AUTOMATED VEHICLES

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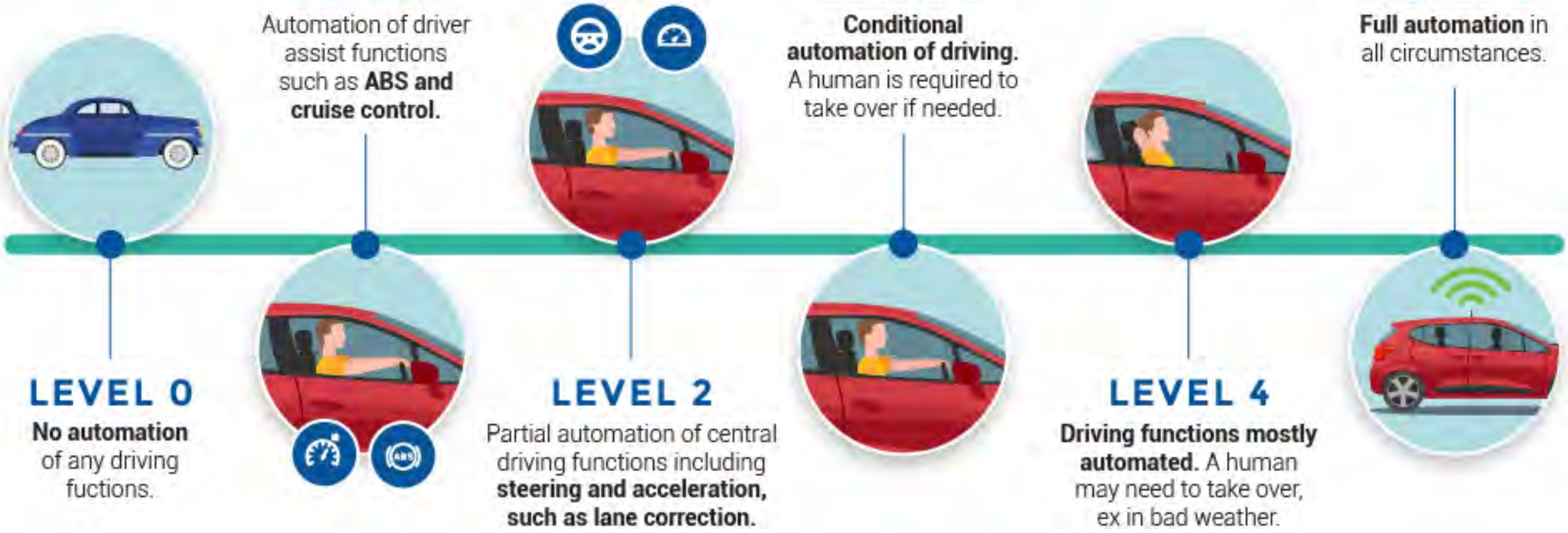
LEVELS OF AUTOMATION



VEHICLES ON THE ROADS

85%

New vehicle equipped with Automated Driver Assistance Systems (ADAS) by 2025

VEHICLES TESTING

AUTOMATED USE CASES

1. Commercial Vehicles

2. Local Delivery Vehicles

3. Full Size Transit Vehicles

4. Low-Speed Automated Shuttles

5. Shared Mobility / Ride Hailing

6. Personal Delivery Devices

AUTOMATION IN PA

Aurora

Qualcomm

Carnegie Mellon University

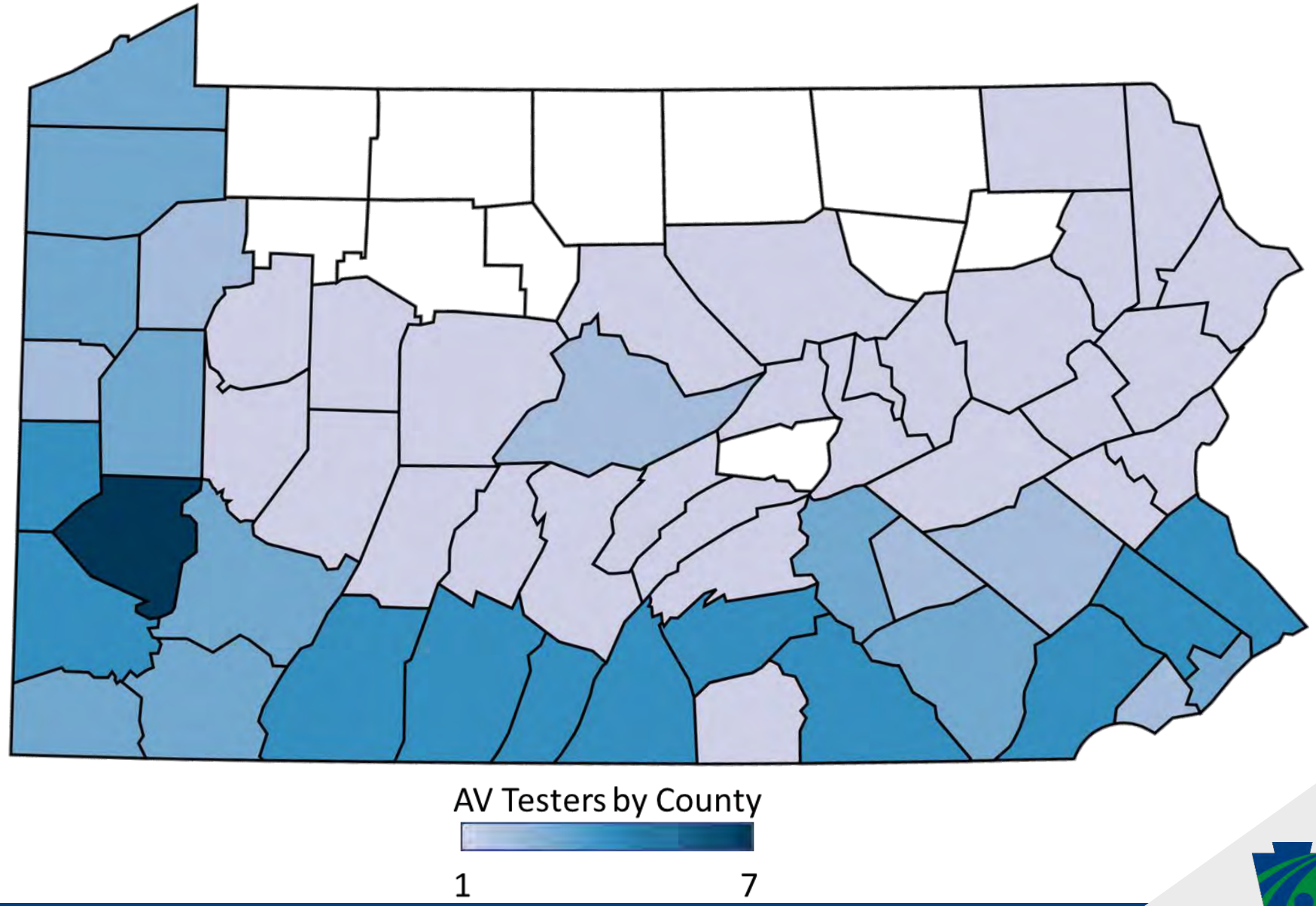
ARGO AI

Motional

plus.ai

LOCOMATION

NVIDIA



INDUSTRY IS DRIVING TECHNOLOGY

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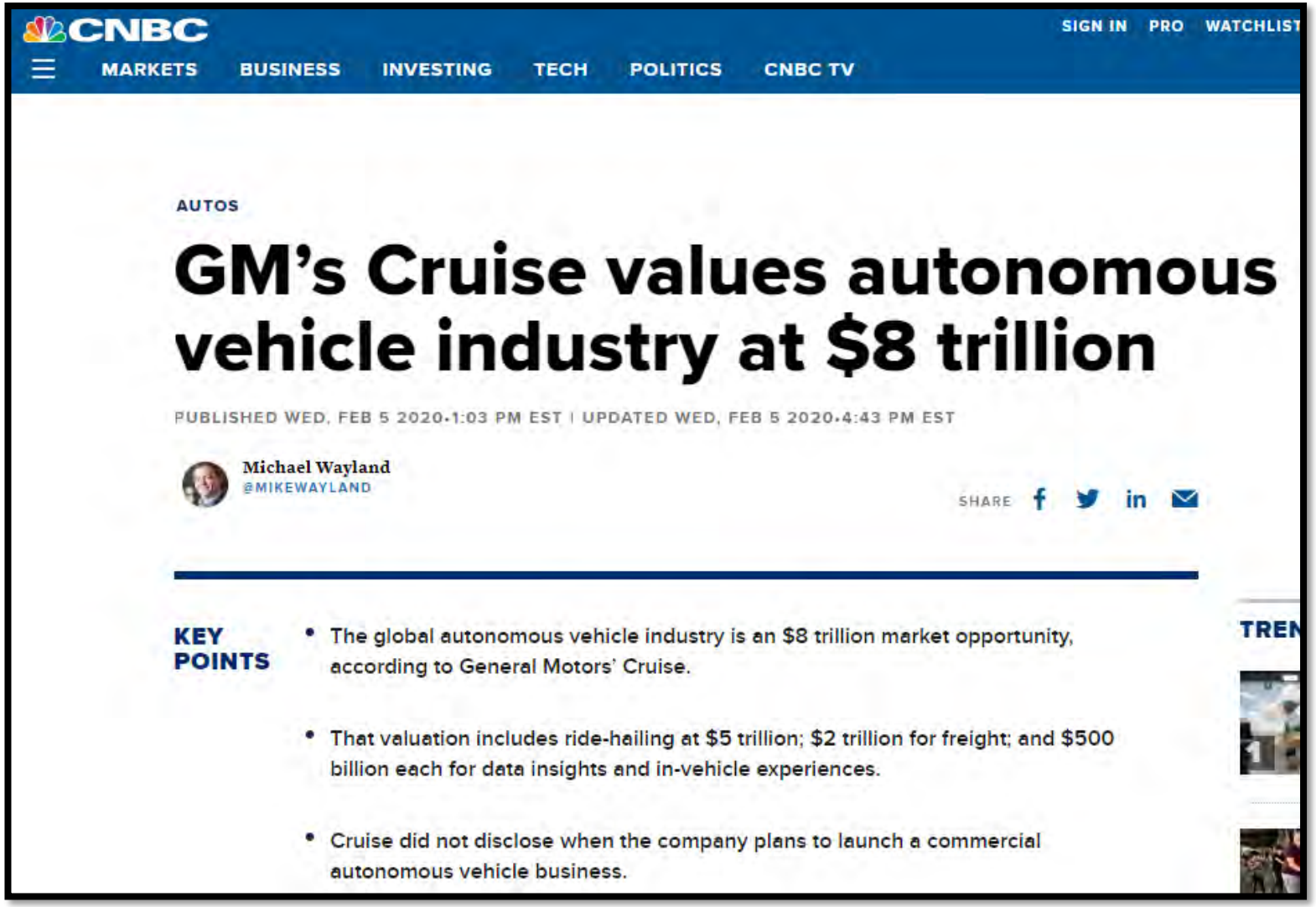
INDUSTRY IS DRIVING TECH.



CNBC

SIGN IN PRO WATCHLIST

MARKETS BUSINESS INVESTING TECH POLITICS CNBC TV

AUTOS

GM's Cruise values autonomous vehicle industry at $8 trillion

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KEY POINTS

- The global autonomous vehicle industry is an $8 trillion market opportunity, according to General Motors' Cruise.
- That valuation includes ride-hailing at $5 trillion; $2 trillion for freight; and $500 billion each for data insights and in-vehicle experiences.
- Cruise did not disclose when the company plans to launch a commercial autonomous vehicle business.

ADAS Sensor Market is Predicted to Attain Valuation of $40.8 Billion by 2030: P&S Intelligence

GN GlobeNewswire March 4, 2020

Al-Bawaba

Uber Who? Robotaxis to Create a $2 Trillion Market Globally Over the Next Decade

With the advent of autonomous vehicles, ride-hailing promises to raise ... create a $2 trillion market globally over the next decade, with each vehicle ... Delivering 10 billion passenger trips per year, DiDi is working toward the

6 days ago

INDUSTRY IS DRIVING TECH.

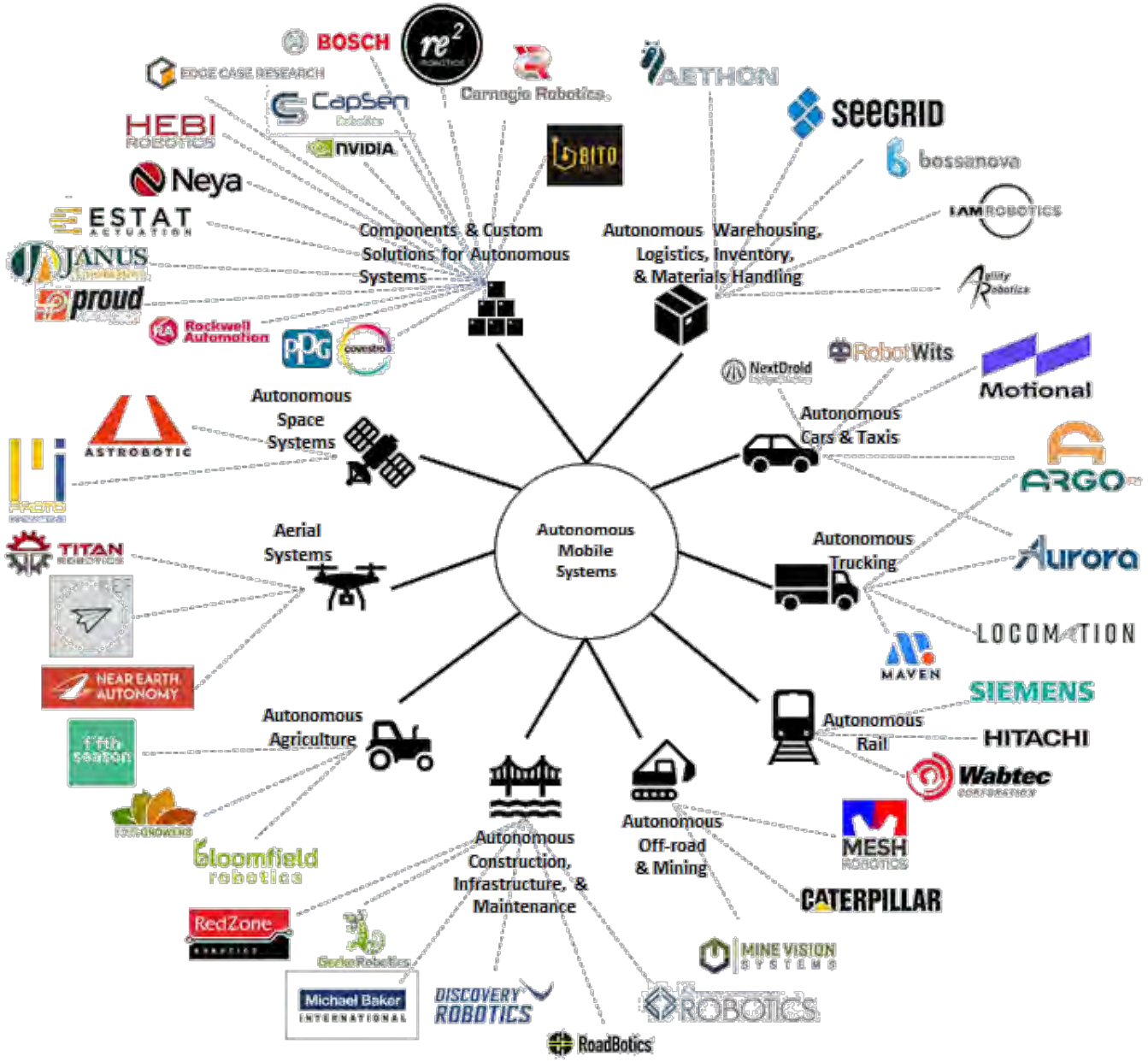
CBINSIGHTS

www.cbinsights.com

PITTSBURGH REPORT

"The estimated direct employment footprint of **Pittsburgh's autonomy sector totals over 6,300 jobs** which provide an estimated $651 million in labor income, $34.7 million in state and local tax revenues, and $126.7 million in federal tax revenues. These companies generated an additional 8,604 full- or part-time indirect jobs, **bringing the total number of jobs in the region that are dependent on the industry to 14,923."**

PITTSBURGH INDUSTRY CLUSTER



PROACTIVE VS. REACTIVE RESPONSE

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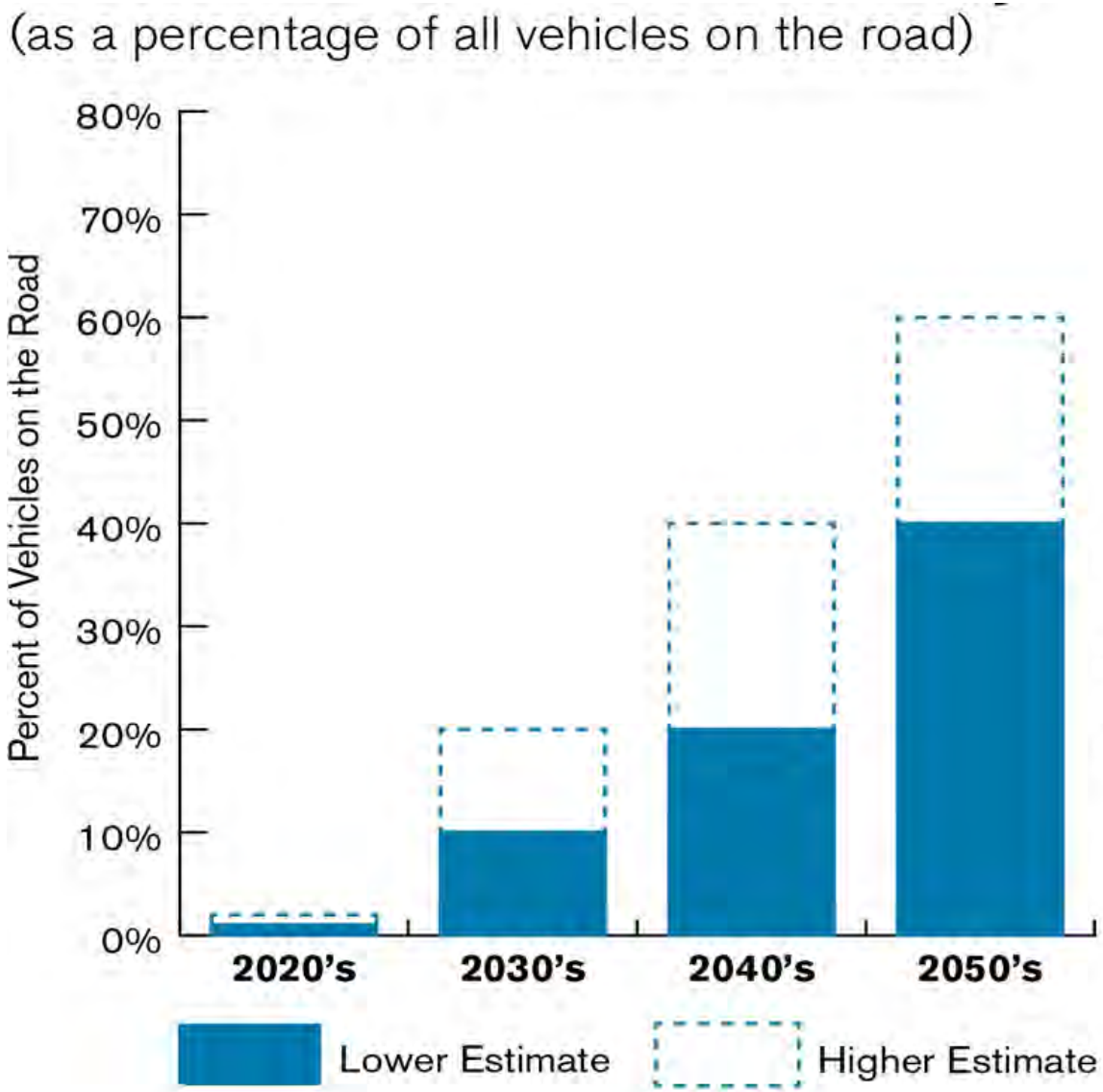
AUTOMATED VEHICLE PENETRATION PROJECTIONS



2020's: Large Price Premiums
(01%-02%)

2030's: Moderate Price Premiums
(10%-20%)

2040's: Minimal Price Premiums
(20%-40%)

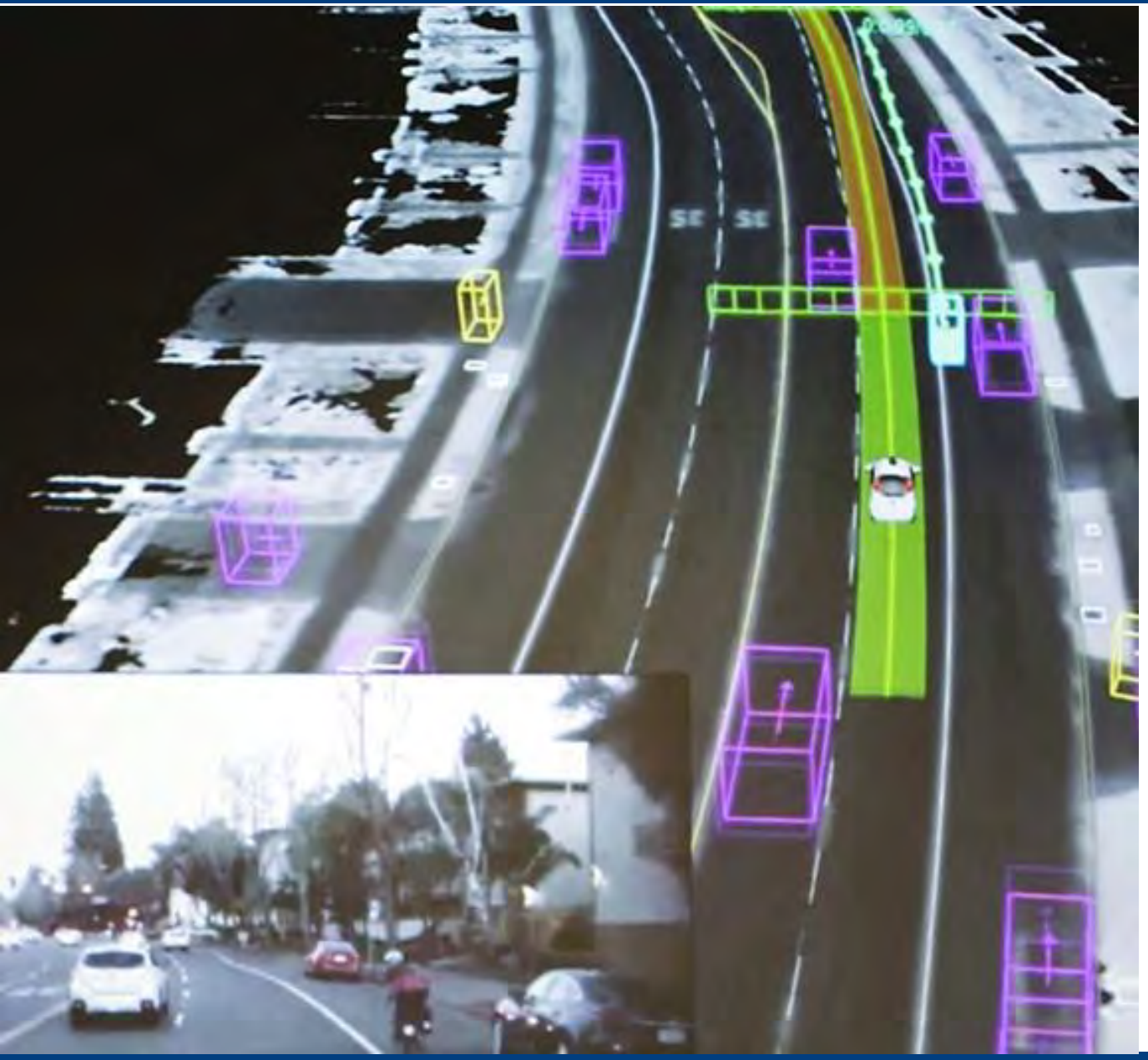
2050's: Standard on Most New Vehicles
(40%-60%)

Source: GHSA

HOW OUR ROADS WILL CHANGE

- Infrastructure
  - Human error (e.g., driver wander)
  - Pavement markings
  - Fiber
  - Curb space management
- Asset Management
  - HD mapping
- Situational Awareness
  - 4,000GB data per day
- Work Zones
  - In-vehicle alerts
  - Worker safety

HOW WILL OUR ROADS CHANGE – LANES



Human Error

- Eliminate driver wander
- Reduction up to 20%

Consistent Wheel Paths

Reduced Following Distance

- Platooning

Dedicated Lanes

- HOV/HOT → AV Lanes
- Hard Shoulder Running

HOW WILL OUR ROADS CHANGE – MARKINGS/SIGNAGE

Reduced Signage

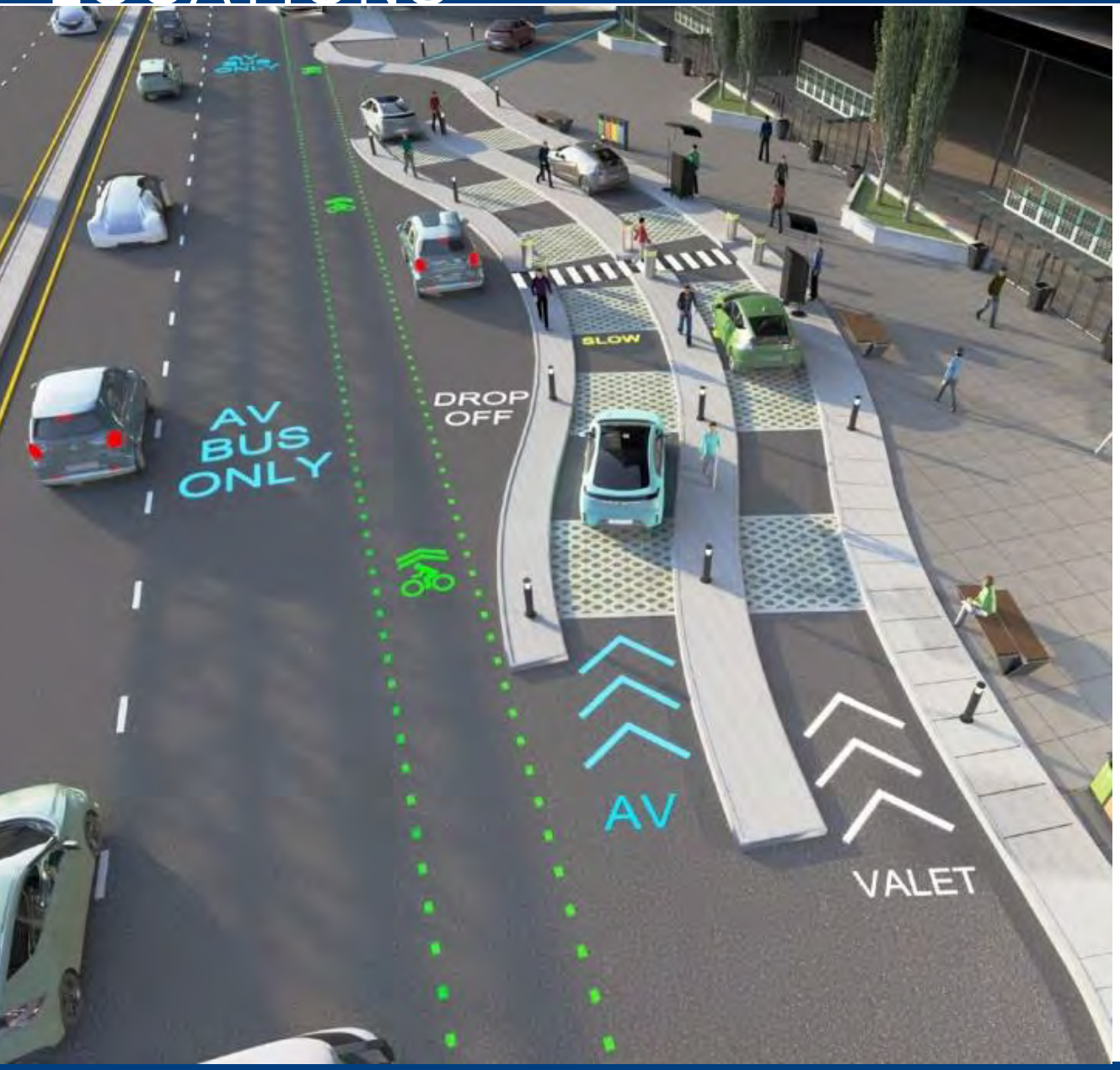
- Incorporated
- Connected

Pavement Markings

- 6” vs 4”
- Tapes vs. Paint

HD Mapping

HOW WILL OUR ROADS CHANGE – PICK-UP/DROP-OFF LOCATIONS



Reinventing the Curb

Fighting for Space

- AVs
- Shared Mobility
- Deliveries
- Transit

HOW WILL OUR ROADS CHANGE – PARKING

Self Parking

- Reduces on-street parking

Urban Centers Shift

- Remote Parking

HOW WILL OUR ROADS CHANGE – ELECTRIFICATION

AVs + Evs

- Shared Mobility Model
- Weight

Dynamic Electric Vehicle Charging

- Shared Mobility Model
- Select locations

HOW WILL OUR ROADS CHANGE – SITUATIONAL AWARENESS

Lots of Data

- 4,000GB per day

Pavement Conditions

- Roughness
- Potholes
- Traction
- Visual Imagery

HOW WILL OUR ROADS CHANGE – WORK ZONES

Work Zone Warnings

- Pattern Changes
- Speed Reductions

Safety Alerts

- Drivers
- Workers

Work Zone Automation

- TMAs

WHAT IS PENNDOT IS DOING TO PREPARE

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LIMITATIONS IN PA

Currently Permitted in PA

Legislative Change Required

2 Safety Operators*

Two safety operators in the vehicle. A safety operator is seated in the driver's seat. The other operator is typically seated in the passenger seat and monitoring operators on a computer.

Single Safety Operator*

A safety operator is seated in the driver's seat. Operations in monitored remotely.

Non-Driver Safety Operator*

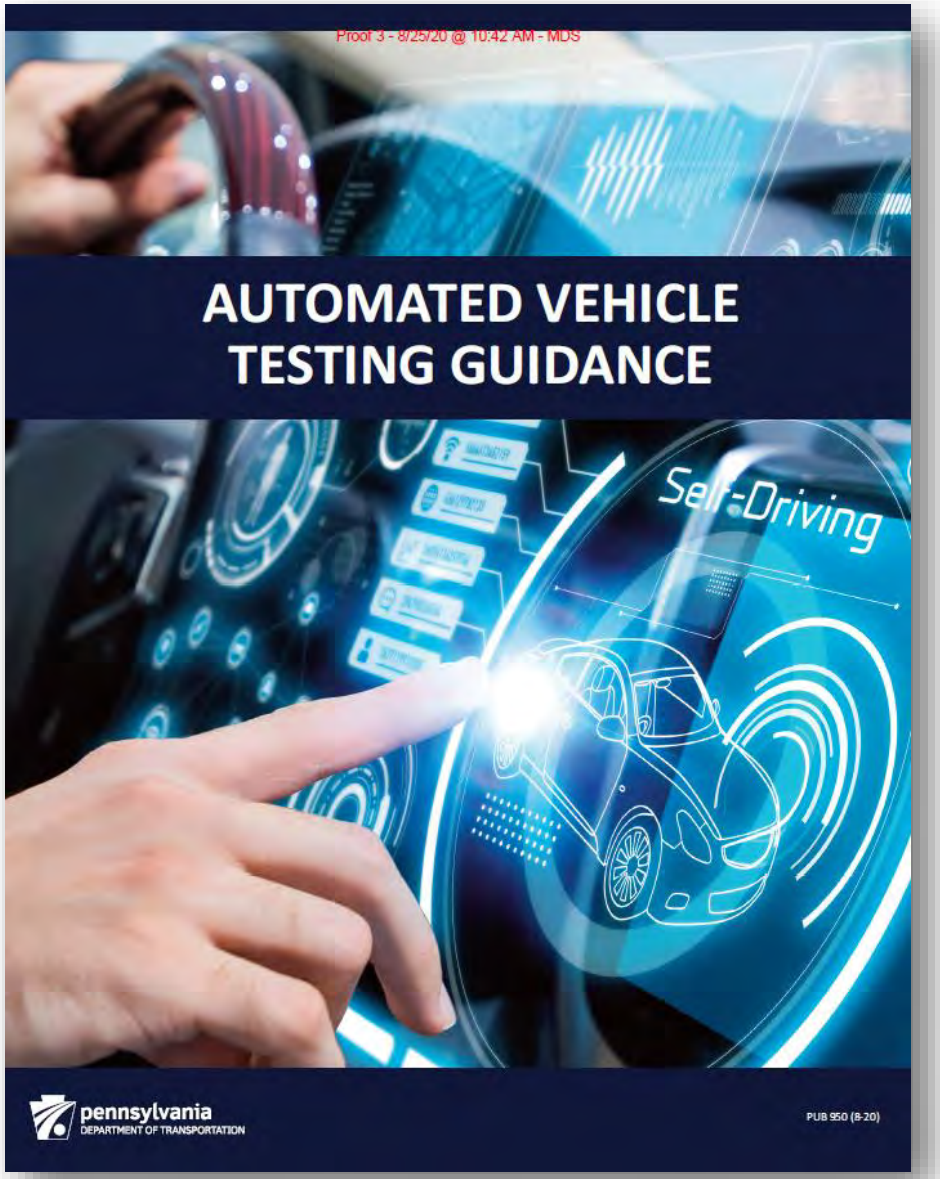
A safety operator is monitoring the AV from a location other than the driver's seat (e.g., passenger seat or chase vehicle)

No Safety Drivers*

No safety operator.

* In addition, on-road testing, simulation and closed course testing is occurring

AUTOMATION IN PA

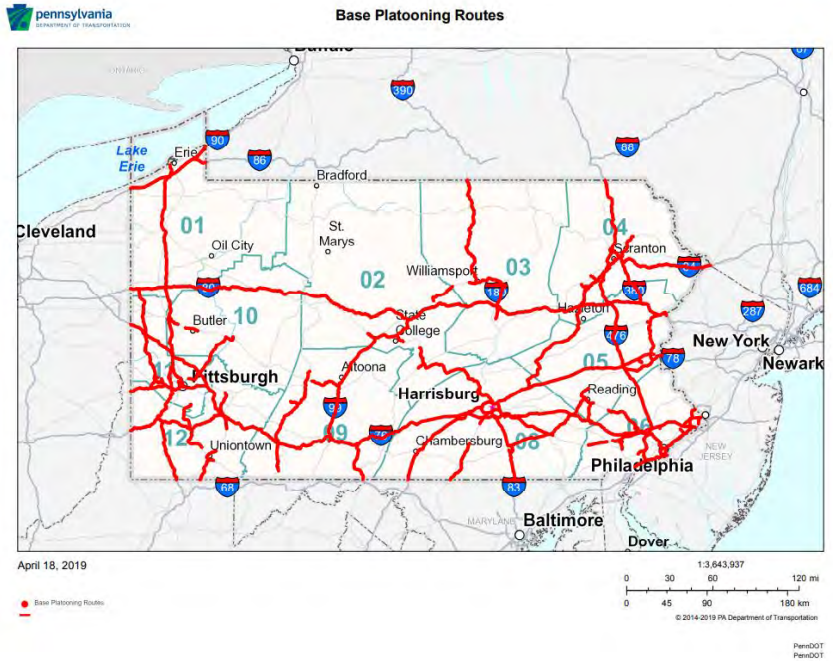


- **Under existing Pennsylvania law, the driver of any vehicle is a natural person who drives or is in actual physical control of a vehicle. Currently during AV testing, a licensed driver is required to be seated in the driver's seat with the ability to intervene in situations where the Automated Driving System (ADS) experiences a system interruption or other problem rendering the ADS unable to safely perform the dynamic driving task and the vehicle is unable to come to a minimal risk condition on its own.**

- **<u>Under existing law, unoccupied and/or remote testing on trafficways is prohibited.</u>**

ACT 117 OF 2018

- **Platooning**
  - Limited to two or three buses, military vehicles or motor carriers.
  - Restricted to limited access roadways
  - Must have visual identifier
  - Must submit operations plan for evaluation
  - April 2019 Policy



ACT 106 OF 2020

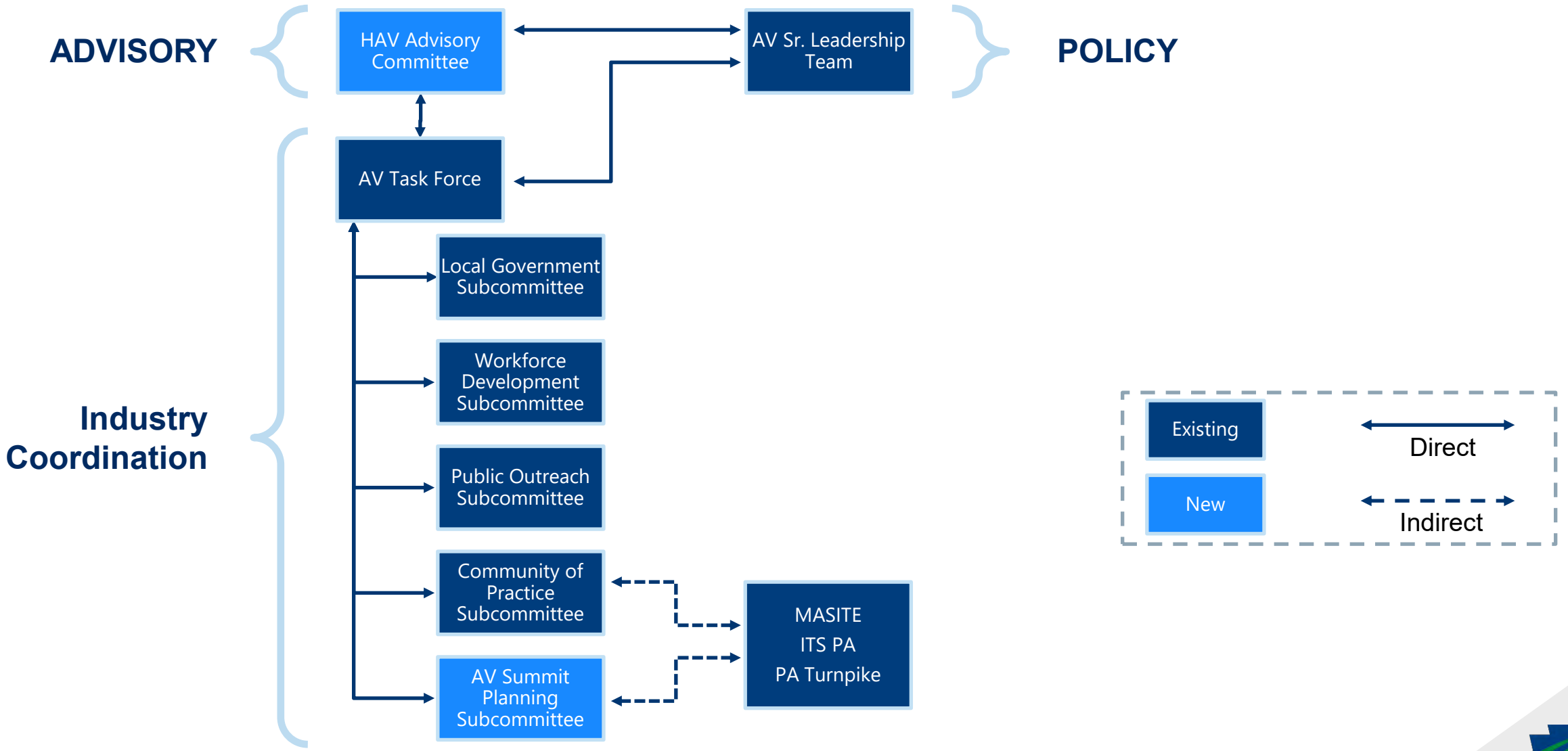
A ground-based delivery device that is manufactured for transporting cargo or goods and is operated by a driving system that allows for autonomous and/or remote operations.

FedEx Roxo

Amazon Scout

Starship

ORGANIZATIONAL STRUCTURE



PENNSTART

Partnership between PennDOT & PA Turnpike

- **Mission**
  - Advance a state-of-the-art research, testing and training facility to address the transportation safety and operational needs of Pennsylvania and the Mid-Atlantic Region.
- **Focus Areas**
  - Connected and Automated Vehicles
  - Traffic Incident Management
  - ITS/Signals/Tolling
  - Work Zones
  - Commercial Vehicles
  - Transit
- **Systems Engineering Completed**
  - June 2020
  - Anticipated Opening –2024/2025

AUTOMATED DRIVING SYSTEM DEMONSTRATION GRANT

Safe Integration of Automated Vehicles into Work Zones

- Goal
  - Develop a consistent approach to allow for AVs to safely operate in work zones
- Approach
  - Connectivity
  - Machine Vision
  - HD Mapping
- Testing
  - Simulation
  - Closed-course
  - Controlled live environment

Submitted By:

pennsylvania DEPARTMENT OF TRANSPORTATION

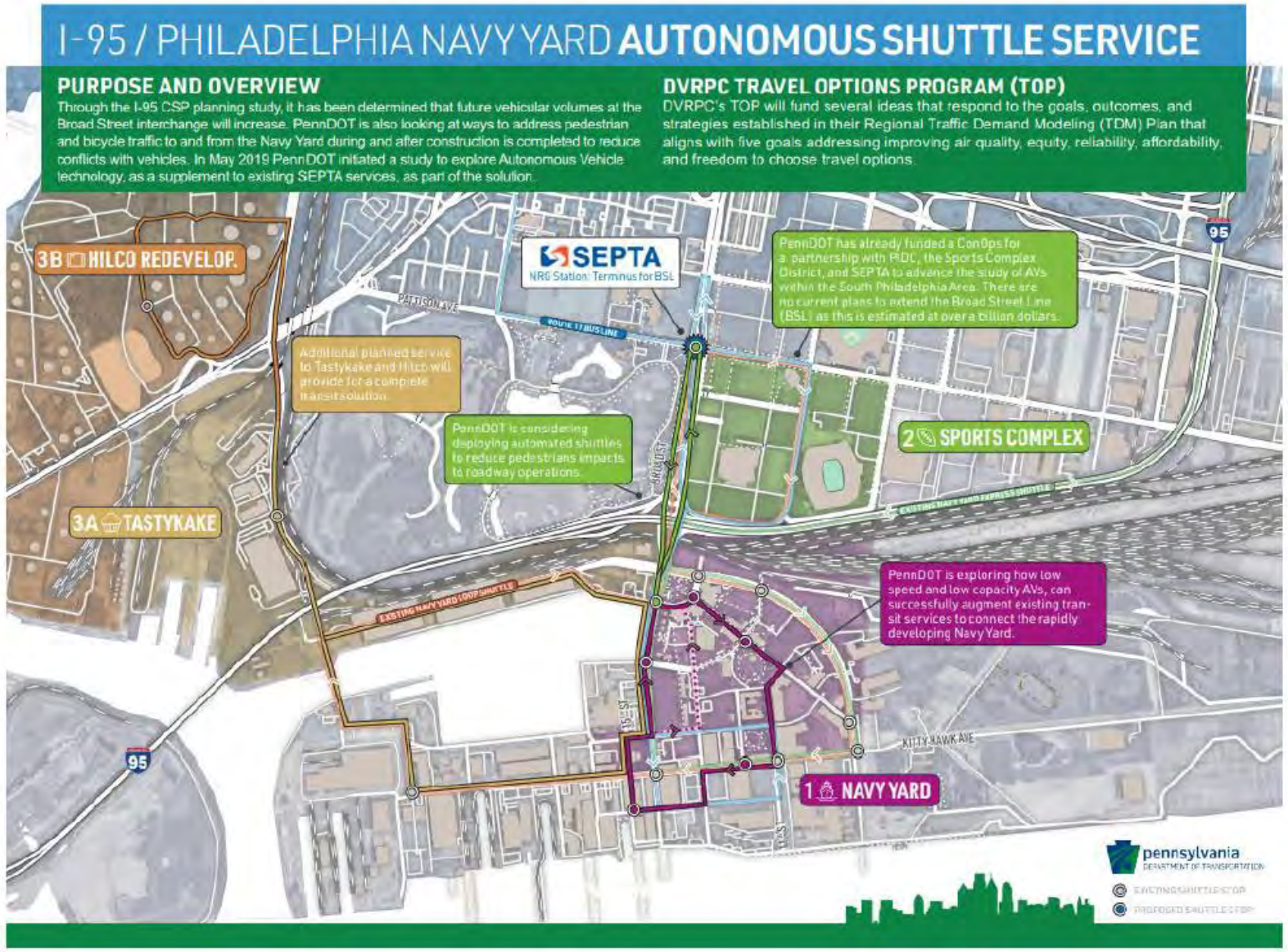
Project Team:

Carnegie Mellon University, PennState, Penna Turnpike, PPG, Qualcomm, HNTB, Michael Baker International, Deloitte., DRIVE Engineering

Community of Support:

City of Philadelphia, dvrpc Delaware Valley Regional Planning Commission, SPC Southwestern Pennsylvania Commission, Ford, Argo AI, Volvo Volvo Group, Mack, SAE International

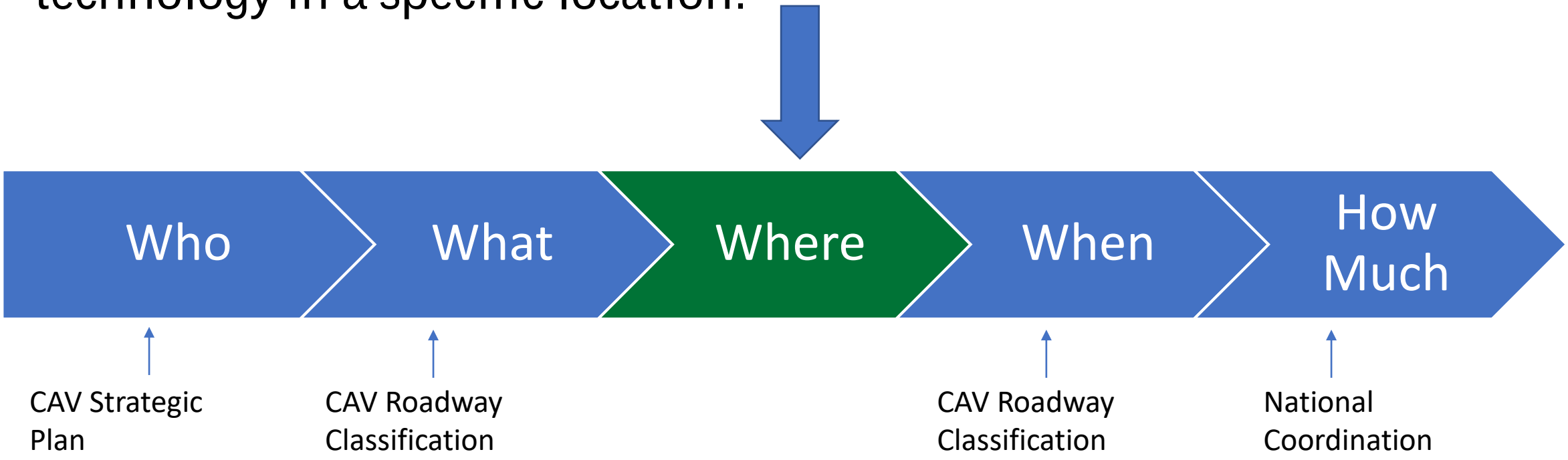
NAVY YARD SHUTTLE PROJECT



- DVRPC grant to PIDC
- Modified FMVSS certified transit vehicle
- ~12-month project
- Initially in the Navy Yard with option to expand out

CAV HOTSPOTS

- Develop an evaluation methodology based on existing data sets to determine the likelihood of early market penetration of CV and AV technology in a specific location.



UPCOMING INITIATIVES

- AV Communications and Engagement Plan
- Local Government CAV Plan
- CV/Smart City Specifications
- Autonomous TMA
- PDD Local Government Education Plan
- PDD Mobility Feed
- CAV Training Modules
- Platooning Integration
- AV Workforce Development Plan

QUESTIONS?

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