Automated Technology

October 2019

What are Connected and Automated Vehicles?

Now

Connected Vehicles

Where a vehicle communicates with something outside itself

- Another vehicle
- Pedestrians
- Infrastructure (signals)
- Buildings
- Parking
- Toll systems

Now

Automated Vehicles

Where some or all driving task is done by a machine

- Braking
- Steering
- Speed changes

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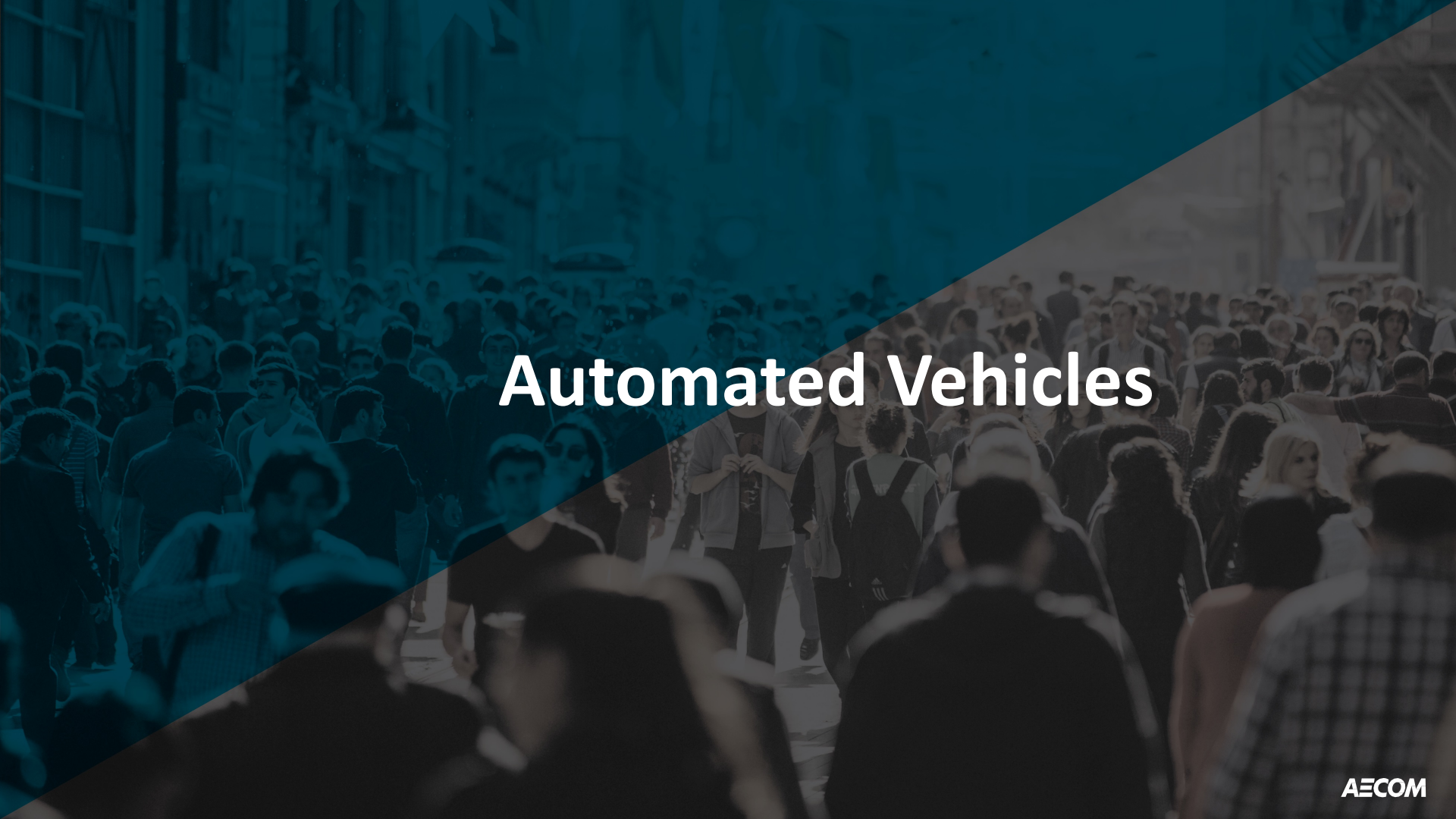

Automated Vehicles

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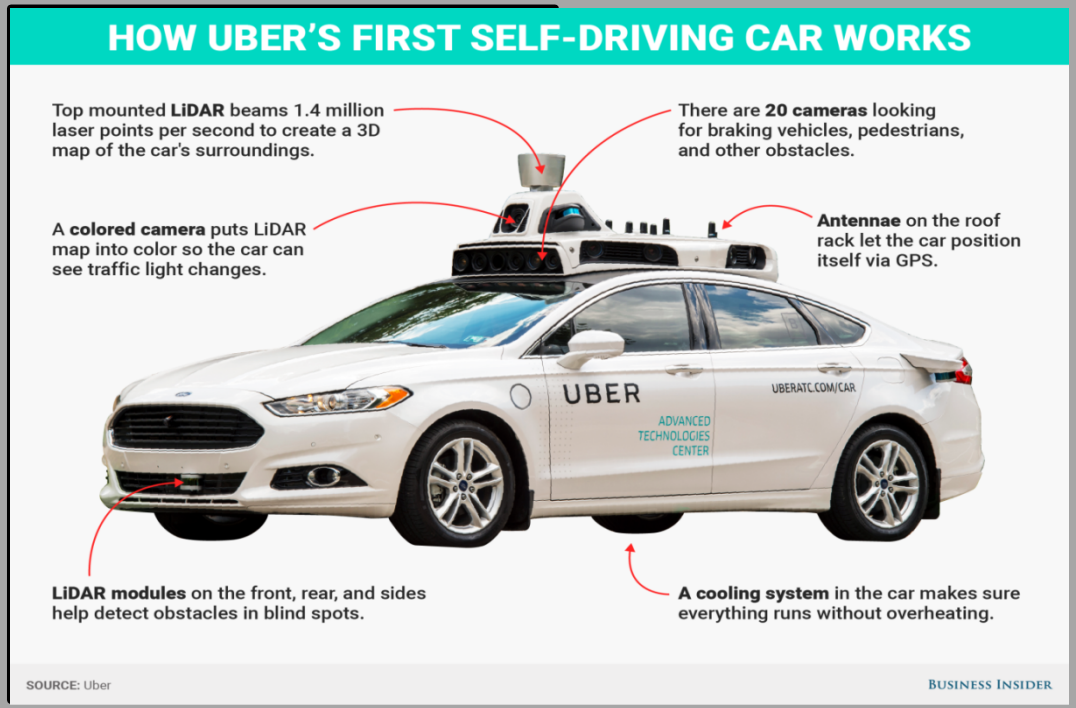
Overall Deployments

- Uber, Lyft
- Waymo
- Automated Trucks
- EVTOLs

Elements of Automated Vehicles



Federal AV Guidance 3.0

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Federal AV Regulation

BAG17C69

115TH CONGRESS
1ST SESSION

S. _____

To support the development of highly automated vehicle safety technologies, and for other purposes.

IN THE SENATE OF THE UNITED STATES

Mr. THUNE (for himself and Mr. PETERS) introduced the following bill; which was read twice and referred to the Committee on

A BILL

To support the development of highly automated vehicle safety technologies, and for other purposes.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled,

SECTION 1. SHORT TITLE; TABLE OF CONTENTS.

(a) SHORT TITLE.—This Act may be cited as the "American Vision for Safer Transportation through Advancement of Revolutionary Technologies Act" or the "AV START Act".

(b) TABLE OF CONTENTS.—The table of contents of this Act is as follows:

IIB

115TH CONGRESS
1ST SESSION

H. R. 3388

IN THE SENATE OF THE UNITED STATES

SEPTEMBER 7, 2017
Received; read twice and referred to the Committee on Commerce, Science, and Transportation

AN ACT

To amend title 49, United States Code, regarding the authority of the National Highway Traffic Safety Administration over highly automated vehicles, to provide safety measures for such vehicles, and for other purposes.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled,

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EVTOLs

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Context - ABC

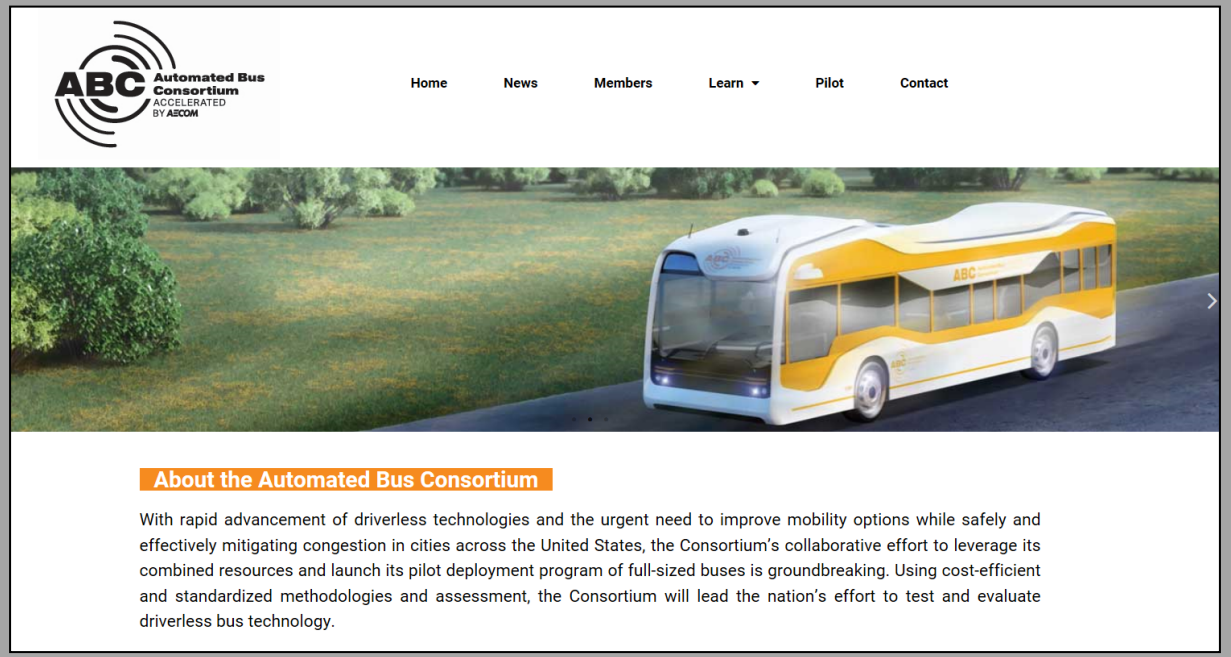
ABC Automated Bus Consortium ACCELERATED BY AECOM

- Automated small vehicle shuttle technology is proven
- Appears feasible to transfer AV shuttle technology to full-sized buses
- Vendors need a market to cost-effectively produce these buses
- Concept: Joint procurement of 75-100 buses by 12 agencies

Consortium Agencies

Connecticut Department of Transportation (CTDOT) | Dallas Area Rapid Transit (DART) | Foothill Transit | Long Beach Transit (LBT) | Los Angeles County Metropolitan Transportation Authority (Metro) | MetroLINK (Moline) | Metropolitan Atlanta Rapid Transit Authority (MARTA) | Metropolitan Transit Authority of Harris County (Houston) | Michigan Department of Transportation (MDOT)/Michigan's mobility initiative, PlanetM | Minnesota Department of Transportation (MnDOT)/Rochester Public Transit | Pinellas Suncoast Transit Authority (PSTA) | Virginia Department of Rail and Public Transportation (DRPT)/Hampton Roads Transit

Check Out ABC



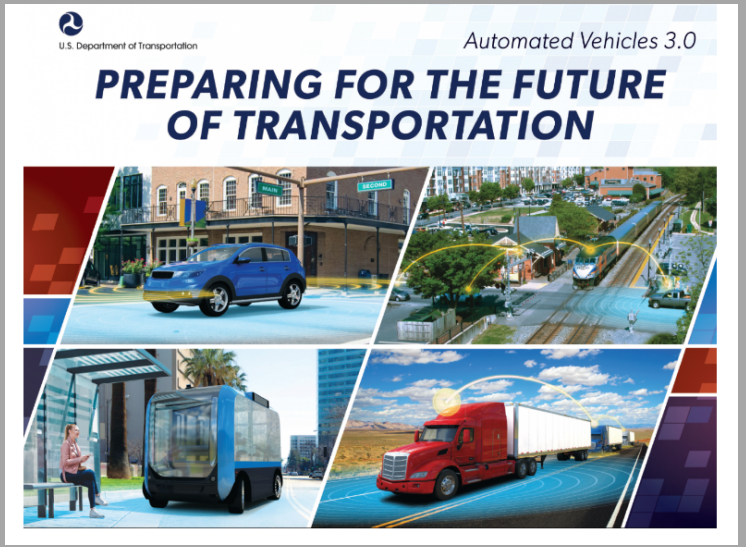
www.automatedbusconsortium.com

Regulatory Environment

FEDERAL, STATE & LOCAL ROLES	FEDERAL	STATE	LOCAL
Motor vehicle safety standards	■		
Regulate interstate commerce	■		
Traffic control standards (i.e. uniformity in road markings, signing and other devices	■		
Contribute to the development of cyber security standards and protocols	■	■	■
Develop testing and deployment programs	■	■	
Driver licensing and vehicle registration	■	■	
Commercial motor vehicle operations, driver training and licensing	■	■	
Insurance regulations		■	
Public safety and law enforcement		■	■
Assess infrastructure for CAV readiness		■	■
Workforce training and public outreach	■	■	■
Environmental and health standards	■	■	

Federal Safety Oversight 3.0

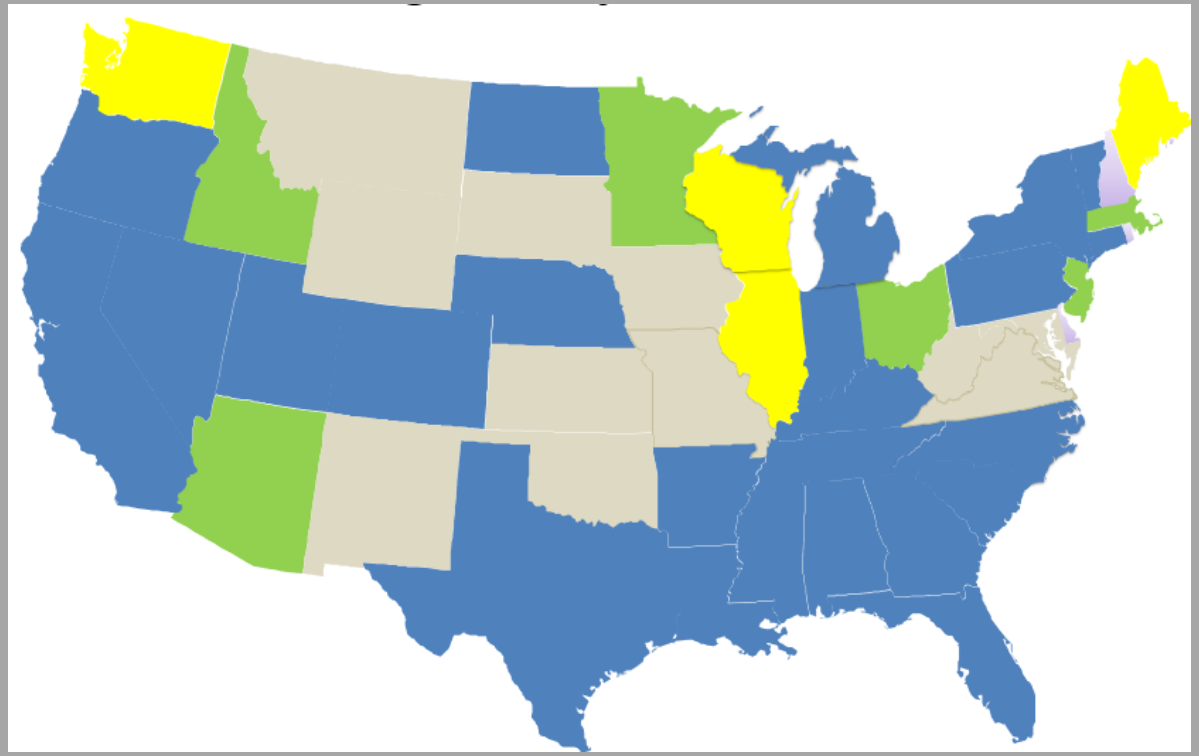
- Emphasis on system safety
- Operational domain
- Object & event detection and response
- Fallback position
- Validation methods
- Human machine interface
- Vehicle cybersecurity
- Crashworthiness
- Post-crash ADS behavior
- Data recording
- Consumer education
- Federal, state and local laws



Summary of State Regulatory Environments

Regulate AV	Testing Permits	Insurance	Fail Safe	Platooning	Preempt Local
• California • Florida • Georgia • Michigan • Texas • Washington, DC	• California • Georgia • Maryland	• California • Connecticut • Florida • Texas	• California • Florida • Washington, DC	• Georgia • Michigan	• Illinois • Texas

State Approaches



Florida

- Florida law permits self-driving vehicles to operate without a human driver.
- The new law also exempts operators inside AV from laws that ban texting while driving and other potentially distracting activities.
- Florida law also requires there must be
  - a means to engage and disengage the automation technology, and
  - a visual indication when the vehicle is operating in automated mode.
  - Testing entities are required to submit proof of insurance prior to any testing.
- If there is no operator present to take control of the AV, it must be capable of safely coming to a complete stop.

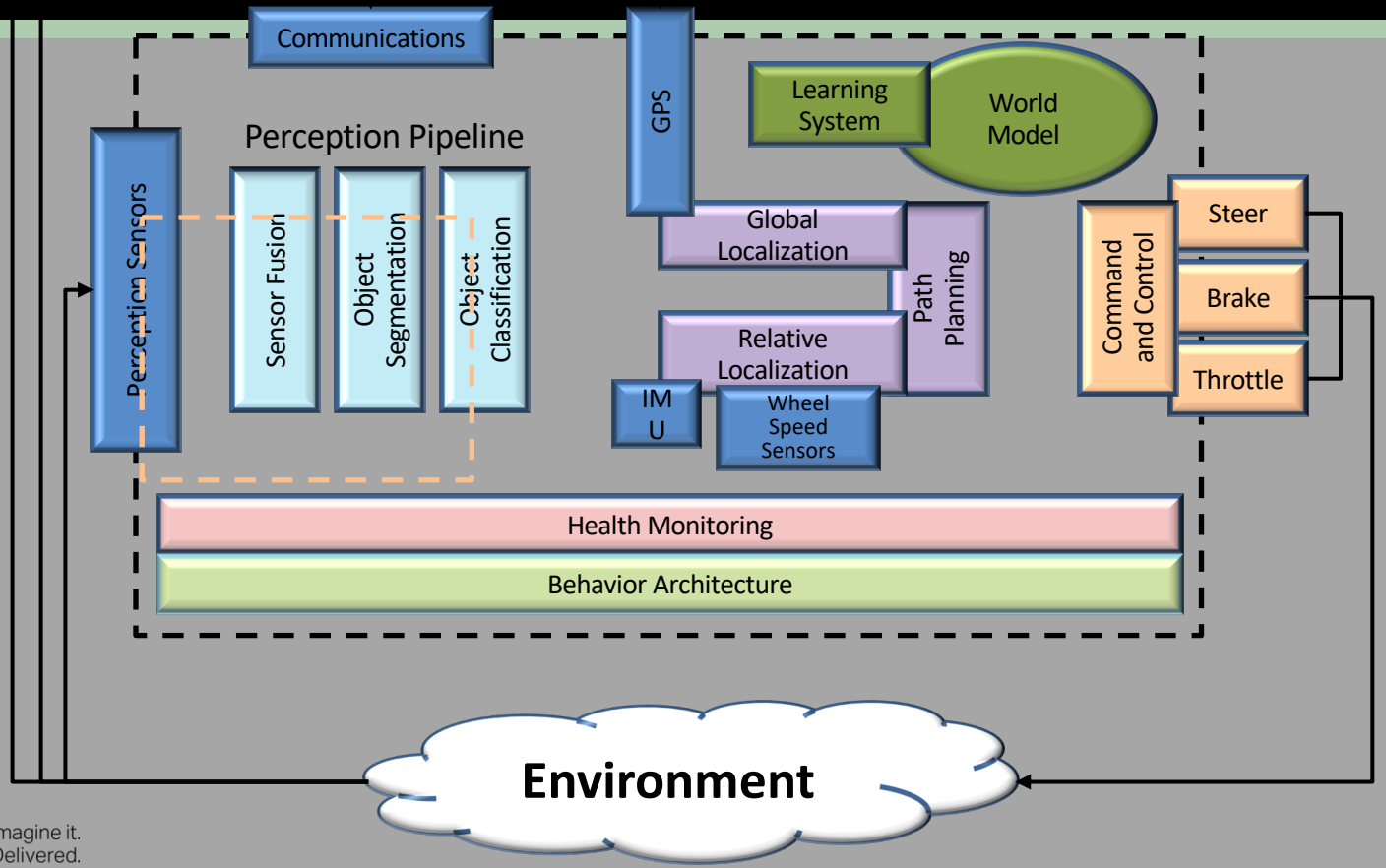
Automated trucks are being tested in Florida by Starsky Robotics.

Broad Automated Vehicle Considerations

- Generally AVs can navigate any route (within physical limitations), but:
  - #1 How safe (inside/outside)?
  - #2 How comfortable for riders?
    - Complexity of route (cluttered/unpredictable) increases risk
- Steps / process
  - Select route / environment
  - Select sensors for route environment / function requirements
  - Software development
    - Perception of pipeline
    - Behavior architecture
    - Localization
    - Path planning
    - Command and control

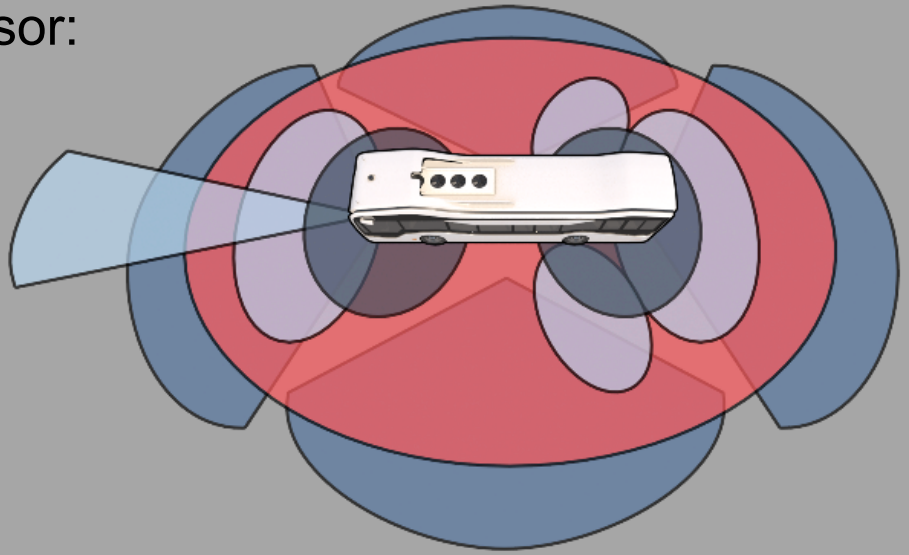
Perception pipeline algorithms (sophistication and robustness) are critical!

Major Components of an Automated Vehicle

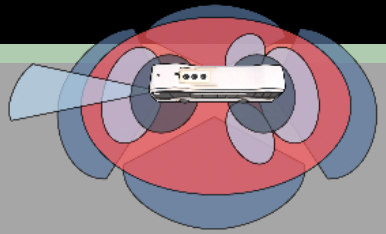


AV Sensor Technologies

- Critical characteristics of a sensor:
  - Field of View (FOV)
    - Horizontal
    - Vertical
  - Data resolution and content (available information)
  - A bus has different FOV requirements than a passenger vehicle



Perception Sensors



- Light detection and ranging (LiDAR)
  - Can be very expensive
  - Requires extensive post processing to fuse and filter data, increasing computing requirements
  - Used for ground extraction, and object detection, localization, and limited classification
- RADAR
  - Robust sensor used for simple object detection, localization, and classification (location and distance)

Mono (single) vision
- Color or monochrome
- Used for object detection, localization, and classification
- Can measure object horizontal and vertical position relative to vehicle, but not necessarily distance

Stereo (dual) vision
- Provides depth perception
- Used for object detection, localization, classification, and distance. Highly dependent on camera baseline, sensor resolution, and lens optics.

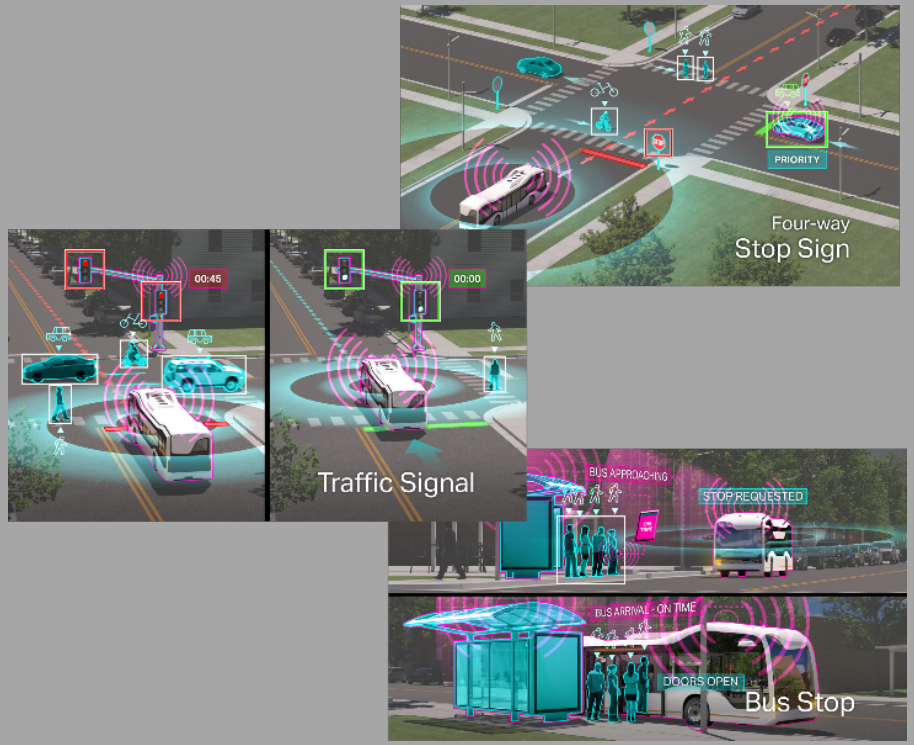
Ultrasonic
- Short-range simple object detection (location and distance)

Localization
- GPS, Inertial Measurement Unit (IMU), wheel speed, gyroscope, etc

Automated Coach Operational Design Domain (ODD)

In what environment will the bus operate?

- Urban roadways with mixed traffic
- Existing service routes
- Maintenance yards
- Bus stops
- Passenger interactions
- Intersections
  - Signalized
  - 4-way and 2-way stop
  - Mid-block crossings
- Bike lanes
- Pedestrians
- Scooters



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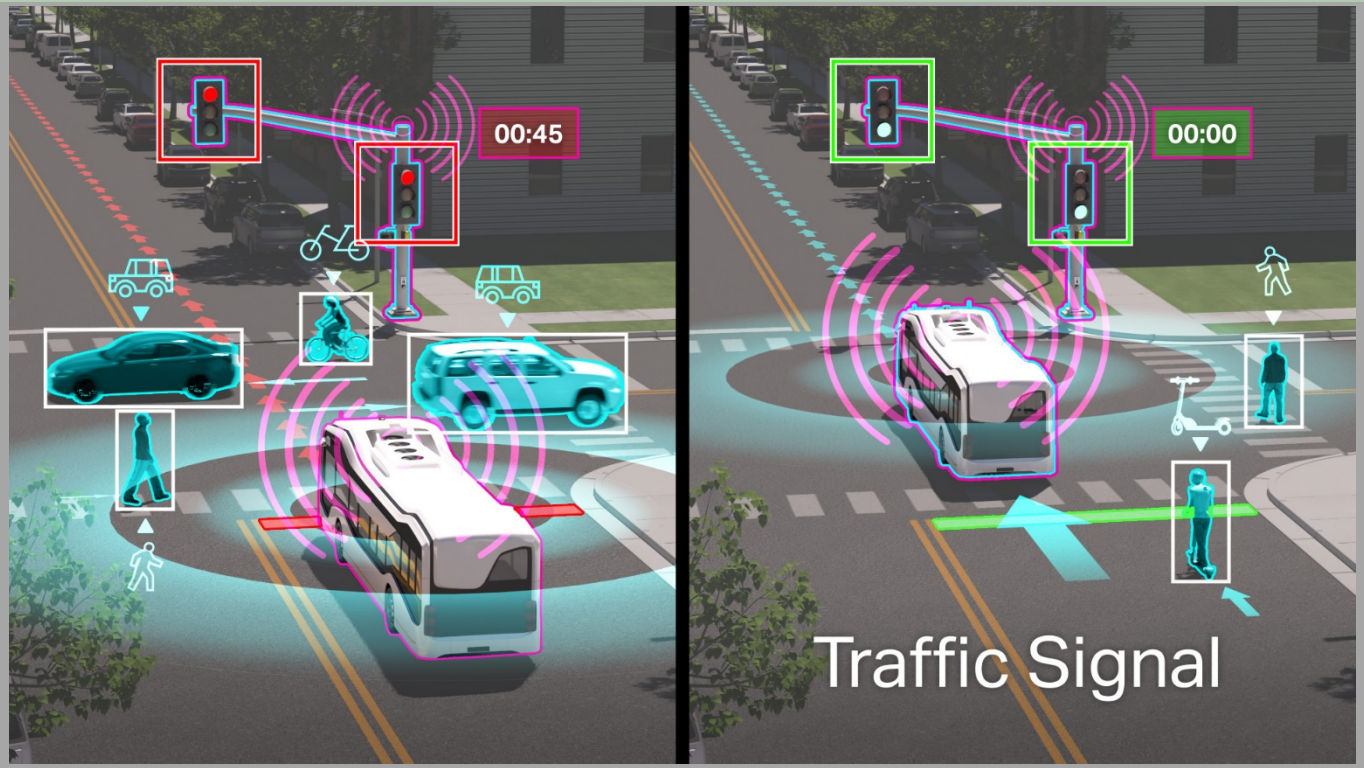
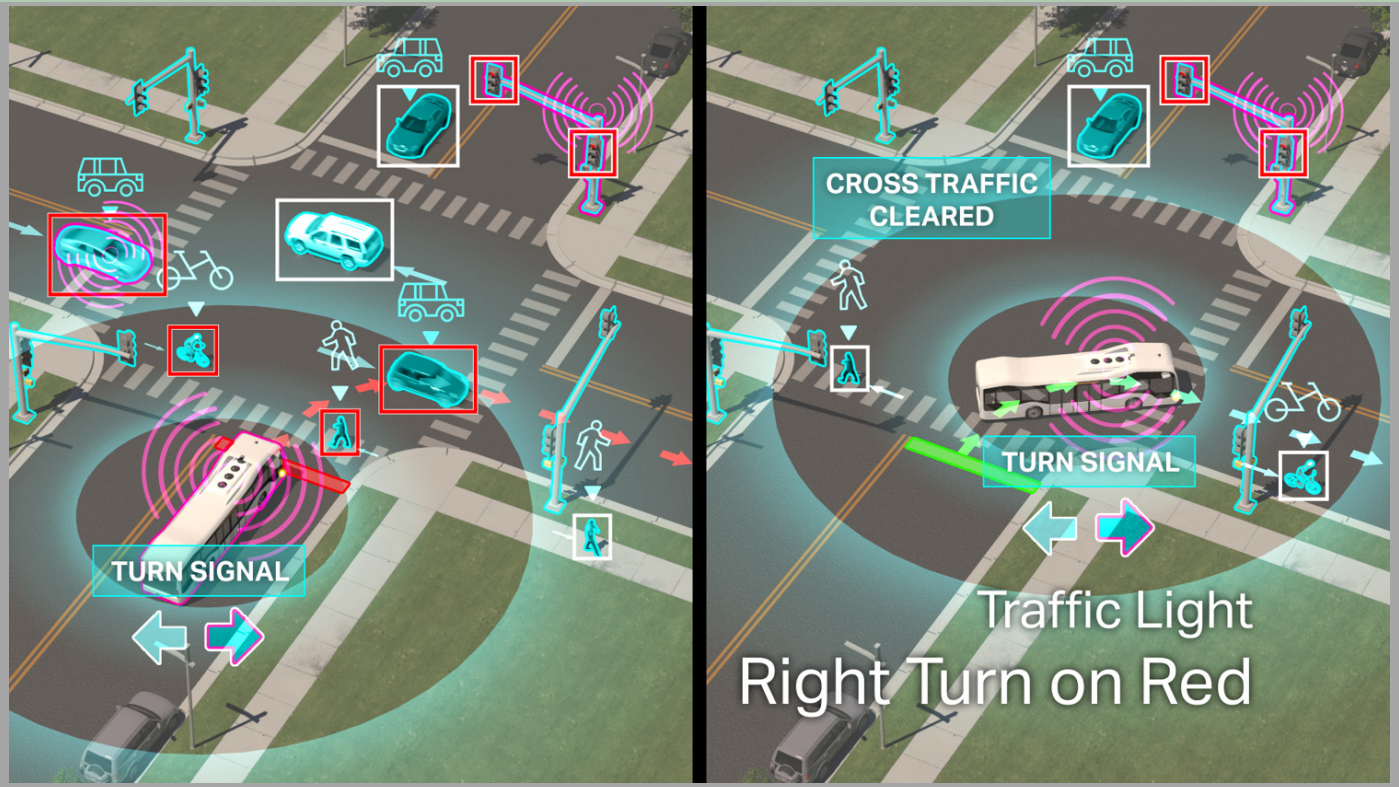
Traffic Signal Interaction

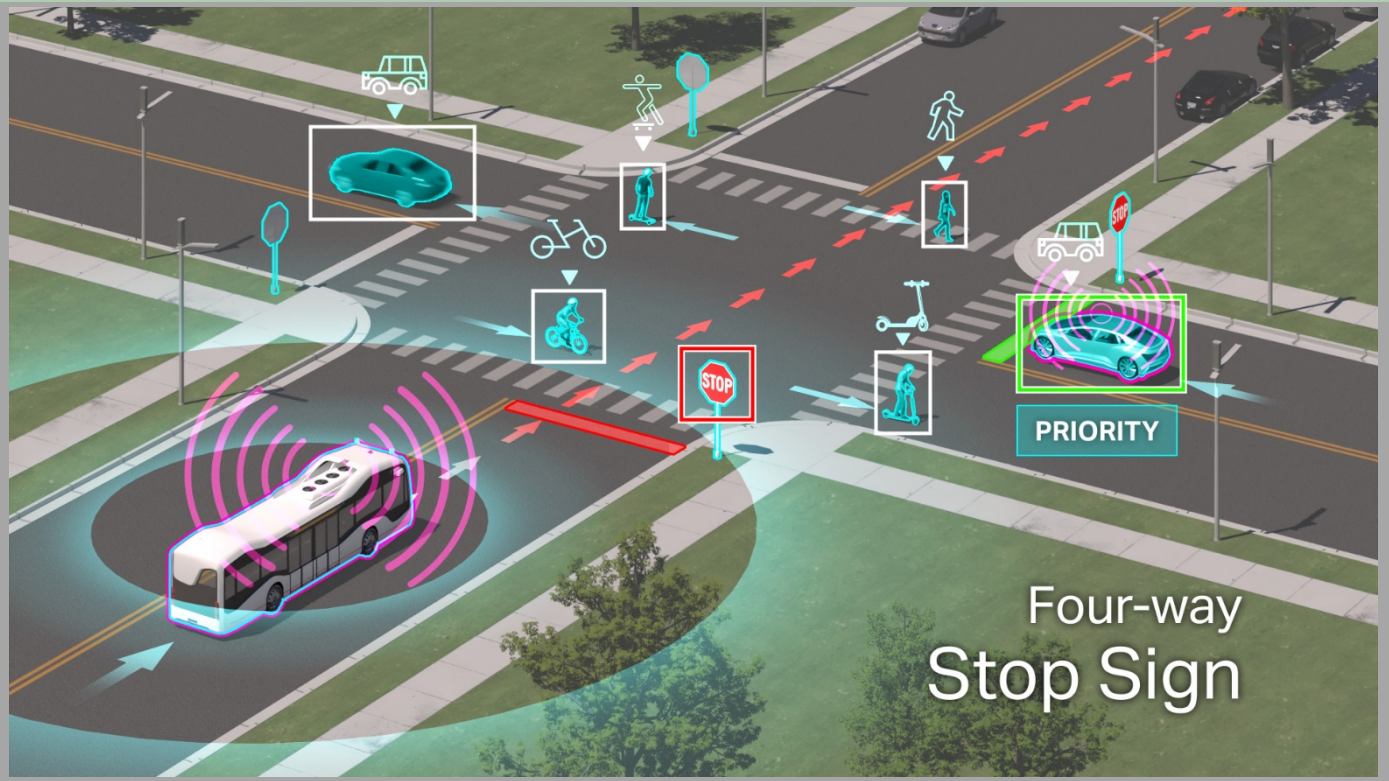


Right Turn on Red

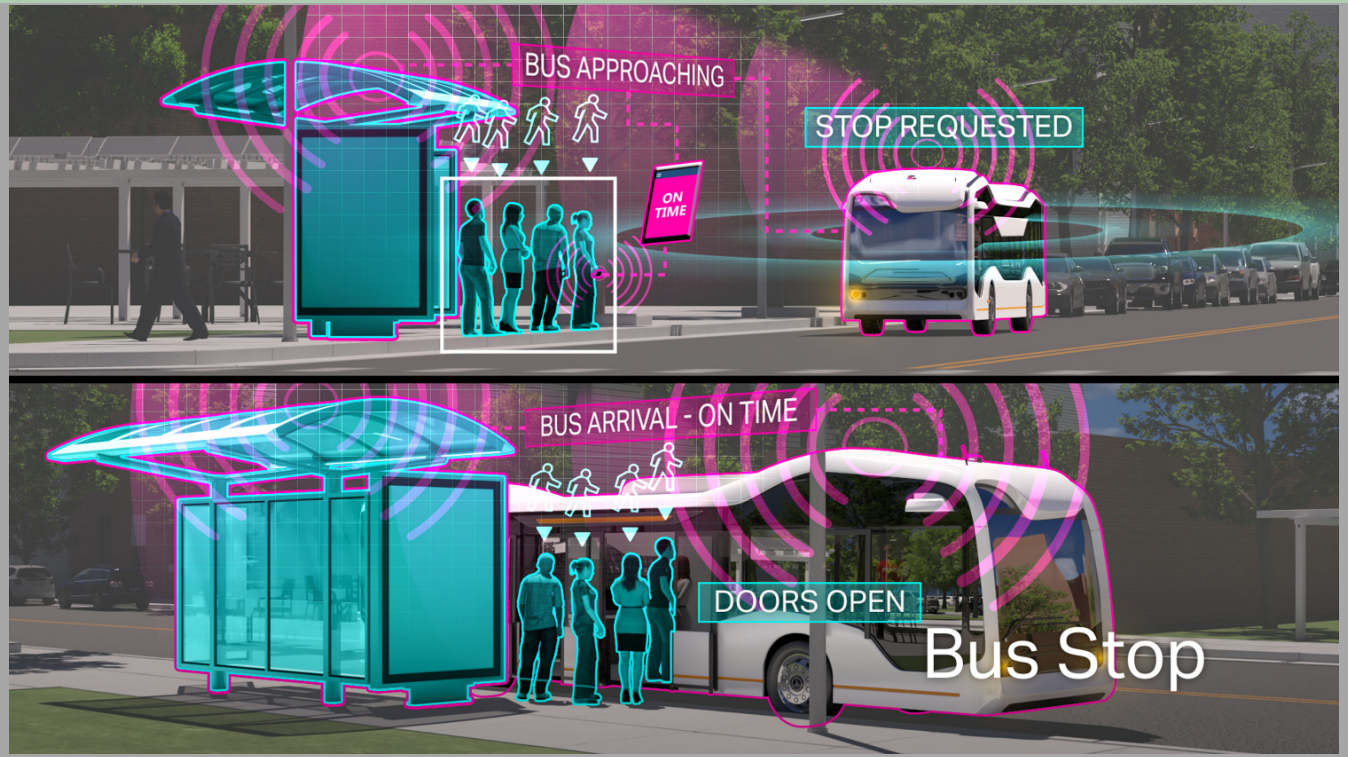


Left Turn Yield on Green

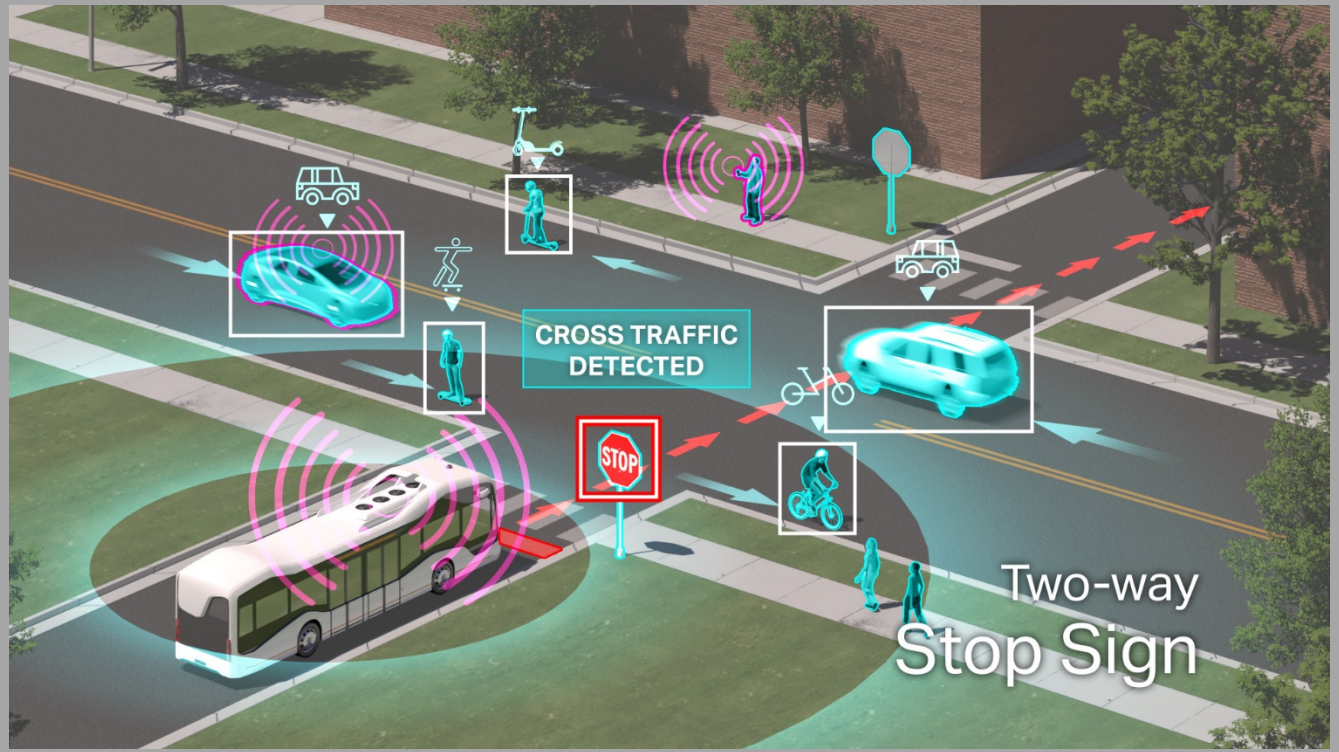
Four Way Stop Sign



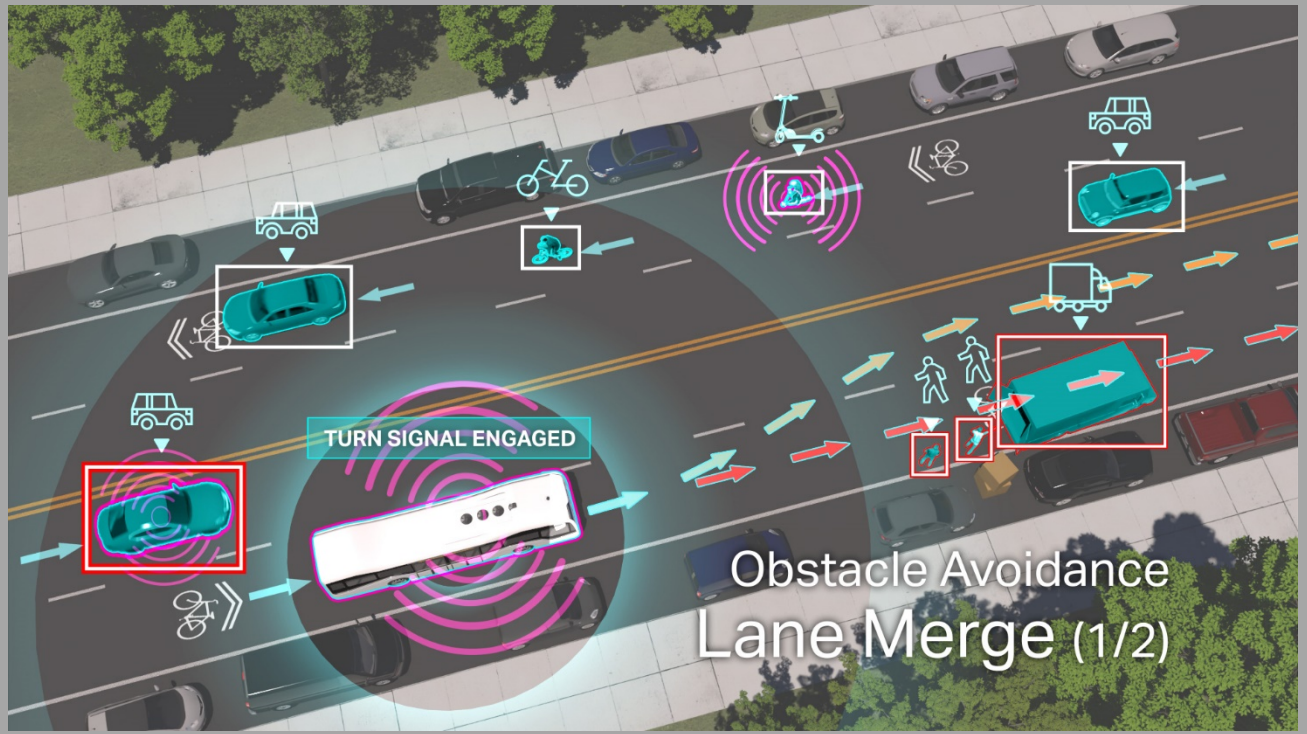
Bus Stop


BUS APPROACHING
ON TIME
STOP REQUESTED
BUS ARRIVAL - ON TIME
DOORS OPEN
Bus Stop

Two-way Stop Sign



Obstacle Avoidance



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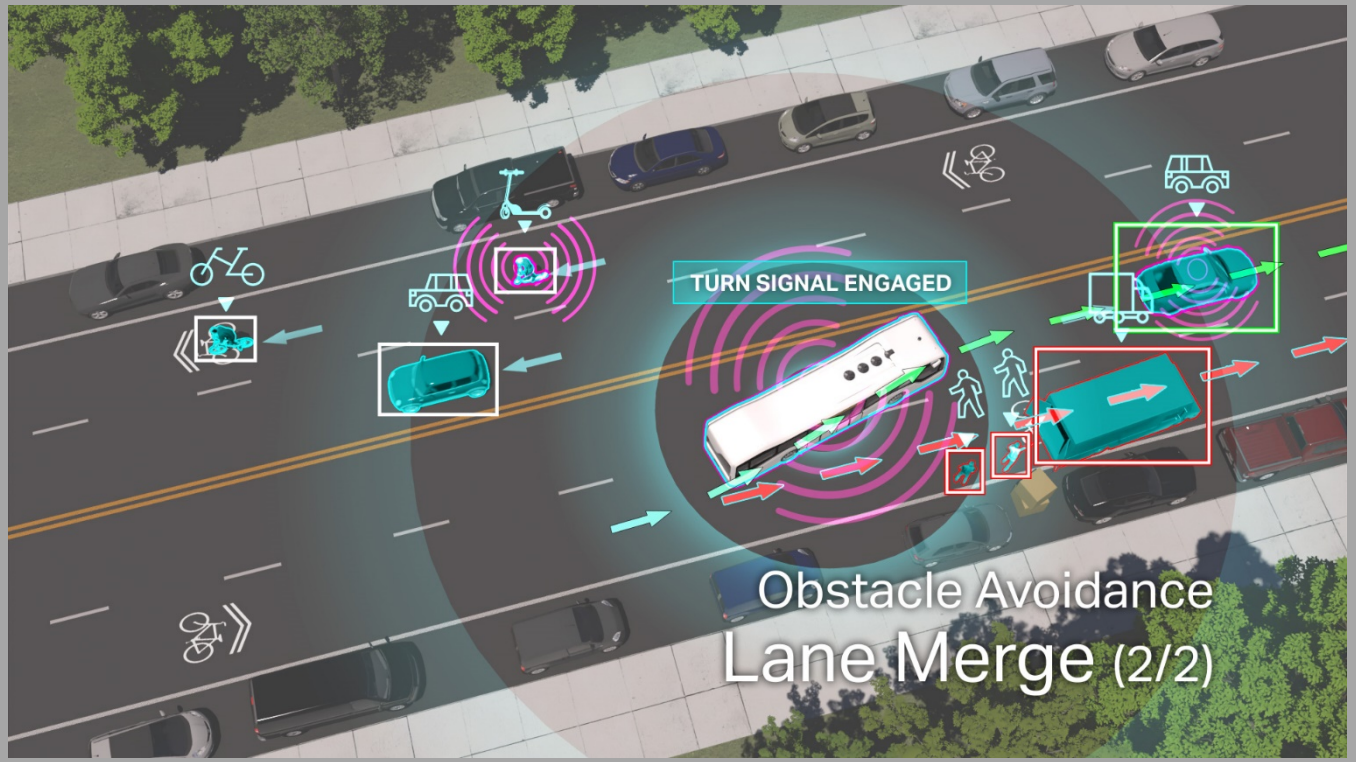
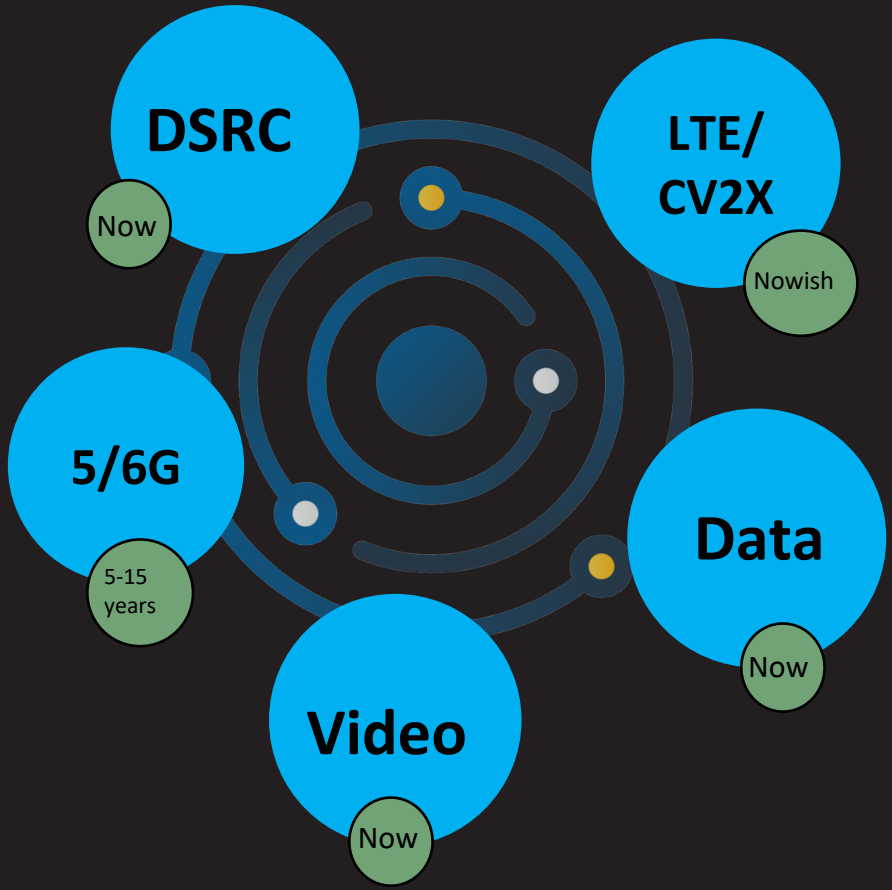


Lane Merge

Lane Merge


Connected Vehicles

Types of Connectivity



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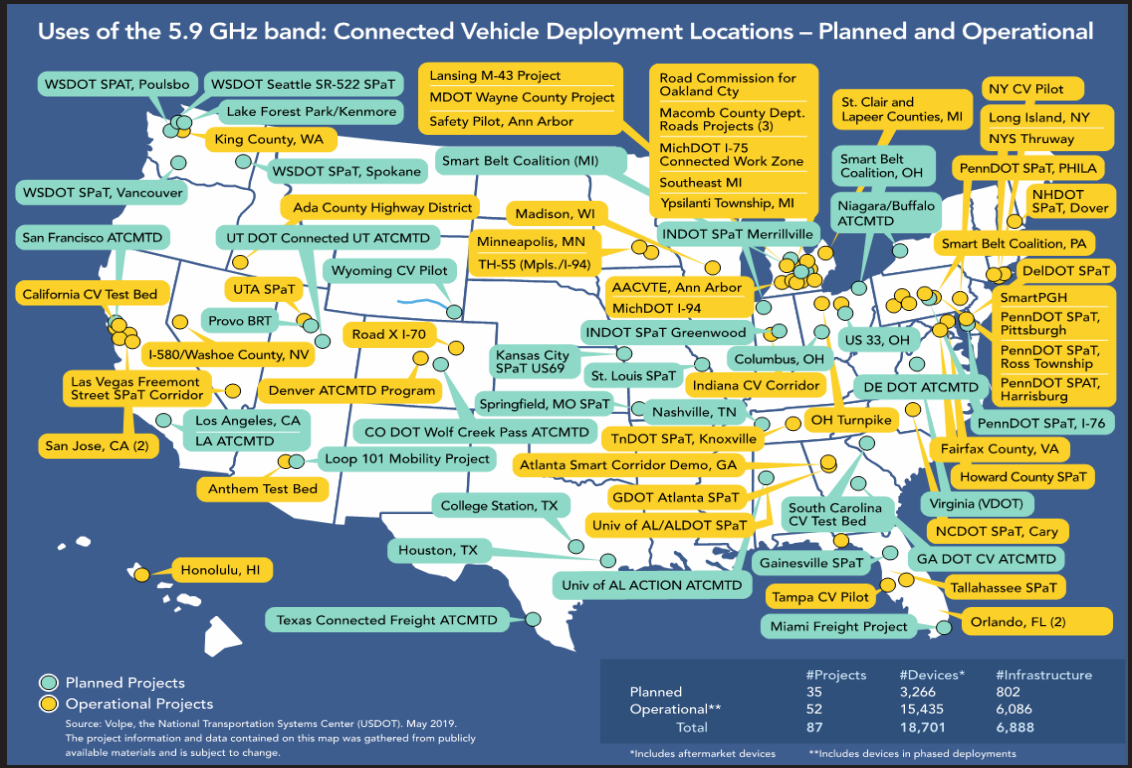
DSRC Deployments in the US

…and sample applications



Sample Applications

- Commerce Applications
- Truck Platooning
- Taxi Management
- Geo-Fencing
- Intersection collision avoidance
- Signal prioritization
- Intersection movement assist
- Wrong way driving

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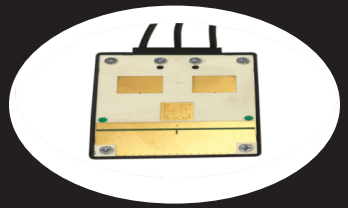
What Does Deployment Look Like?



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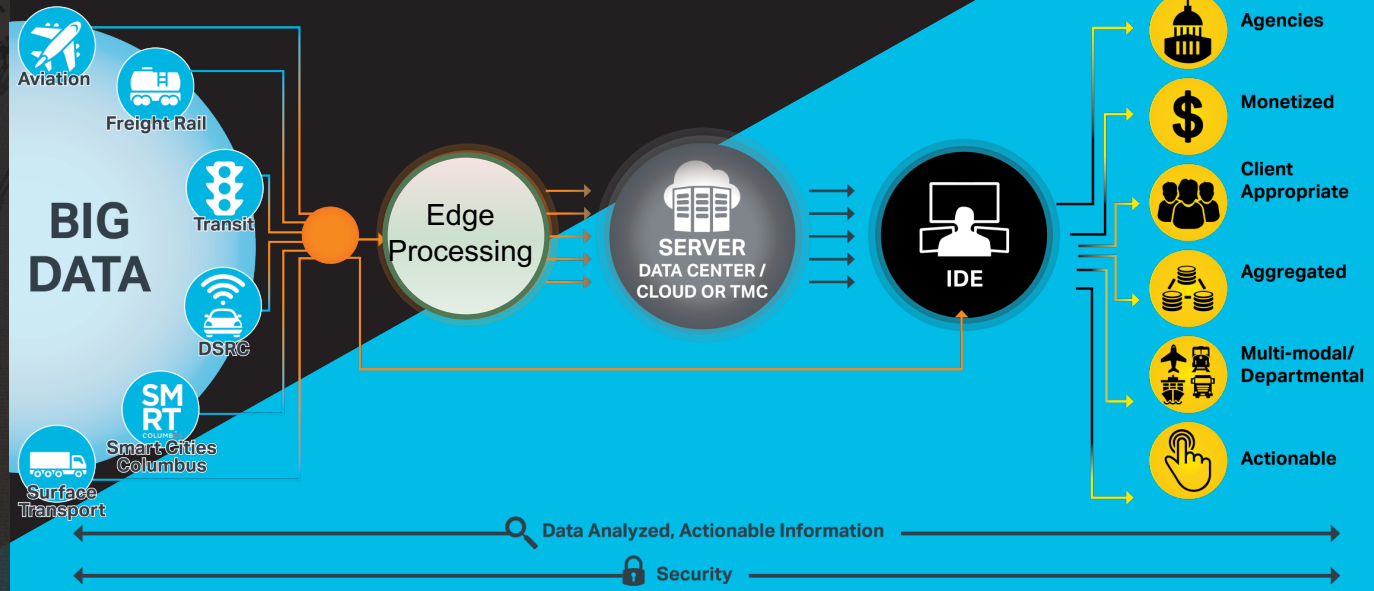
Data

Data


Aviation
Freight Rail
BIG DATA
Transit
DSRC
SMART COLUMBUS
Smart Cities Columbus
Surface Transport
Edge Processing
SERVER
DATA CENTER / CLOUD OR TMC
IDE
Agencies
Monetized
Client Appropriate
Aggregated
Multi-modal/ Departmental
Actionable
Data Analyzed, Actionable Information
Security

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Processing

I. Dashboard portal
II. Reporting
III. Notifications & alerts
IV. Pattern identification
V. Predictive analytics
VI. "What If" simulation

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Tolling Advances

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Supporting Shifts in Tolling

Mobility on Demand Apps

Next Generation Toll Reader

Smart Parking

geo toll

Mobile Payment Technology

Tesla screen

Smart Mobility Hubs

carma

High Occupancy Commuting

Technology Marketplace


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Imagine it.
Delivered.