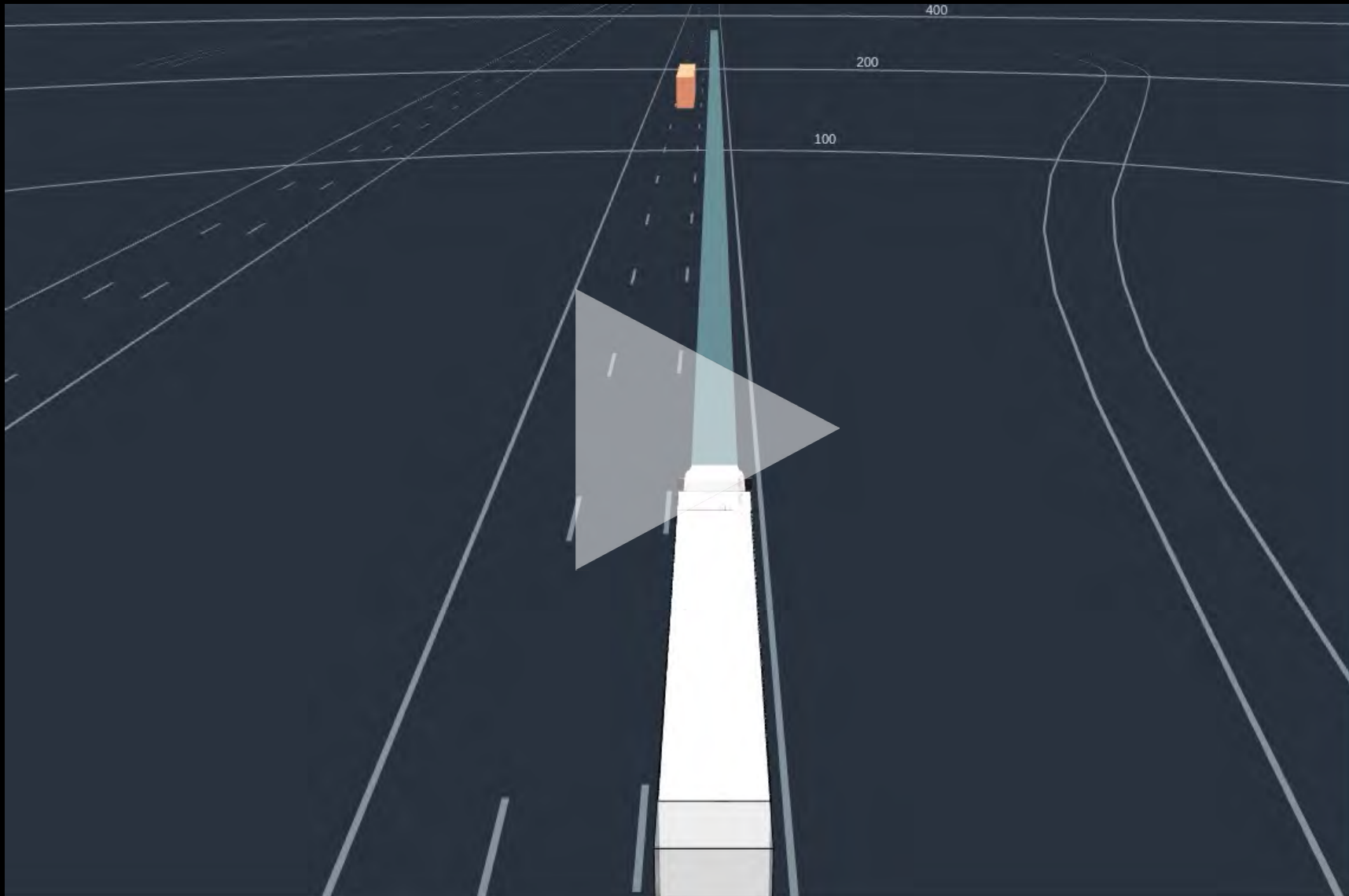


Resim: Step 2 Simulation with New Perception Results: Click here or to the left to play video

# Another Typical Case: Pedestrians on the Shoulder
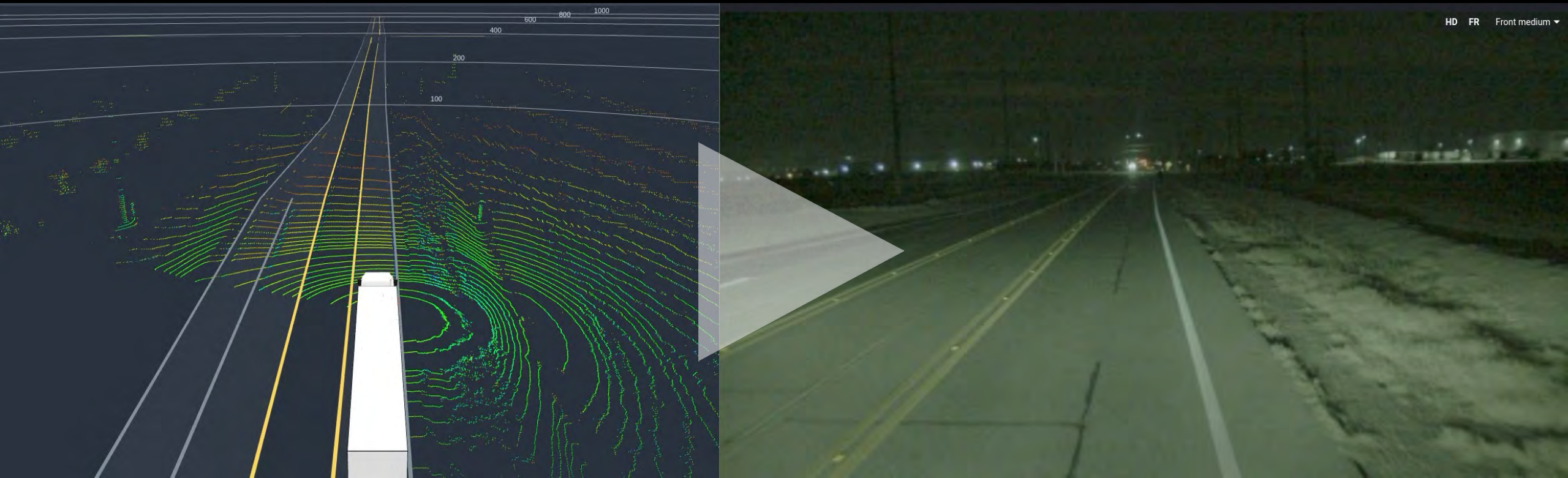


Pedestrians on the Shoulder:
Click here or above to play video

# Resim: Simulation with Existing Perception Results
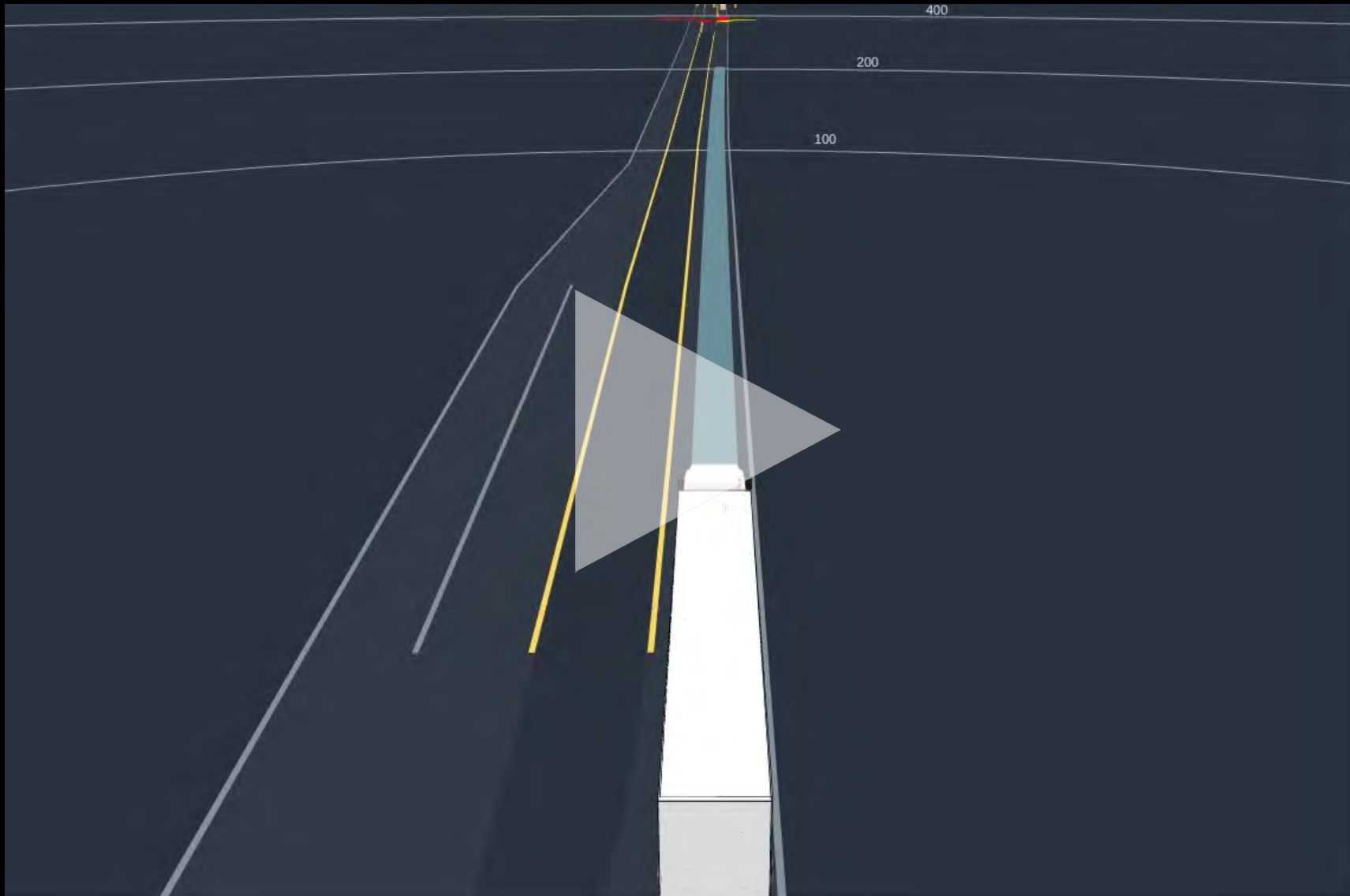


Simulation with Existing Perception Results:
Click here or to the left to play video

# TuSimple Simulation Ecosystem

```
Driving Data  →  Sim from Real  →  Regeneration  ┐
                                                  │
                                  ┌─────────────┐ │
Product/Safety  →  Sim Craft  →   │ ReSim       │ ├→  Auto Triage  →  Manual Triage
Requirements                      │ Planning Sim│ ┘
                                  │ Meta Sim    │
                                  └─────────────┘
```
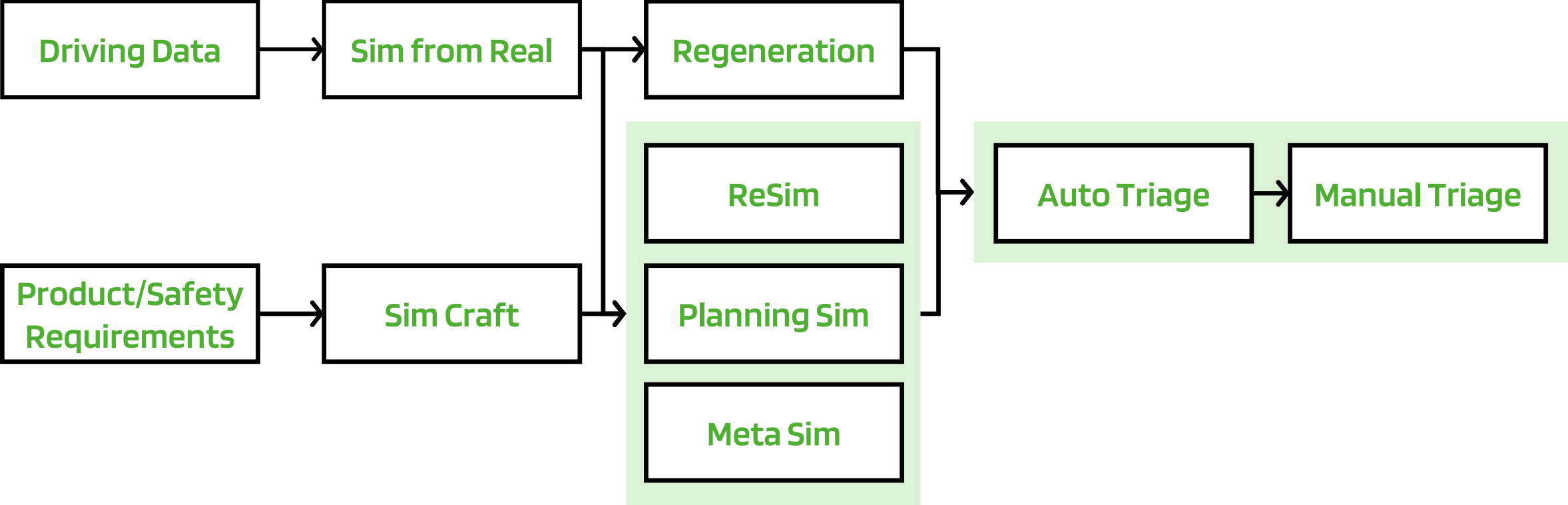
# TuSimple Simulation Ecosystem
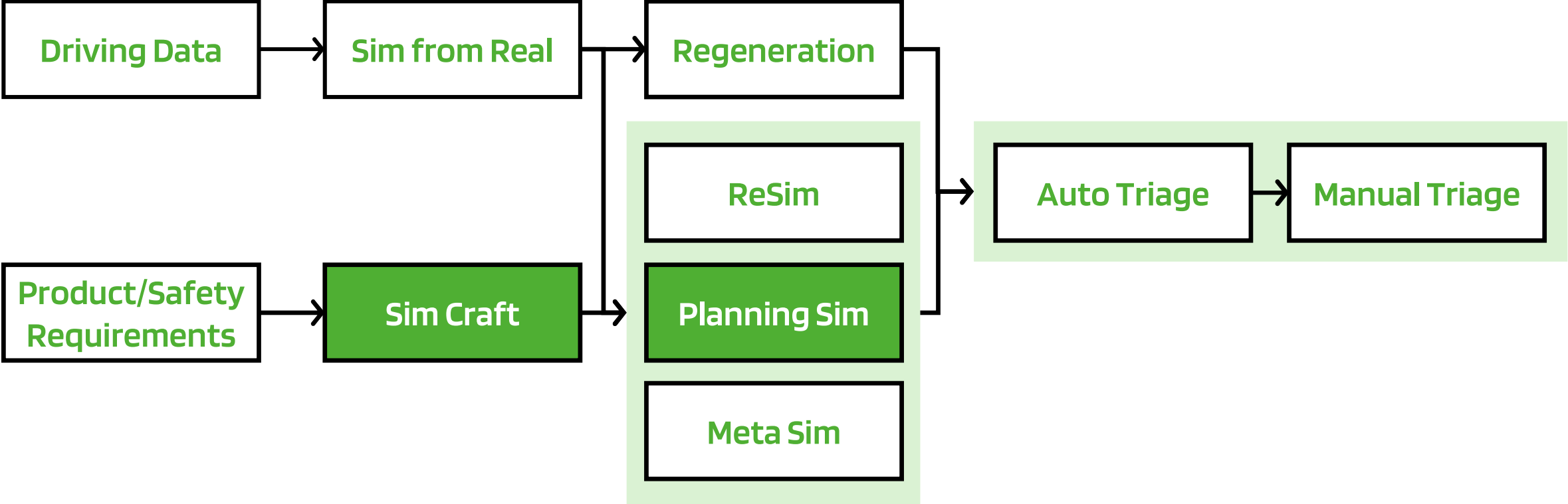
# Simcraft: Product/Safety Requirements
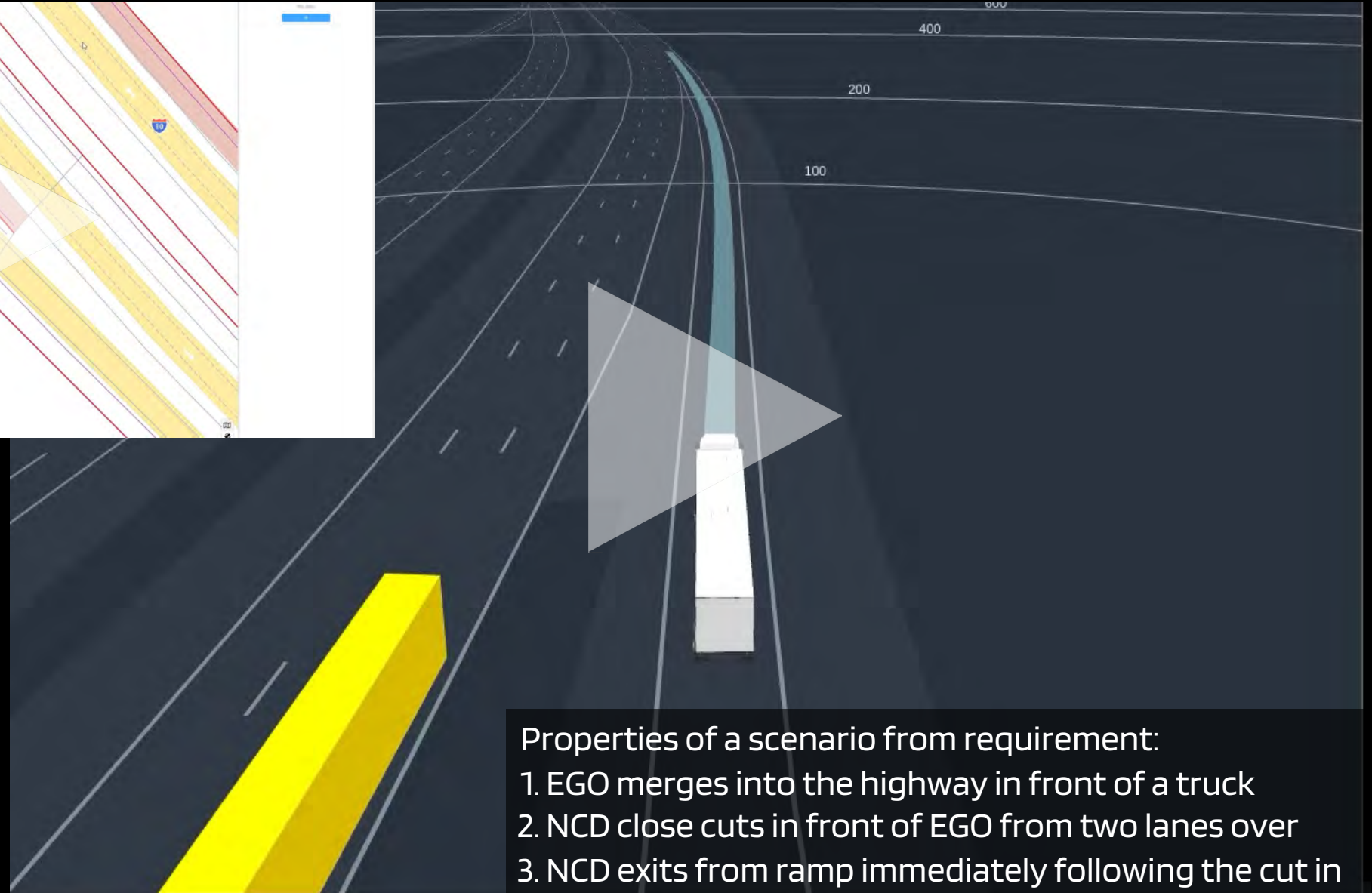
Properties of a scenario from requirement:
1. EGO merges into the highway in front of a truck
2. NCD close cuts in front of EGO from two lanes over
3. NCD exits from ramp immediately following the cut in

tu simple | Investor Day 2022
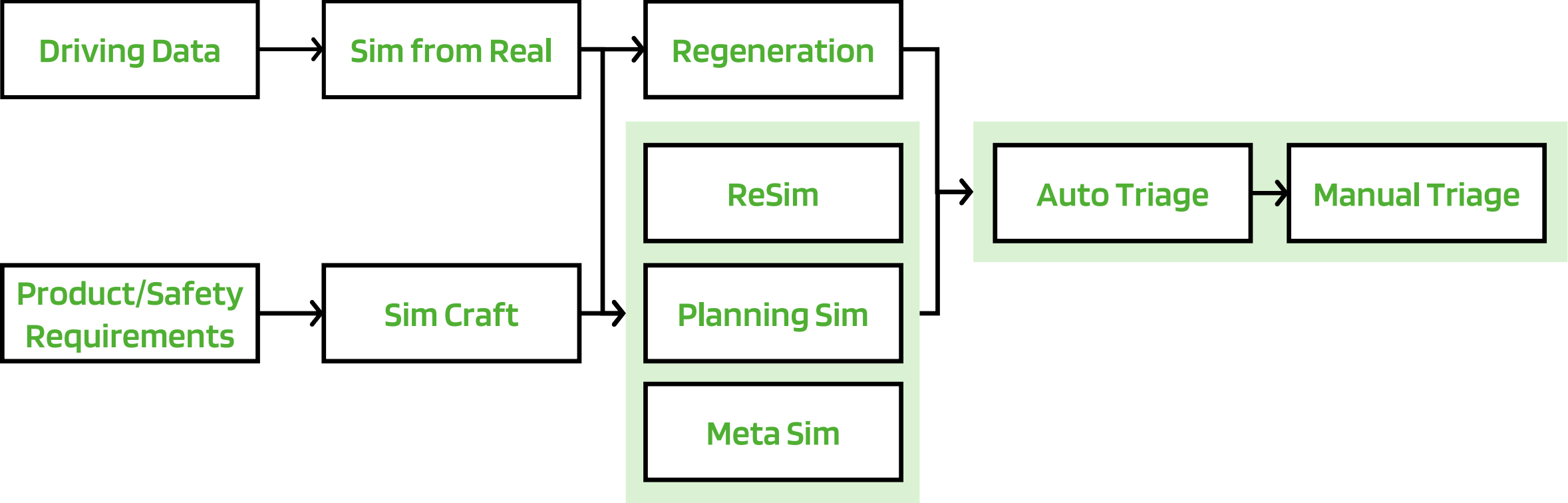
105

# TuSimple Simulation Ecosystem

# TuSimple Simulation Ecosystem

Investor Day 2022
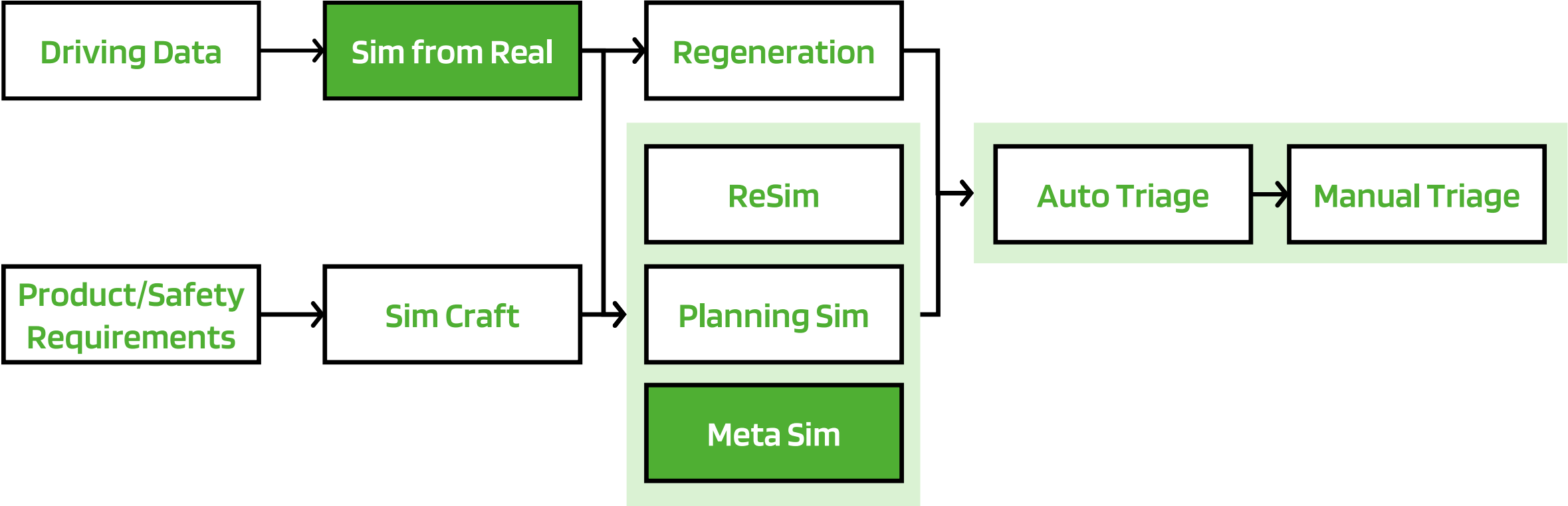
# TuSimple Simulation Ecosystem

# TuSimple Simulation Ecosystem
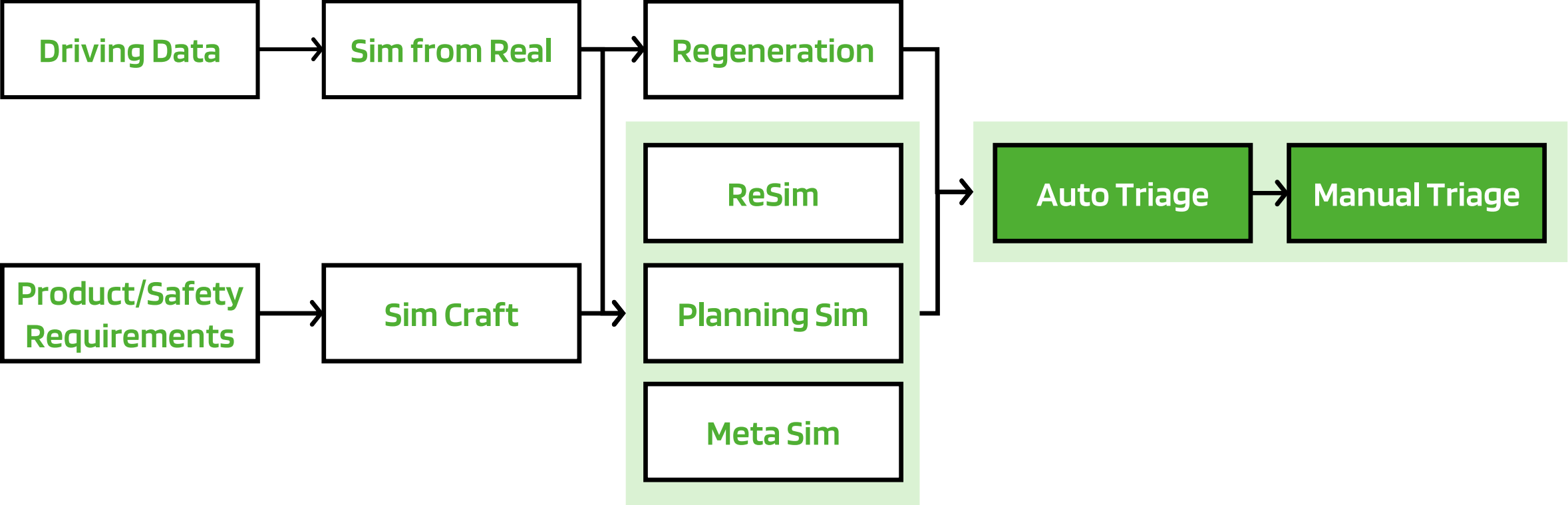
# Safety Case: Virtual Runs

## Rapid virtual ADS experience in addition to road tests to build validation confidence

- 10M+ miles per 24h in simulation

- Auto event candidate detection:
  - 100% recall of critical cases

- Auto-triage:
  - High confidence results for 90+% cases

- Manual-triage for:
  - Low confidence score during auto-triage
  - Random sampling from the rest



9%

91%

89%

11%

■ Auto-Triaged        ■ False-Positives
■ Manually-Triaged    ■ Non-Safety Critical
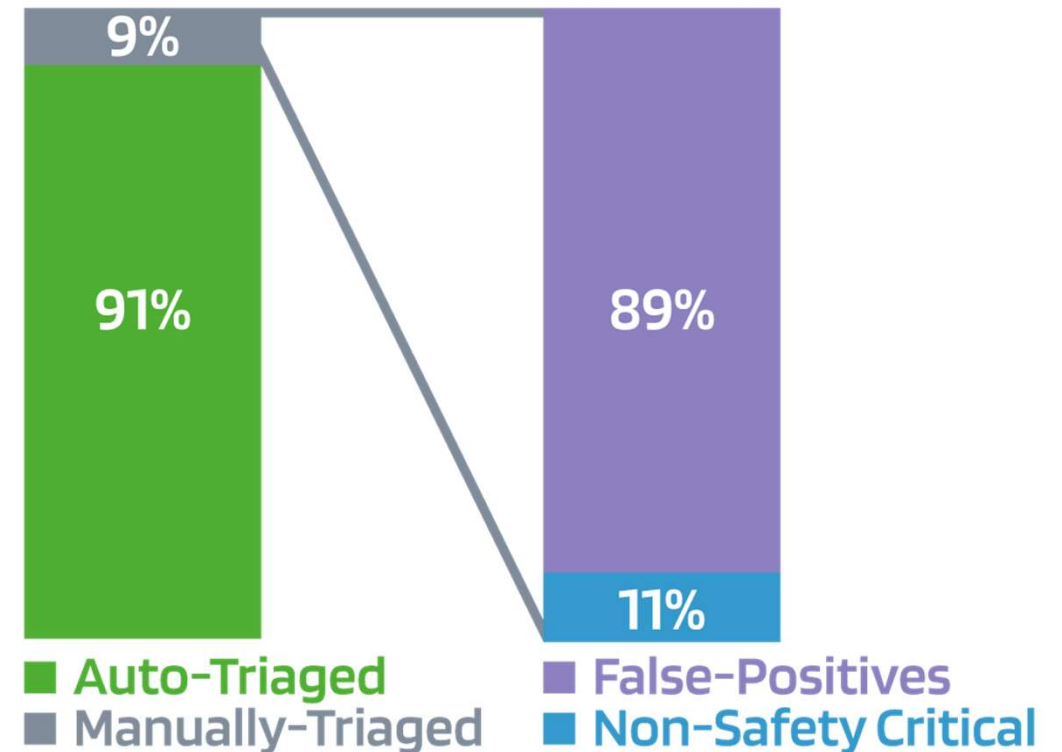
# Validation: Systems Safety

## Adrian Thompson

VP, Systems & Safety Engineering

Feature

Redundancy

Validation

DRIVER OUT

Efficiency / Cost Optimization
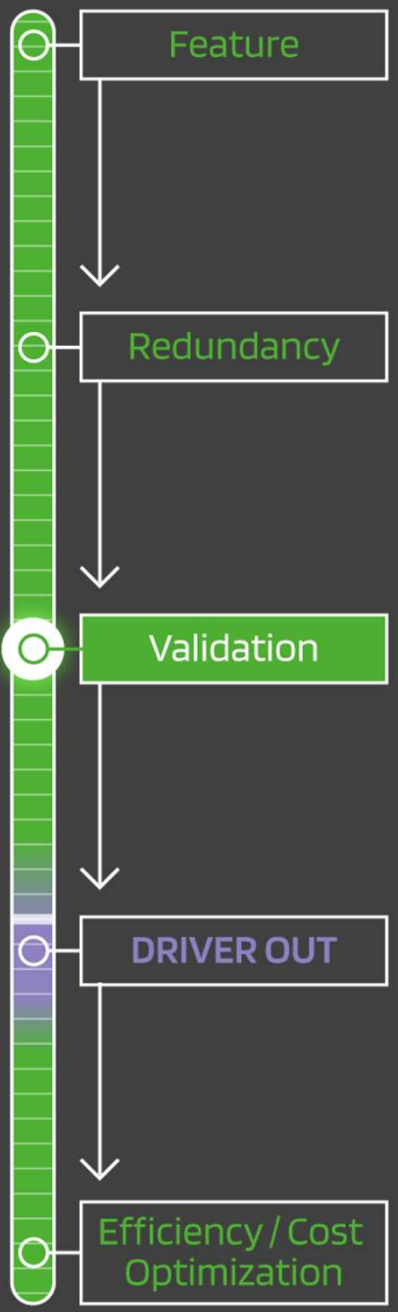
# Safety for Class 8 Trucks is a Unique Challenge

## AV Trucks Need Higher Standards

- 80,000 lbs fully loaded
- Hundreds of meters to stop
- Jack-knife risk
- Highway speeds
- Dynamic traffic and bad actors
- Steep grade surfaces
- Cross-winds and weather



**Must Design for Safety from the Ground Up**

# TuSimple's Safety Approach is Holistic

## Not just about the AV Truck

- Entire AV operation must be safe

## Covers:

- Base truck platform

- Autonomous Driving System (ADS)

- Remote monitoring network

- Maintenance and "Pre-Flight" checks

- Safety Culture



TuSimple's Approach Provides a Holistic and Consistent Safety Viewpoint

# TuSimple Aims to Solve Lack of Unified Standards

There isn't a standard that adequately covers safety for Autonomous Trucking. This required us to take the best practices of adjacent industries combined to create our own safety framework.

**Relevant Safety Standards**

- ISO 21448
- DO-178
- MIL-STD-882
- IEC 61508
- DO-254
- ISO 26262
- UL 4600
- SAE J3168
- SAE JA1011
- ISO/SAE 21434
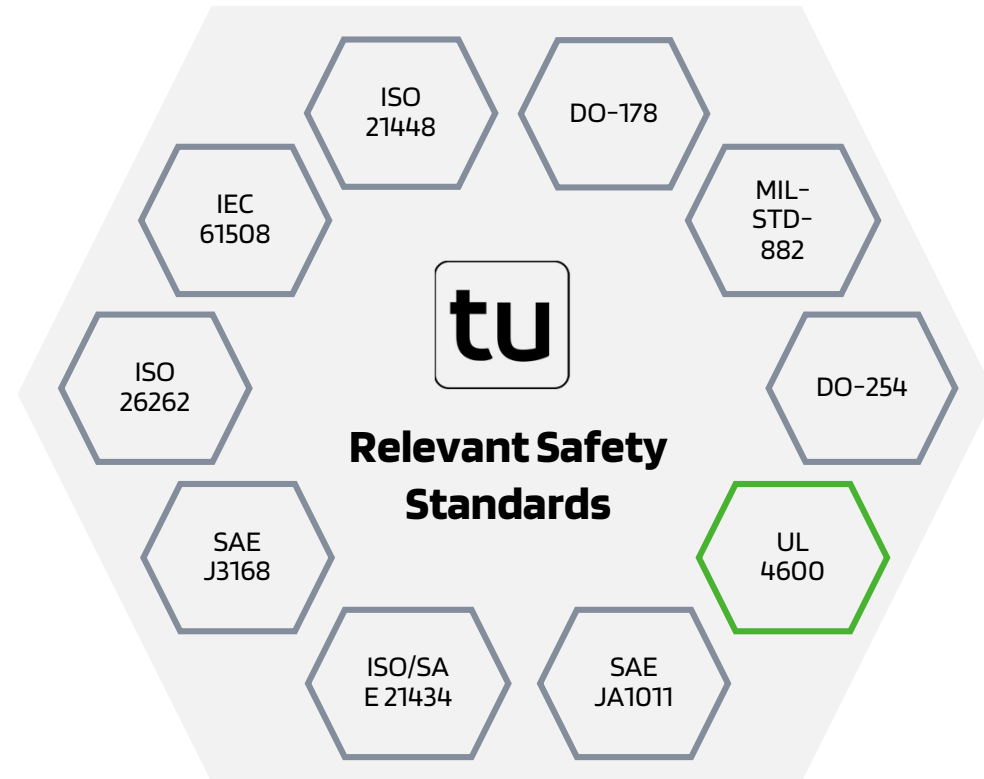
**Leading the Industry in Defining Class 8 ADS Safety Criteria**

# TuSimple Safety Framework



Combining all safety practices results in the TuSimple Safety Framework. Meeting the safety performance measures in this framework proves readiness for Driver Out operations.

## TuSimple Safety Framework

**Reliability**
(robust design)

**Fail-Safe**
(functional safety)

**Sufficient**
(safety of the intended function)

**Proven**
(substantive safety)

**TuSimple Safety Framework Sets the Standard for Autonomous Trucking**

# Hierarchical Validation



We prove safety standards are met at the component, subsystem, system, and full-solution levels. We do not integrate elements unless each one is individually proven to meet safety standards.
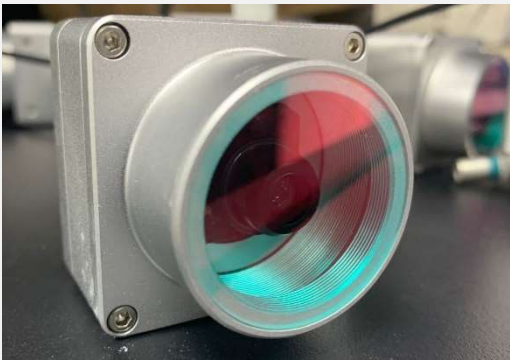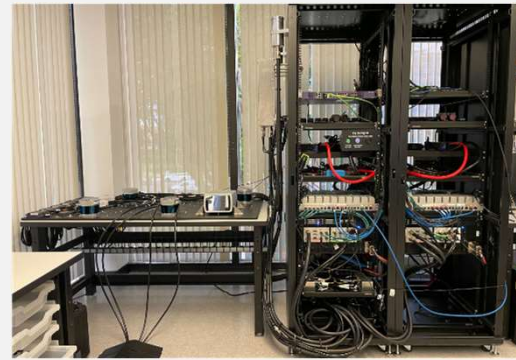
| Component Testing | Subsystem Testing | System Testing | Vehicle Testing |
|---|---|---|---|

**Multi-level Validation Increases Safety Performance**

# Improved Safety Through "Adversarial Testing"

An independent team conducts adversarial testing to find weaknesses in the solution and holds the rest of the company accountable to fix them.



"Adversarial Testing" Hardens the Solution Against Unforeseen Weaknesses

# Fail-Safe Case Study 1: Redundant Steering

**Source:** Failure Modes Effects Analysis

**Goal**: Maintain Directional Control During a Failure

**Challenge**: Redundant steering control needed for safety

**Key Requirements**:

- Safe steering handoff @ 65 mph
- Transfer control within 6 feet of travel (~60ms)

Highly Responsive Safety Critical Steering Redundancy in Every TuSimple Truck

# Fail-Safe Case Study 2: Redundant Localization



**Source:** Fault Tree Analysis

**Goal**: Precise Position and Orientation tracking throughout the mission

**Challenge**: Sparse landmarks, visual indicators, and GPS signals vary throughout the current I-10 route in Arizona

**Key Requirements**:

- Capable of operating on a subset of signal
- Mandated triple redundant localization & pose



Triple Redundant Localization and Pose in Every TuSimple Truck

# TuSimple's Commitment to Safety

**TuSimple: sets the standard for Class 8 Level 4 Autonomy**
- Holistic and comprehensive Safety Case Framework

**TuSimple has built a world-class Systems & Safety Engineering organization**
- Independent and rigorous verification process

**Safety Case continuously updated**
- TuSimple continuously updates its Driver Out safety case based on relevant emerging standards, frameworks, or regulations



**TuSimple Delivers a World-class Safety Solution for Autonomous Trucking**

# TRATON Partnership Update

## Pat Dillon
Chief Financial Officer

"At Navistar, we are excited to continue building our partnership with TuSimple to develop the world's first autonomous semi-truck. We believe our collaboration will make freight transportation safer, more environmentally friendly and more cost efficient. "
– Srini Gowda
Vice President - Autonomous Vehicles, Navistar

# TuSimple & Navistar Partnership

# Navistar Production Progress Update

**tu simple | NAVISTAR**

*Latest Agreed Upon Timeline*

| Bill of Materials | Production Facility | Production-Intent Prototype Vehicles | Fully Integrated Vehicles | Carrier-owned Capacity |
|---|---|---|---|---|
| *H1 2022* | *H1 2022* | *2024* | *2025* | *2026* |

**Bill of Materials** — *H1 2022*
- Significant progress on setting the bill of materials
- Overall vehicle architecture and components agreed
- Detailed supplier selection work underway

**Production Facility** — *H1 2022*
- Selected Escobedo, Mexico as the site for production
- World class production facility with subassembly lines for Navistar's own production lines

**Production-Intent Prototype Vehicles** — *2024*
- Production-intent prototype semi-trucks expected in 2024
- Expect prototypes to be utilized for pre-production testing and revenue-generating TuSimple capacity operations

**Fully Integrated Vehicles** — *2025*
- Fully integrated production semi-trucks expected in 2025
- Will announce exact date of Start of Production at a later date

**Carrier-owned Capacity** — *2026*
- Business model requires a production truck that is sellable to customers
- First significant Carrier-owned Capacity revenue expected in 2026

# TRATON Europe Partnership

## Partnership Summary

- ✓ Announced in September 2020

- ✓ TRATON selected for its global reach which allows for rapid scaling & adoption

- ✓ The Scania brand is highly respected in in European & Asian markets

- ✓ Developing first L4 autonomous hub-to-hub truck freight route

**tu simple**

**TRATON**

## Near-term Milestones

- ▪ Completion of L4 hub-to-hub route in Sweden

- ▪ Additional Driver Out projects across Europe

- ▪ Production agreement for purpose-built truck under Scania brand

- ▪ Go-to-Market strategy finalization, including pricing structure

# Driver Out and Path to Commercialization

## Xiaodi Hou
Co-Founder and CEO

## Pat Dillon
Chief Financial Officer

Feature

Redundancy

Validation

DRIVER OUT

Efficiency / Cost Optimization

tu simple | Investor Day 2022
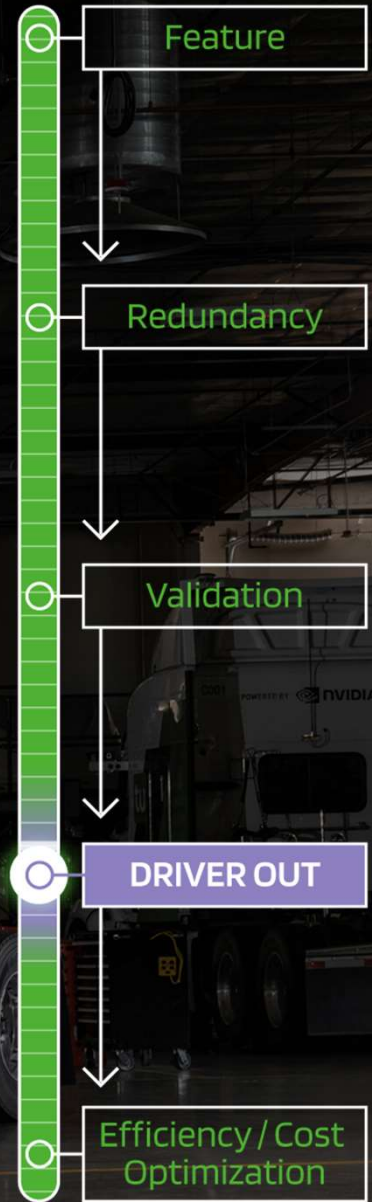
# The Path to Commercializing AV Technology

**Safety:** Ability to Operate Driverless Runs Safely on Open Public Roads

*Accomplished Starting 2021 with Certain Precautions*

**Efficiency:** Ruggedization of Our Technology and Hardware to Increase Productivity

*Near-term Focus*
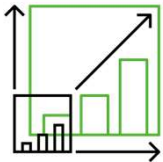
**Scale:** Production Truck Program to Scale to 1,000s and 10,000s of Trucks

*Development Underway*

# The Path to Commercializing AV Technology

**Safety**

*Accomplished Starting 2021 with Certain Precautions*

**Efficiency**

*Near-term Focus*

**Scale**

*Development Underway*

**Commercialization Planned by 2023**

*Requires Efficiency Improvement*

## What does Commercialization Mean?

**1** Market Freight Rates for Service

**2** Continuous Operations on Real Freight Lanes and Meet or Exceed Customer Requirement for Level of Service

**3** Improve Driver Out Operating Cost per Mile with Clear Line of Sight to Parity with Human-Operated Trucks

# The Evolution of TuSimple Driver Out Operations

| | 2021 | 2022 | 2023 | 2024 | 2025 | 2026 |
|---|---|---|---|---|---|---|

**Driver Out Testing** — (green bar from 2021 onward)

**Driver Out Commercial Runs** — (green bar from mid-2022 onward)

**Driver Out Operating Cost**
- Uncompetitive with Human Operation
- Competitive with Human Operation
- Significant Cost Advantage

**Number of Driver Out Trucks**
- ~10 (2021)
- 10's (2022)
- 100's (2023)
- 1,000's (2025)

**Truck Type**
- Retrofit
- Prototype
- Fully Integrated Vehicles

**Business Model**
- TuSimple Capacity
- Carrier-Owned Capacity

---

**Driver Out**
*"Safety"*

**Initial Commercialization**
*"Efficiency"*

**Full AFN Rollout**
*"Scale"*

# Initially Focused on High-Value, Dense Freight Routes

## Initial Driver Out Commercial Operations Routes
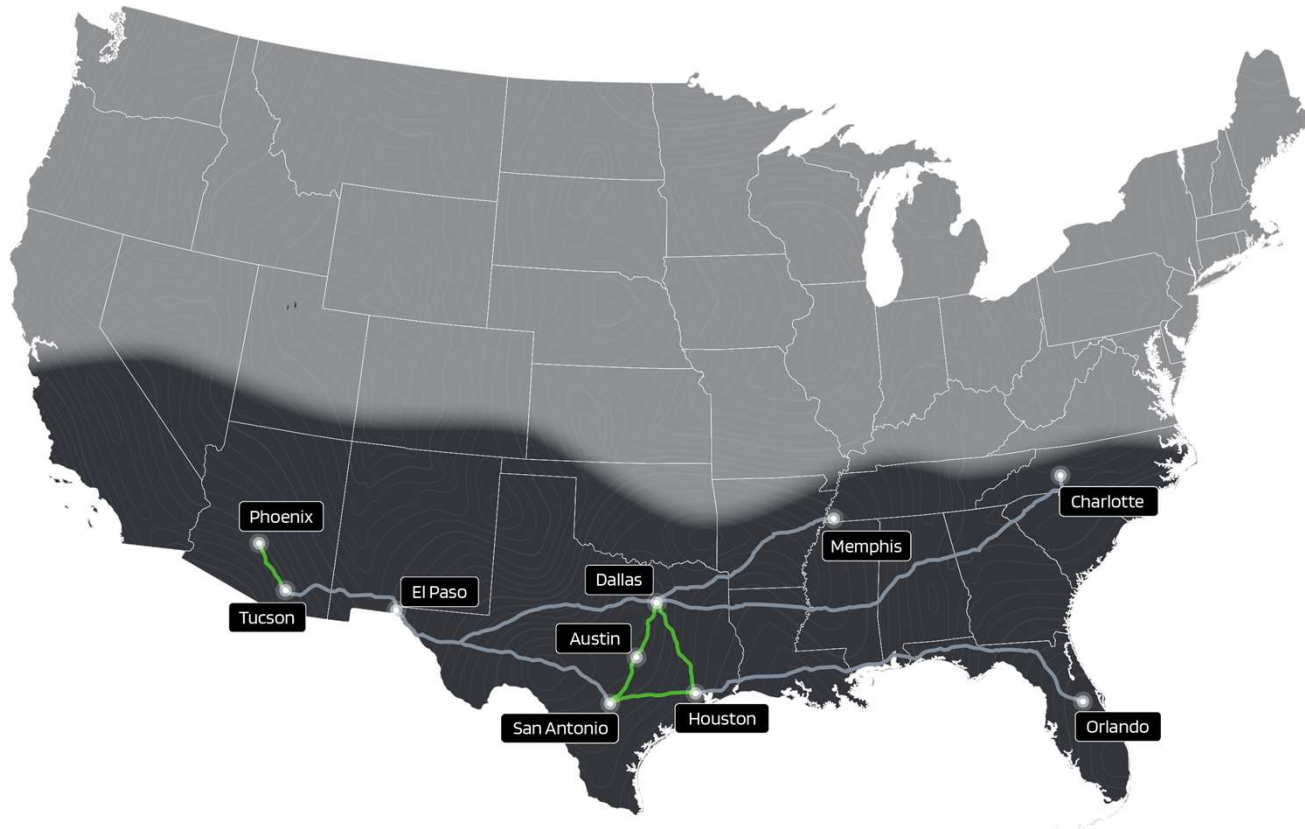


- **Hauling real customer freight**, building upon our existing announcements to haul driverless freight for Union Pacific

- Systematically **adding routes** based on customer demand and lane density

Expertise and Efficiency Built Through Initial Driver Out Commercial Operations
Help Scaling with Purpose-built Production Trucks

# How Do You Measure Efficiency?

**Human-Operated Truck Baseline**

Vs.

**Driver Out AV Truck Costs**
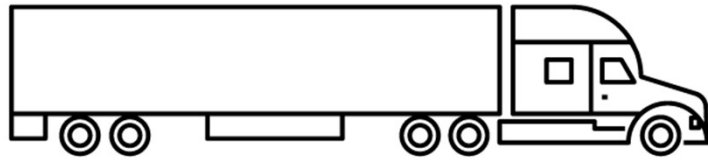
Cost of Operation:
~$2.50 / Mile[1]

✓ <u>All</u> Ongoing Operating Costs for AV Operations

✗ True Development Costs

1. Estimate based on data from ATRI and NPTC.

# A Comparison of the Operating Cost Structure

**AV Cost Elements**



| Human Operations | AV Operations |
|---|---|
| Other | Other |
| Fuel | Fuel |
| Maintenance | Maintenance |
| Vehicle | AV Vehicle |
| Human Driver | Virtual Driver |

*Note: illustrative bars – not to scale*

- Insurance
- Tolls
- Permits } *No difference*

- ~10% fuel economy improvement

- Base vehicle maintenance
- AV hardware maintenance
- Calibration & AV rescue } *Incremental*

- Base vehicle
- Sensors, compute, cabling, electrical

- Data transmission and storage
- Remote monitoring and oversight
- Mapping maintenance

Note: Does not include any expected terminal costs, drayage costs, development costs, and non-cash accounting costs (e.g., depreciation and amortization).

# Driver Out is the Starting Point on Path to Commercialization

|  | **AV Trucking** | **Robotaxi** |
|---|---|---|
| **Driverless** | tu simple<br>*No Teleoperation* | WAYMO ONE    cruise |
| **Safety Driver** | Aurora    EMBARK<br>kodiak    WAYMO VIA | ARGO AI    Aurora<br>Motional    ZOOX |
|  | *More Complex Vehicle*<br>*More Defined ODD* | *Less Complex Vehicle*<br>*More Expansive ODD* |
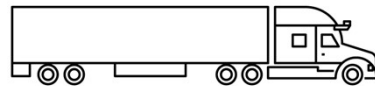
Note: Based on Company disclosure.

# Driver Out: Evolution from Today to Initial Commercialization



**Configuration**

**Today**

Chase Van

Autonomous Truck

Survey Vehicle

**End of 2023**

*No Support Vehicles*

Autonomous Truck

*No Support Vehicles*

**Capability**

- Night Operations

- Limited Availability

- High Maintenance and Calibration Need

- Arizona Freight Routes Only

- Day and Night Operations

- Expanded Availability to Support Customer Freight

- Improved Hardware

- Arizona and Texas Freight Routes

- Significant Cost Reduction

# Current Driver Out Configuration



Unmarked Law Enforcement

Chase Van

Autonomous Truck

Survey Vehicle

1/4 to 1/2 mile

1/2 to 1 mile

5 to 6 miles
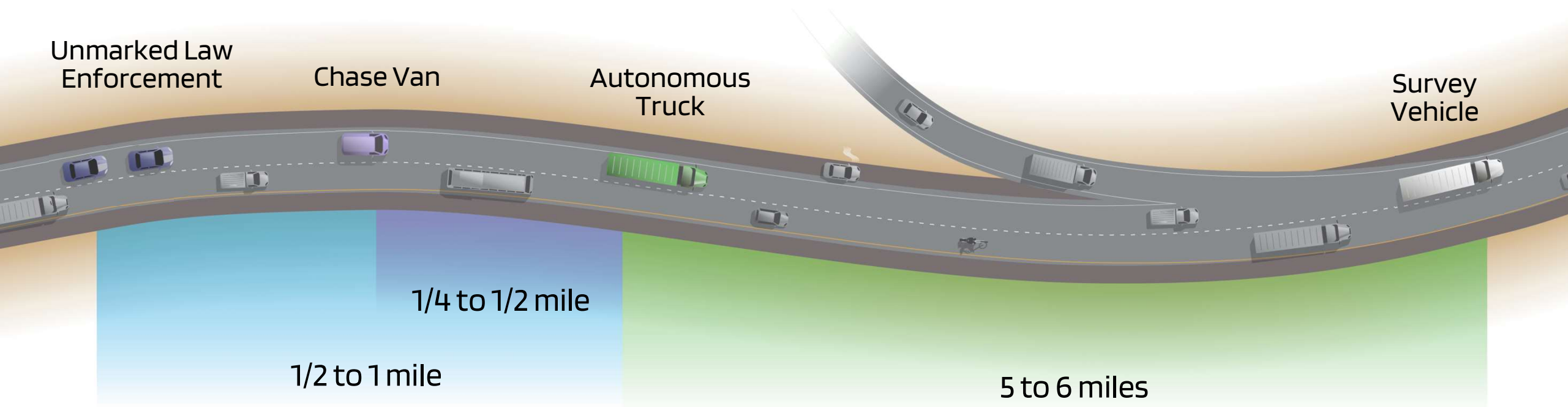
- Survey Vehicle and Chase Van provide no remote control nor environmental influence

- Removing the Survey Vehicle and Chase Van reduces the Cost per Mile by 70%+

# Driver Out for Commercial Operations
## *Removing Support Vehicles*

Chase Van

Autonomous Truck

Autonomous Truck
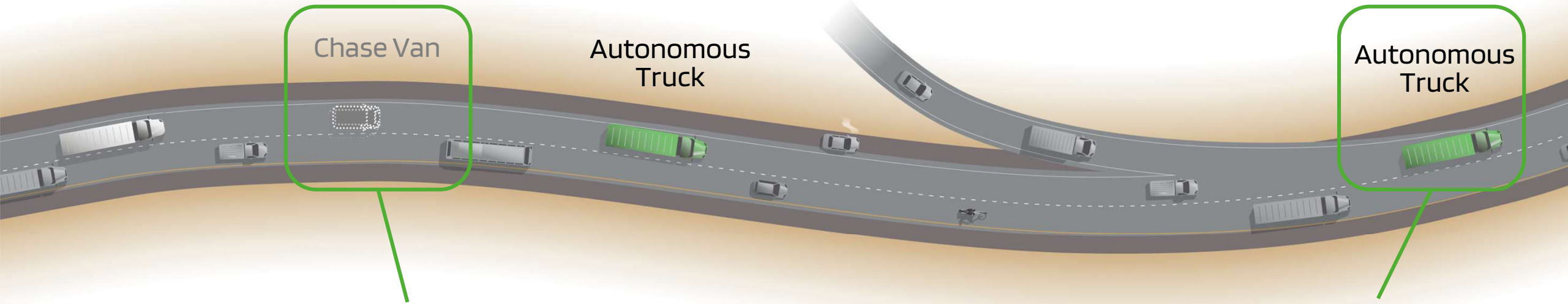
**Remove Chase Van:**

- Increased reliability of hardware
- Roadside assistance program
- Vehicle oversight command center

**Replacing Survey Vehicle:**

- Truck density on routes
- Full suite of MRC capabilities
- Collaborative mapping

# Minimal Risk Condition (MRC)

Configuration:
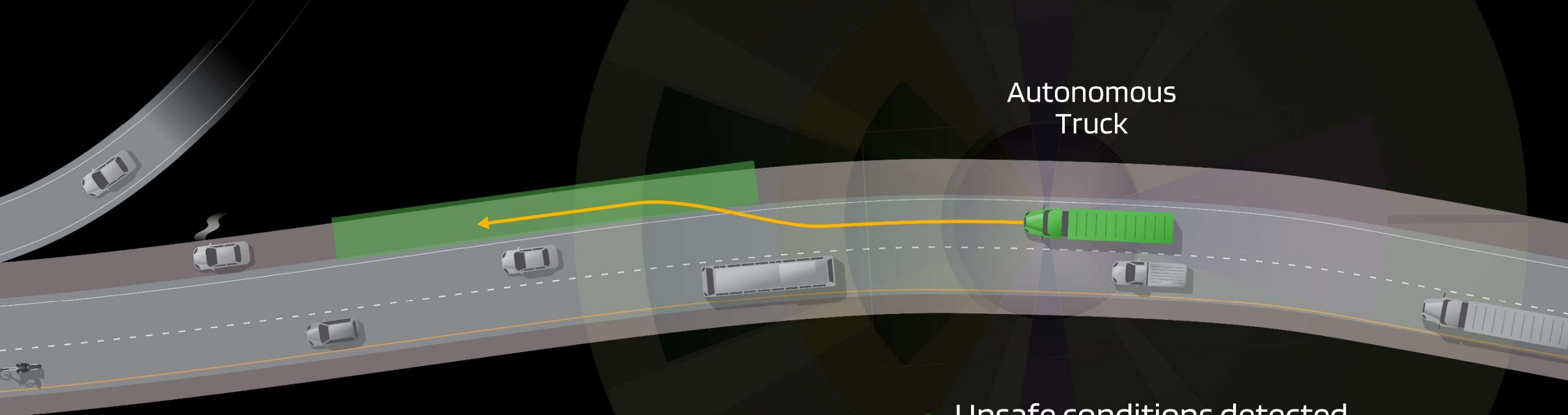


Autonomous Truck

- Unsafe conditions detected
- Identify MRC zone
- Safely pull over and stop

# Minimal Risk Condition

Case Study
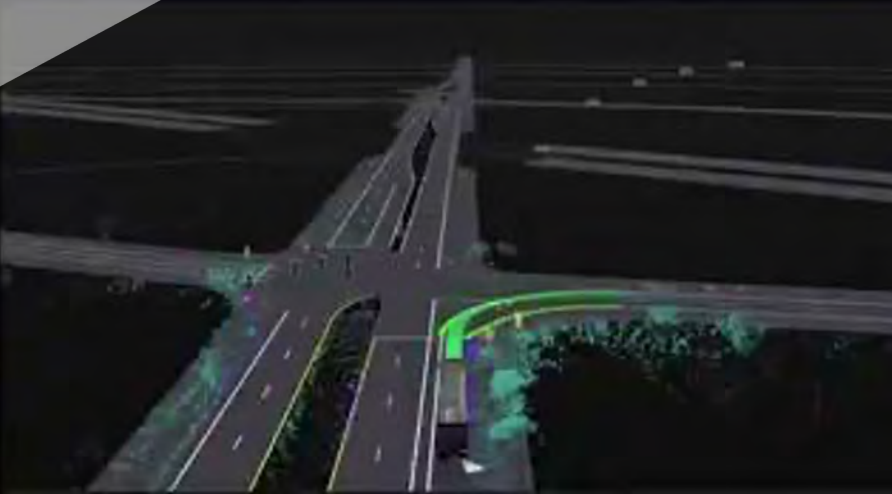
# Estimated Path to Improve Our Unit Economics

## Cost per Mile Evolution



**Today** — $35-40

**End of 2023**

**~2025**

80%+ Reduction

95% Reduction

*(3 hours → 12 hours / day)*

*Clear Line of Sight to Parity*

*Parity Milestone Expected Between 2024 and 2025*

*Increase ratio of trucks to monitoring personnel*

$5-6

~$1.50

~40% Improvement

~$2.50

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Illustrative Driver Out Operational Costs** | *Remove Support Vehicles* | *Improved Utilization* | *Hardware Cost Efficiencies* | *Optimize Remote Monitoring Capabilities* | **Estimated Initial Driver Out Commercial Operations** | *Production Grade Components* | *Further Utilization Improvement* | **Estimated Scale Operations** | **Estimated Human Operated Costs[1]** |

| **Truck Type** | **Retrofit** | | | | | | **Prototype** | | **Production Truck** |
|---|---|---|---|---|---|---|---|---|---|
| **AV Unit Economics** | **Uncompetitive** | | | | **Competitive** | | | | **Significant Advantage** |

1. Based on ATRI and National Private Truck Council data adjusted for current fuel cost environment.

# Cost per Mile Elements

*Support Vehicle Cost*

## Cost per Mile Evolution ($/mile)
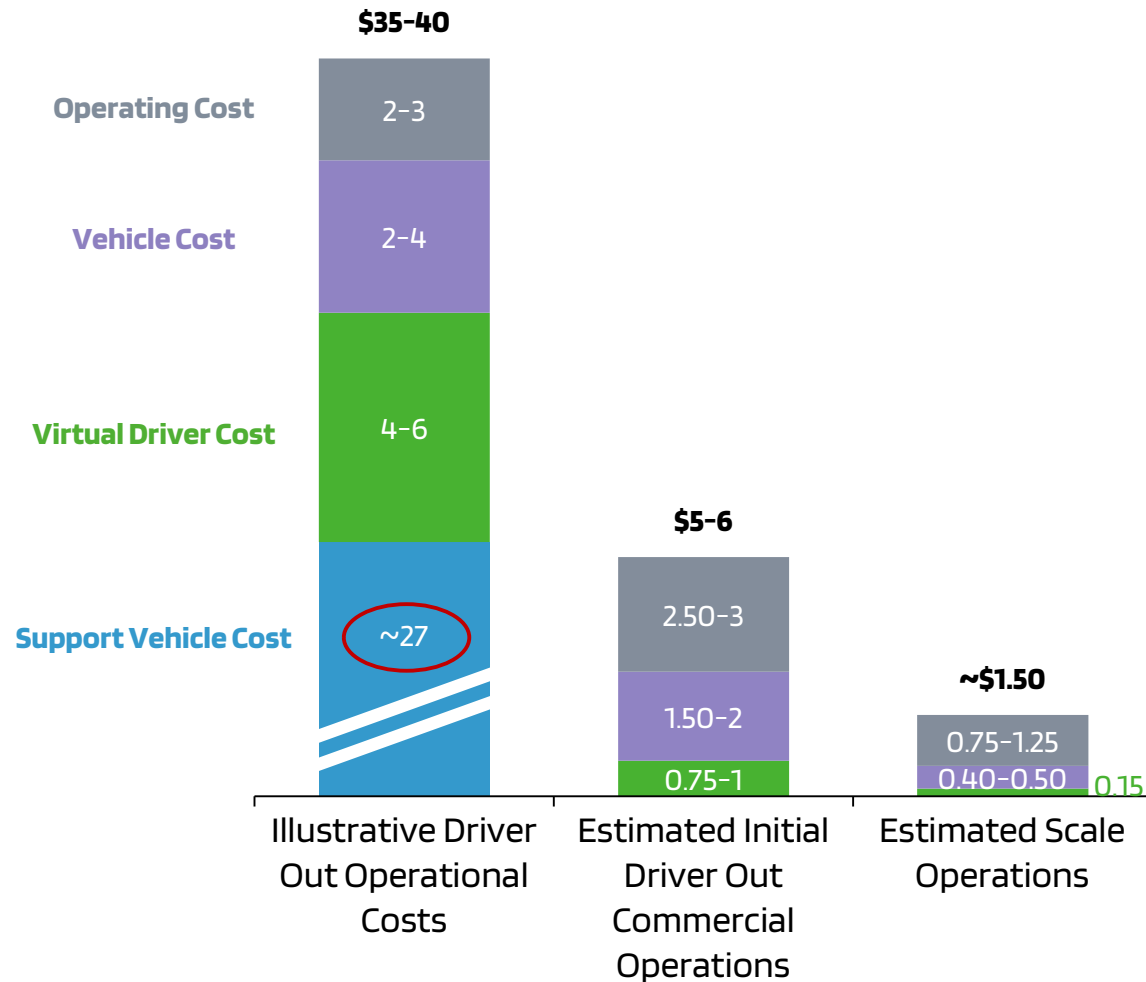


## Cost Structure Elements

- **Support Vehicle Cost**
  - Support vehicle, equipment, personnel, and fuel cost removed before Initial Commercial Operations through full suite of MRC capabilities and more robust hardware
  - Support vehicle daily cost for 160 miles of operation is ~$4,400

- **Virtual Driver Cost**

- **Vehicle Cost**

- **Operating Cost**

# Cost per Mile Elements
*Virtual Driver Cost*

## Cost per Mile Evolution ($/mile)



**$35-40**

Operating Cost — 2-3
Vehicle Cost — 2-4
Virtual Driver Cost — 4-6
Support Vehicle Cost — ~27

**$5-6**

2.50-3
1.50-2
0.75-1

**~$1.50**

0.75-1.25
0.40-0.50
0.15

Illustrative Driver Out Operational Costs

Estimated Initial Driver Out Commercial Operations

Estimated Scale Operations
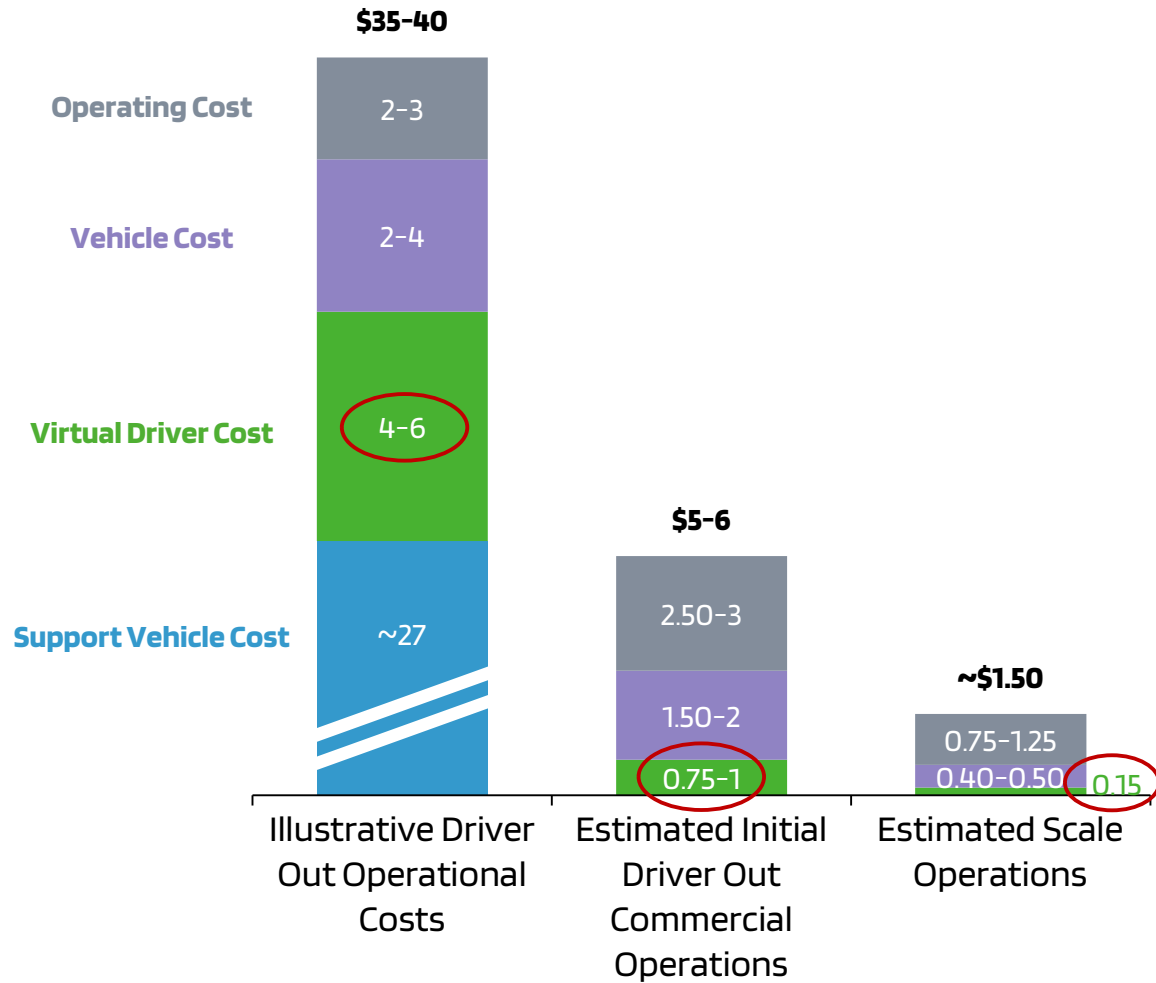
## Cost Structure Elements

- **Support Vehicle Cost**

- **Virtual Driver Cost**
  - Mapping maintenance cost decreases as individual truck utilization and network density increases
  - Data storage and transmission cost (per mile basis) decreases
  - Remote monitoring cost decreases as truck utilization increases

- **Vehicle Cost**

- **Operating Cost**

*All Incremental Relative to Human Operations*

# Cost per Mile Elements

*Vehicle Cost*

## Cost per Mile Evolution ($/mile)



**$35-40**

| | |
|---|---|
| Operating Cost | 2-3 |
| Vehicle Cost | 2-4 |
| Virtual Driver Cost | 4-6 |
| Support Vehicle Cost | ~27 |

**$5-6**
- 2.50-3
- 1.50-2
- 0.75-1

**~$1.50**
- 0.75-1.25
- 0.40-0.50
- 0.15

Illustrative Driver Out Operational Costs

Estimated Initial Driver Out Commercial Operations

Estimated Scale Operations

## Cost Structure Elements

- **Support Vehicle Cost**

- **Virtual Driver Cost**

- **Vehicle Cost**
  - Vehicle cost decreases as utilization increases
  - Significant reduction in AV-related hardware cost through automotive grade components and global procurement process

- **Operating Cost**

# Vehicle Cost Reduction Detail

**~50% Reduction**

**Driver Out Vehicle Cost — Today**

Purpose-built Autonomous Domain Controller Co-Developed with NVIDIA

Automotive Grade Components for Braking, Steering, LiDAR and Electrical

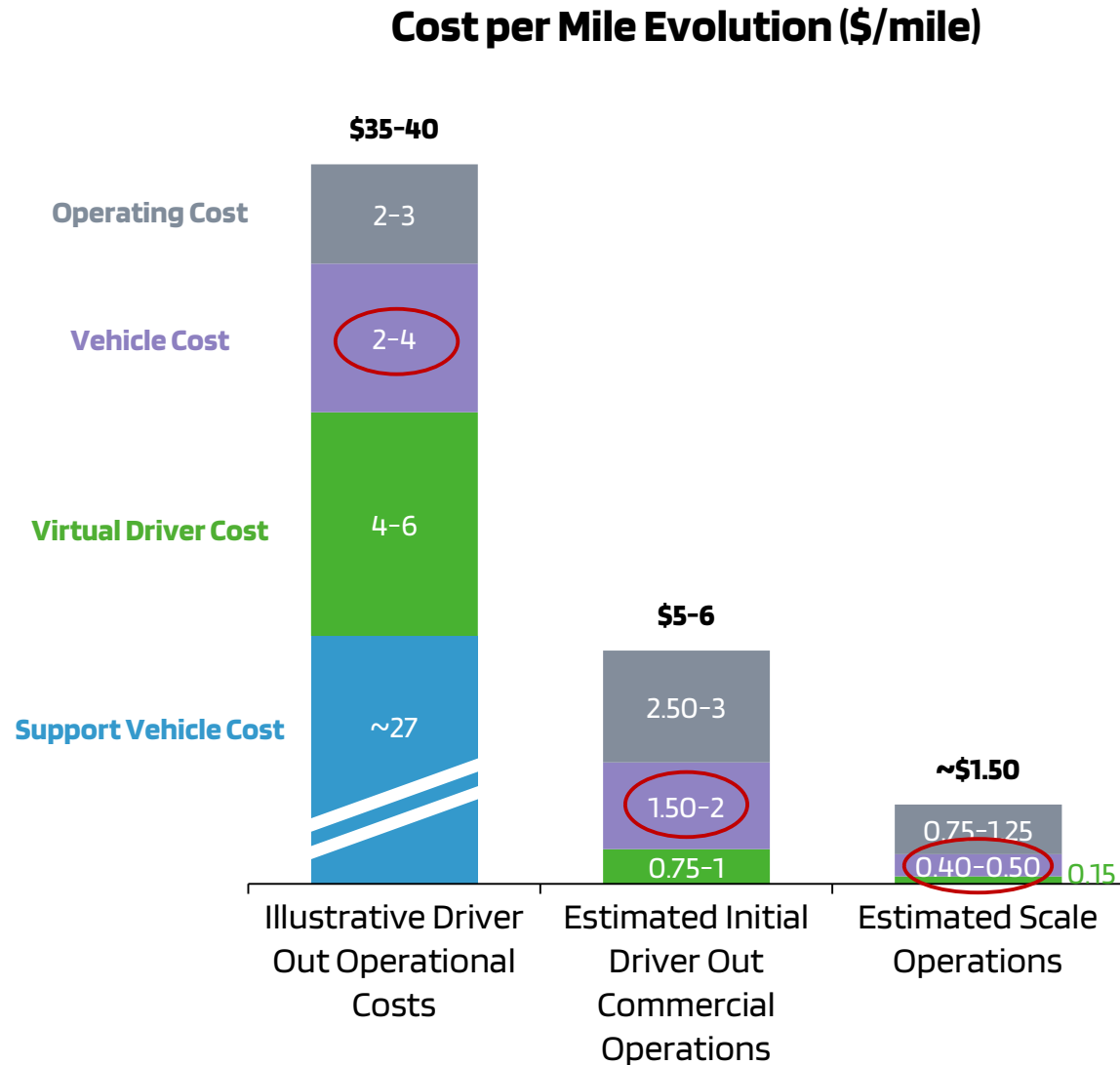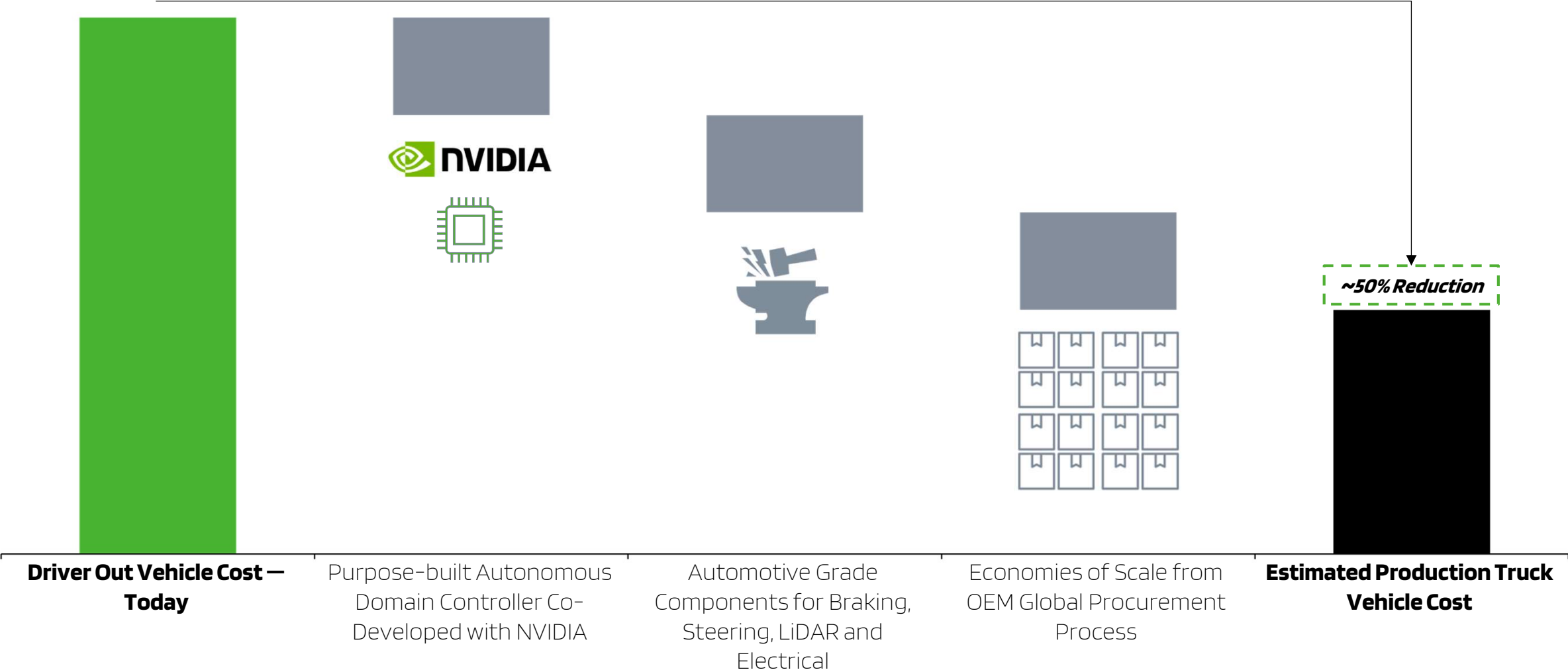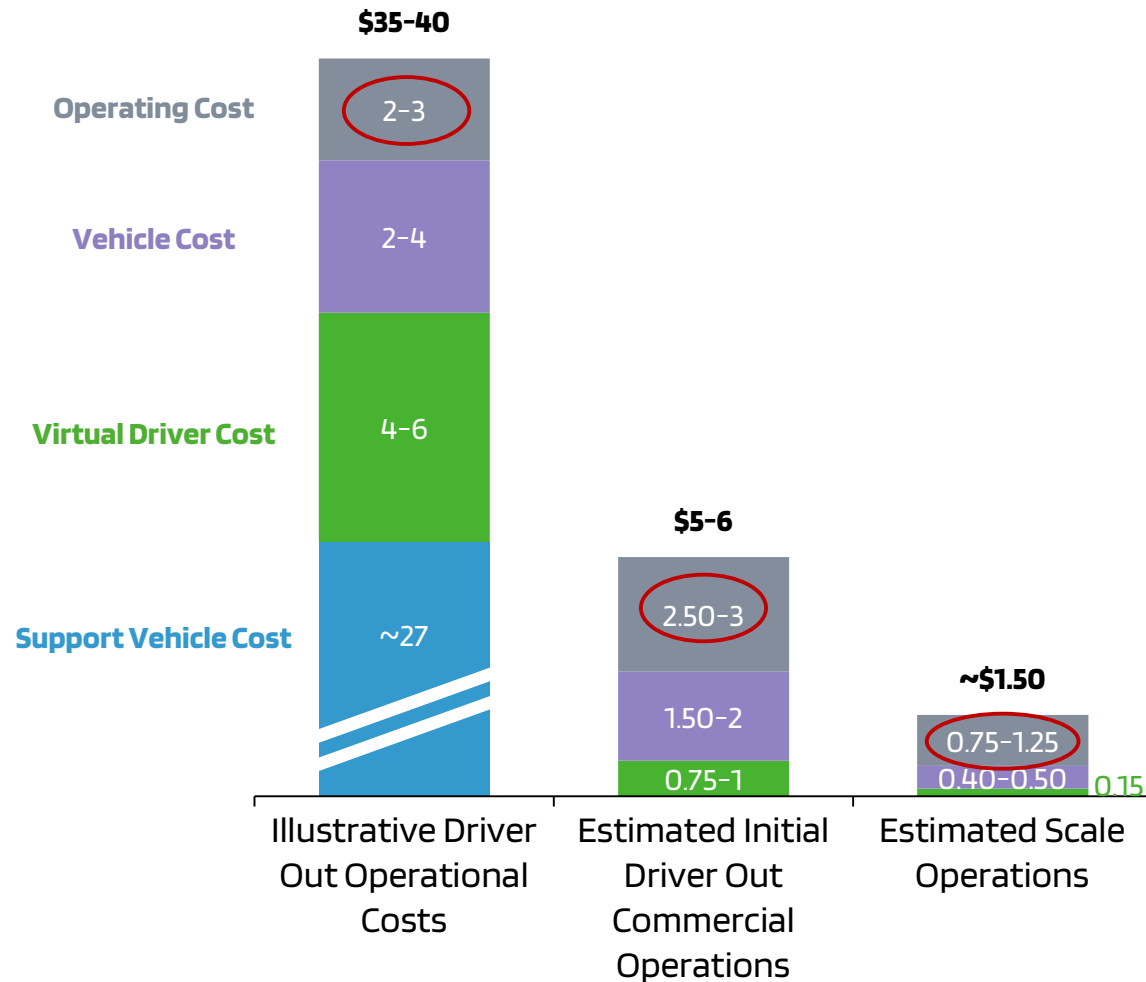Economies of Scale from OEM Global Procurement Process

**Estimated Production Truck Vehicle Cost**

# Cost per Mile Elements

*Other Operating Costs*

## Cost per Mile Evolution ($/mile)



## Cost Structure Elements

- Support Vehicle Cost

- Virtual Driver Cost

- Vehicle Cost

- **Operating Cost**
  - **Constant through Evolution**
    - Permits & Licenses (per mile basis)
    - Tolls (per mile basis)
    - $4.10/gallon fuel cost with ~10% improvement in fuel efficiency over human driven operations
  - Insurance per mile costs reduced as truck utilization increases
  - Repairs and Maintenance per mile cost reduces as truck utilization increases, and production grade hardware component cost reduces and reliability increases
  - Calibration and Rescue costs decreases as miles between rescues / calibration events increase

# Tracking Commercialization Progress

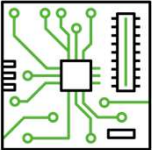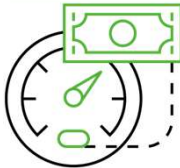| | | |
|---|---|---|
|  | **Routes** | Regular Update |
|  | **Fleet Size of Driver Out Trucks** | Regular Update |
|  | **Customer Participation in Driver Out Freight** | Updates on Ad-Hoc Basis |
|  | **Generations of Hardware** | Updates on Key Milestones on Ad-Hoc Basis Interlinked with Production Truck Program |
|  | **Operational Cost per Mile Metrics** | Annually at the End of 2022 and End of 2023 |

# Financial Update

## Pat Dillon

Chief Financial Officer

# Complementary Business Models

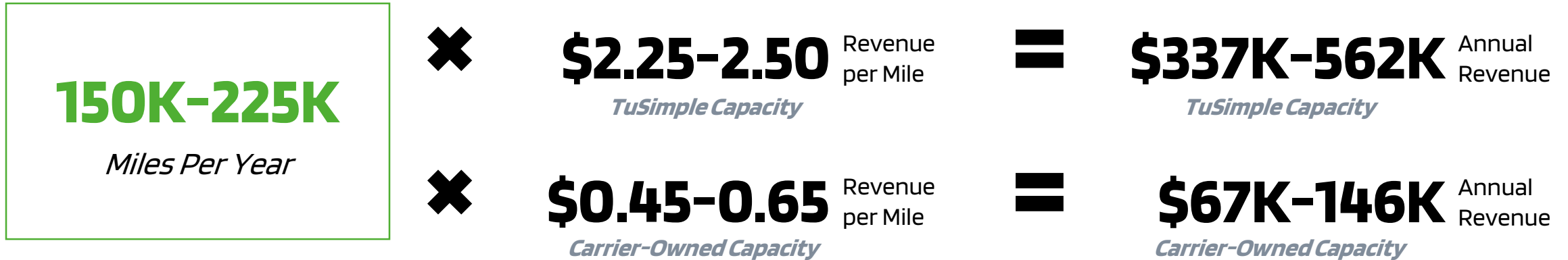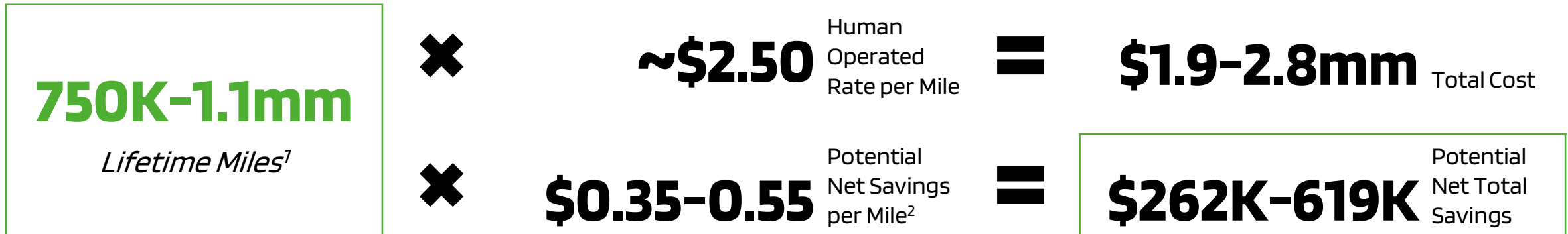|  | United States 🇺🇸 | Europe 🇪🇺 | China 🇨🇳 |
|---|---|---|---|
| **TAM[1]** | $800bn | $400bn | $750bn |
| **Go-to-Market** | ▪ TuSimple Capacity<br>▪ Carrier-Owned Capacity | ▪ Technology License<br>▪ Capital Light<br>▪ Principal Network Responsibility with TRATON | ▪ ADAS Solutions<br>▪ TuSimple Capacity<br>▪ Carrier-Owned Capacity |

1. Industry research.

# Illustrative U.S. Unit Economics – At Scale

**Potential Annual Revenue for TuSimple per Truck**

**150K-225K**

*Miles Per Year*

**×** **$2.25-2.50** Revenue per Mile
*TuSimple Capacity*

**=** **$337K-562K** Annual Revenue
*TuSimple Capacity*

**×** **$0.45-0.65** Revenue per Mile
*Carrier-Owned Capacity*

**=** **$67K-146K** Annual Revenue
*Carrier-Owned Capacity*

**Potential Savings for Carriers per Truck**

**750K-1.1mm**

*Lifetime Miles[1]*

**×** **~$2.50** Human Operated Rate per Mile

**=** **$1.9-2.8mm** Total Cost

**×** **$0.35-0.55** Potential Net Savings per Mile[2]
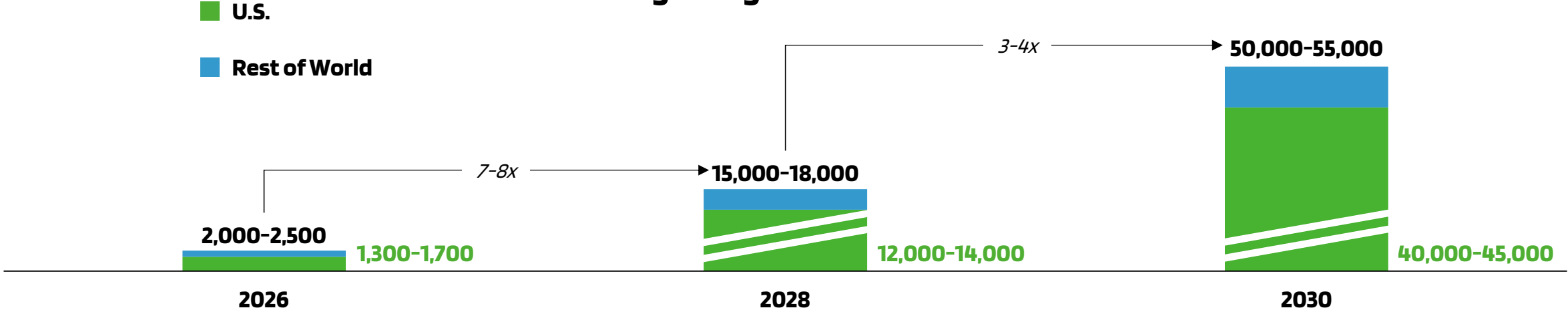
**=** **$262K-619K** Potential Net Total Savings
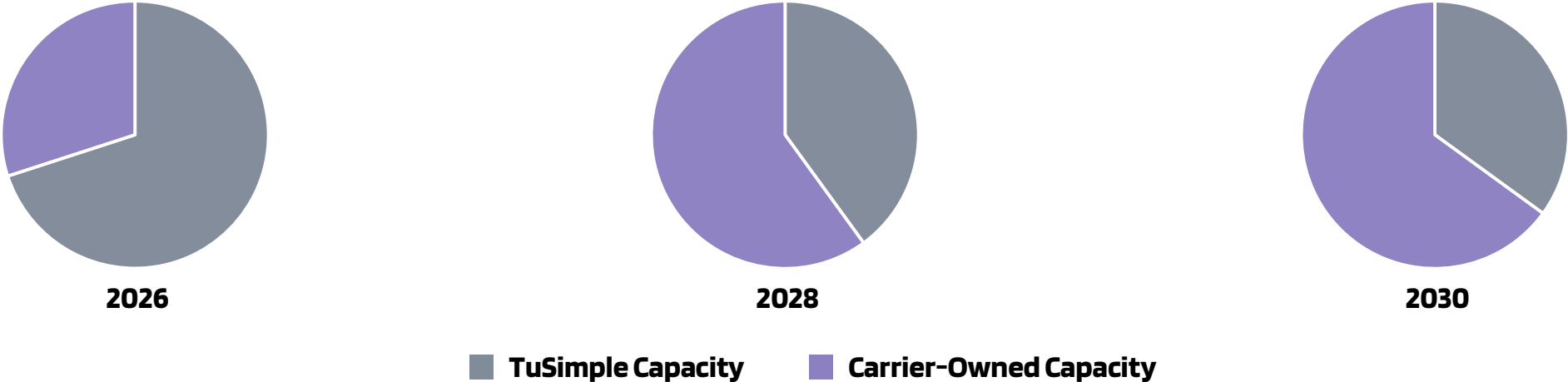
1. Assumes five-year life of truck.
2. Assumes cost of driver as $1.00 per mile; does not incorporate incremental capex associated with higher purchase price of Navistar / TuSimple L4 truck.

# Significant Network Scaling

## Average Target Trucks on AFN



**U.S.**

**Rest of World**

**2026** — 2,000–2,500 / 1,300–1,700

*7–8x*

**2028** — 15,000–18,000 / 12,000–14,000

*3–4x*

**2030** — 50,000–55,000 / 40,000–45,000

## Mix of Trucks by Business Model on U.S. AFN



**2026**

**2028**

**2030**

**TuSimple Capacity**  **Carrier-Owned Capacity**

# Long Term Revenue Targets

**Target Revenue**

40% Gross Margin

35% Adj. EBITDA Margin

■ **U.S.**

■ **Rest of World**

**$10.0-12.0bn**

3-4x

**$3.0-4.0bn**

5-6x

**$0.5-0.8bn**

$0.3-0.5bn

$2.0-2.7bn

$7.0-8.5bn

**2026**

**2028**

**2030**
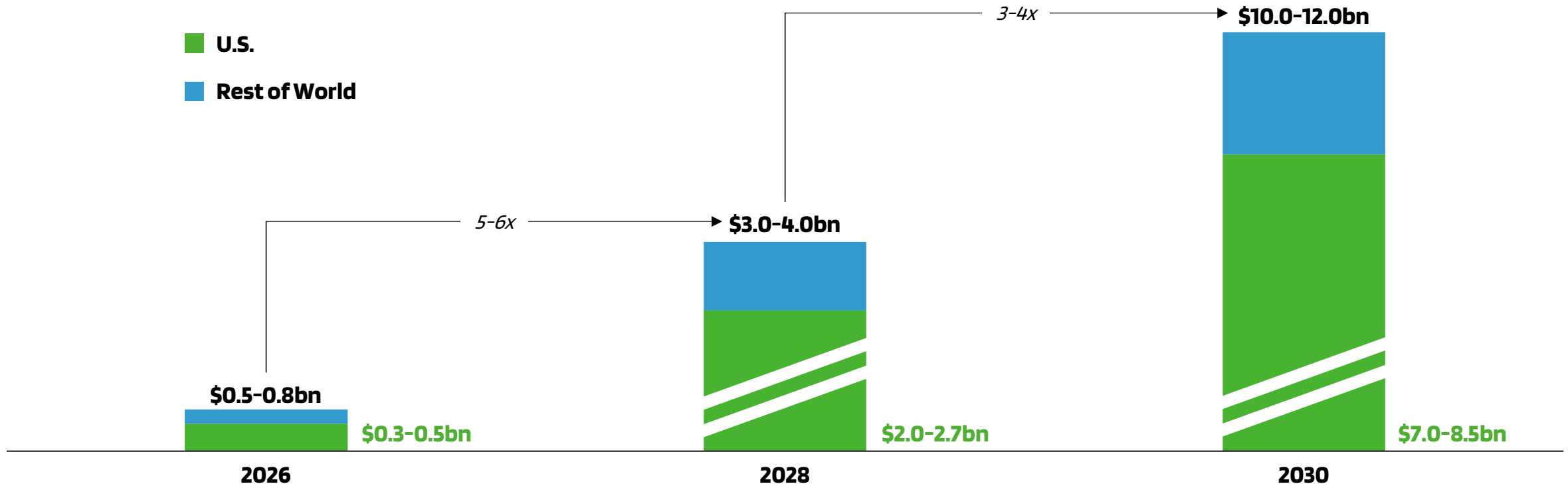
| | 2026 | 2028 | 2030 |
|---|---|---|---|
| *Approx. U.S., EU, and China Market Penetration* | *<0.1%* | *0.2%* | *0.5%* |
| *Approx. U.S. Market Penetration* | *0.1%* | *0.3%* | *1.0%* |
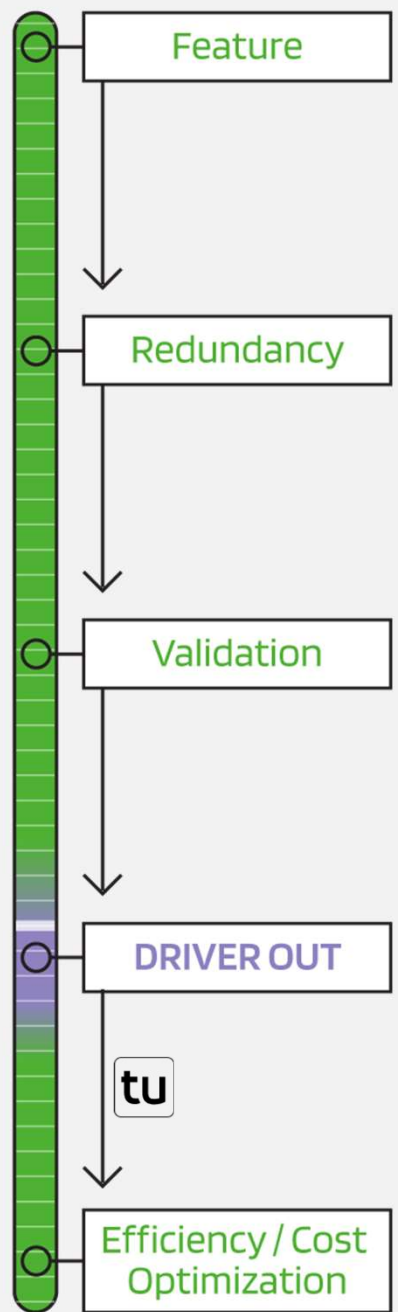
# Takeaways

## TuSimple Is the AV Technology Leader

- Focused approach on trucking since 2015
- First to develop a "Driver Out" framework

## TuSimple Is at the 2nd Episode of the Trilogy

- Rapidly reducing cost of "Driver Out" operations
- Re-applying our "Driver Out" framework to new ODDs

# Takeaways

| | | |
|---|---|---|
| **Speed** | 1st to safe driver out & commercial viability | 1st mover advantage |
| **Scale** | Scalable & cost-efficient technology | Strong margin profile |
| **Network** | Full AFN with deep customer integration | Highly defensible long-term business model |

Feature

Redundancy

Validation

DRIVER OUT

tu

Efficiency / Cost Optimization

tu simple

A BETTER PATH FORWARD