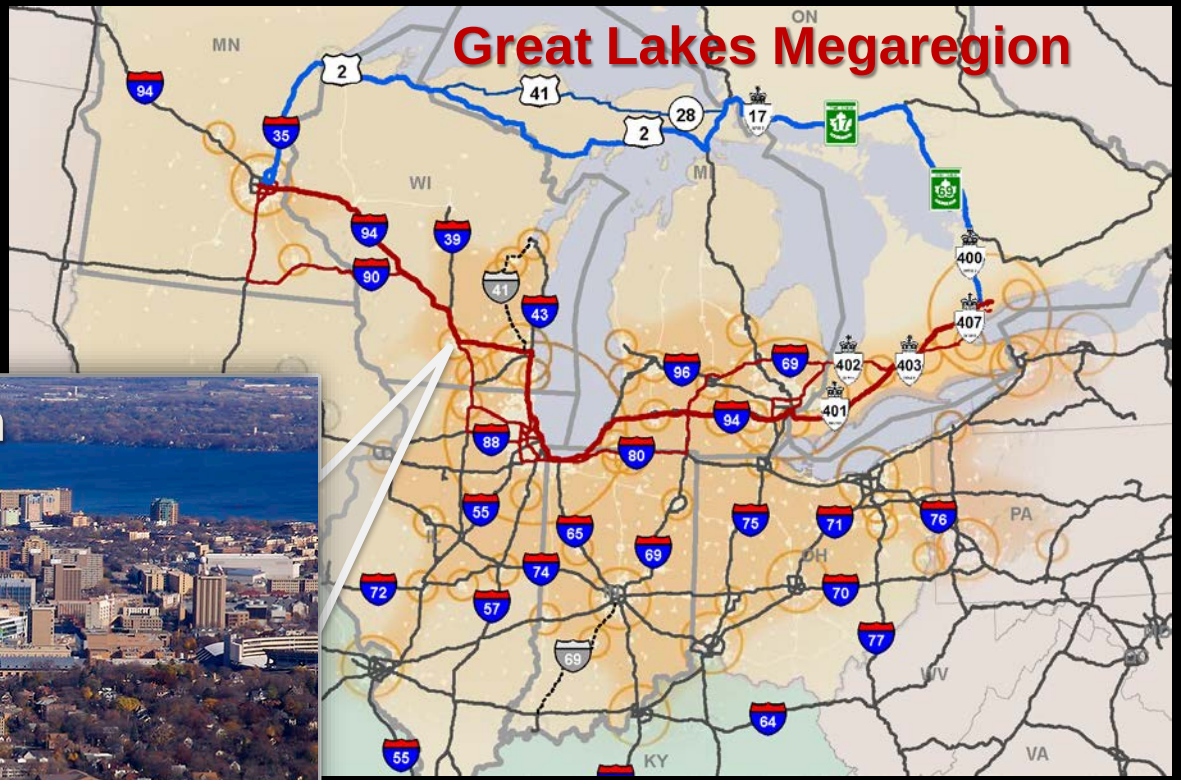
WISCONSIN AUTOMATED VEHICLE PROVING GROUNDS

WISCONSIN
UNIVERSITY OF WISCONSIN–MADISON

An Introduction

City of Madison


Great Lakes Megaregion
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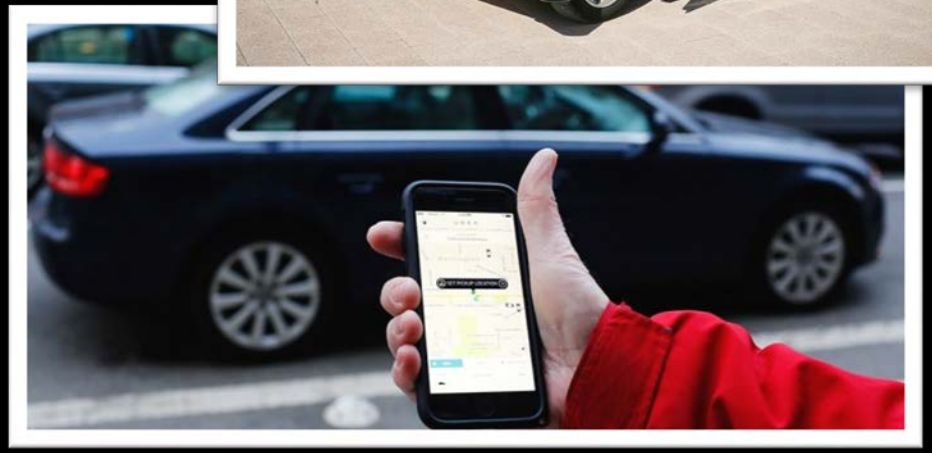
Building a Smart Madison
for Shared Prosperity

leapcraft™
TREK
WISCONSIN TOPS
TRAFFIC OPERATIONS & SAFETY LABORATORY
UBER
Bcycle
mGE
Madison Gas and Electric
SSTI
State
Smart Transportation
Initiative
MADISON TAXI
24 HOUR
Transportation Services
UNION CAB of Madison
CITY OF MADISON WISCONSIN
CISCO
Green Cab
OF MADISON
Badger
NATIONAL CENTER FOR
FREIGHT & INFRASTRUCTURE
CFIRE RESEARCH & EDUCATION
WISCONSIN
UNIVERSITY OF WISCONSIN-MADISON
EASY MILE
ECONOLITE
Group, Inc.
Metro
QUALCOMM
Epic
Madison Area
T·P·B
Transportation Planning Board
A Metropolitan Planning Organization (MPO)
DEPARTMENT OF
Computer Sciences
UNIVERSITY OF WISCONSIN-MADISON
College of Engineering
UNIVERSITY OF WISCONSIN-MADISON
PROPELLER HEALTH

Shared Mobility

Shared



Electric Vehicles

EV

VULCAN

mGOe

Connected Vehicles

CV

V2V

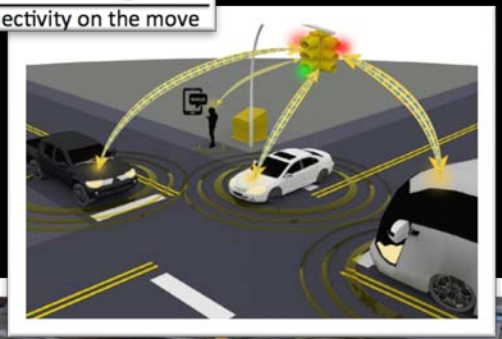
V2I

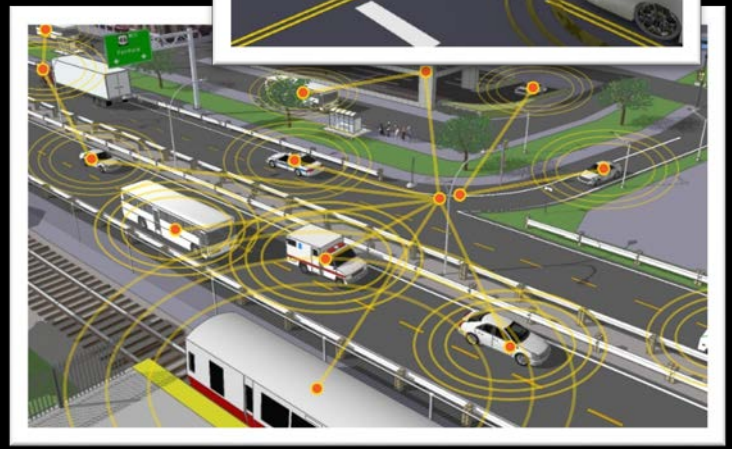
V2X

IoT

WiRover

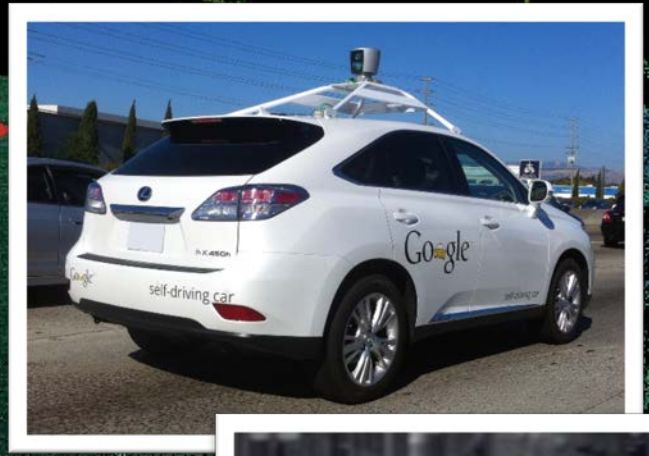
Seamless high bandwidth connectivity on the move

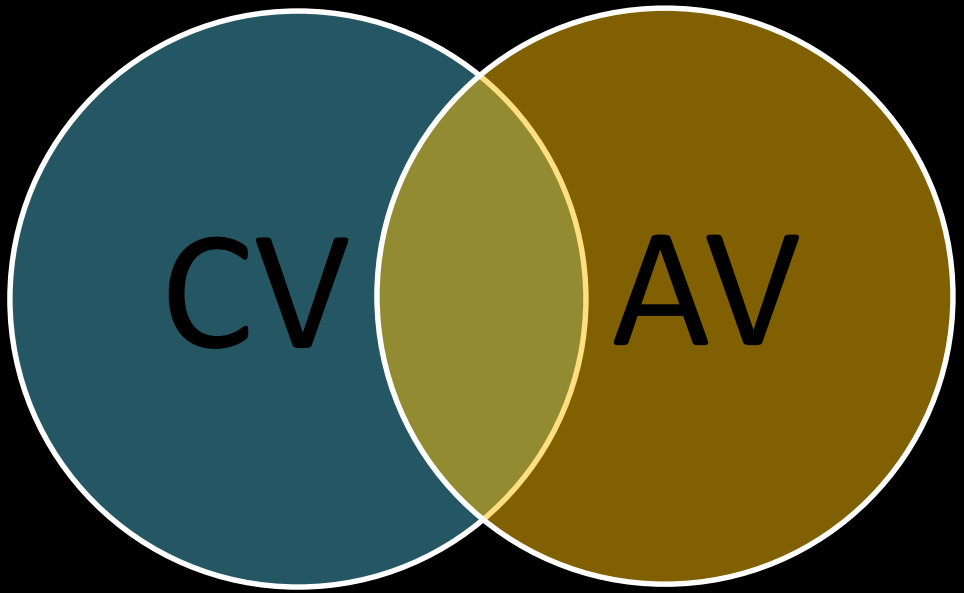


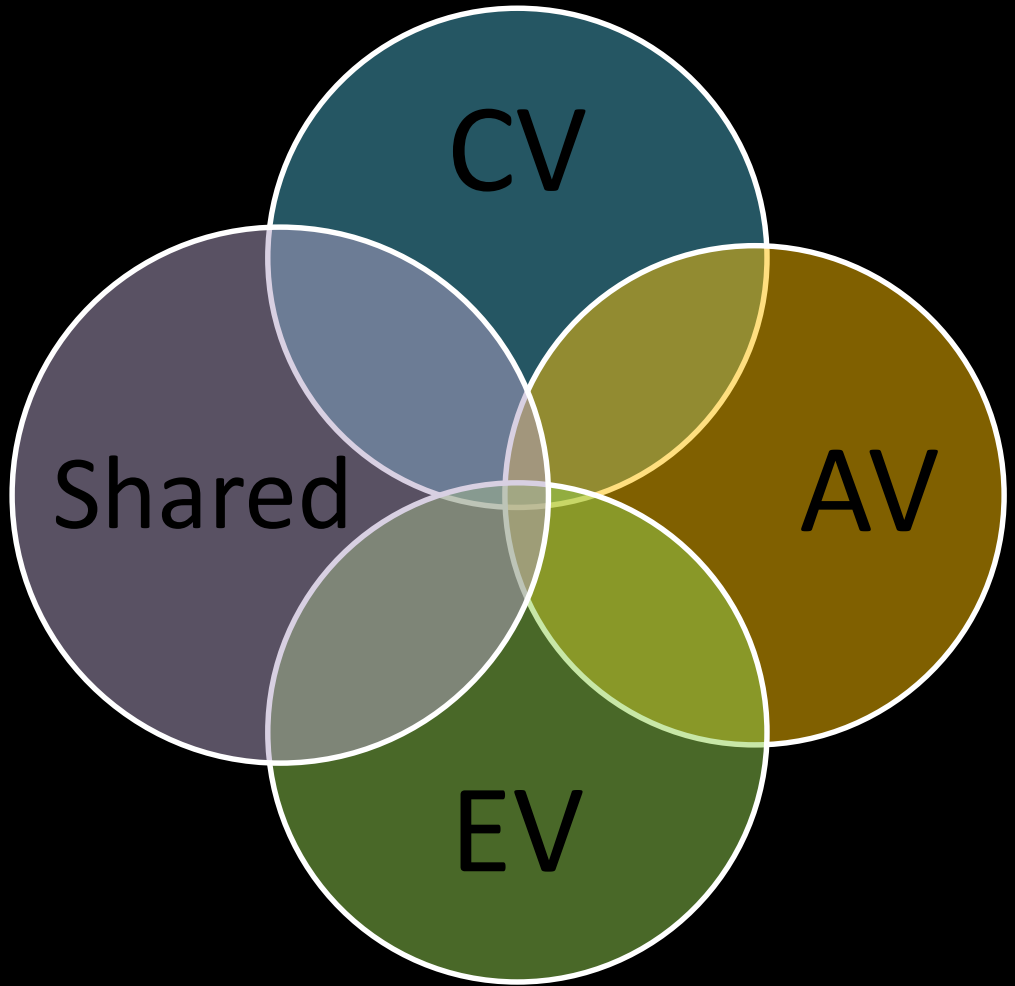


Autonomous Vehicles

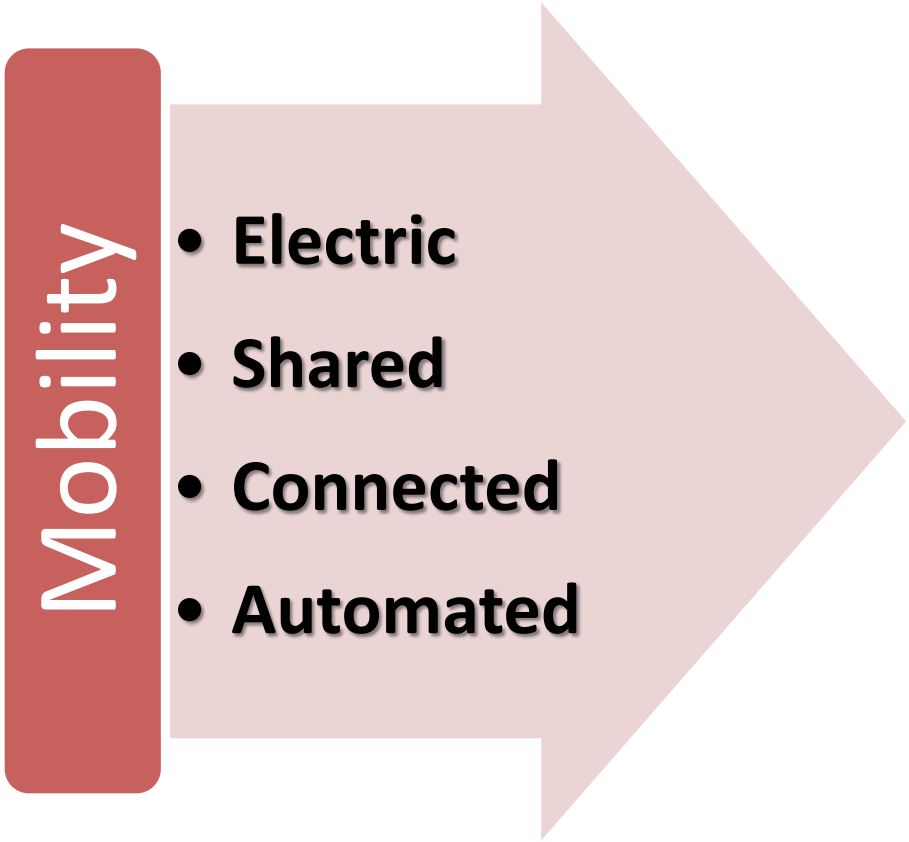
AV




CV
AV


CV
Shared
AV
EV

Trends and Outcomes



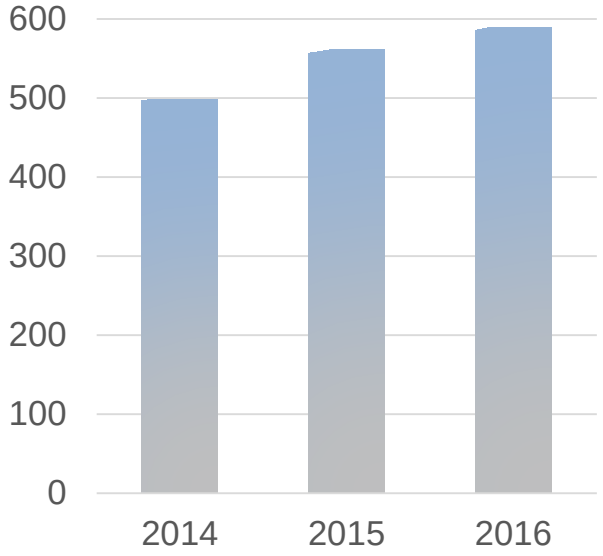
- Safety
- Vehicle Miles Traveled (VMT)
- Sprawl
- Parking
- Energy
- Air Quality
- Public Health
- Equity
- Accessibility

Traffic Fatalities Rising

Nationally:

- Increased for 2nd straight year
- Largest two-year increase in 50 years
- Approaching 40,000 deaths

Wisconsin:



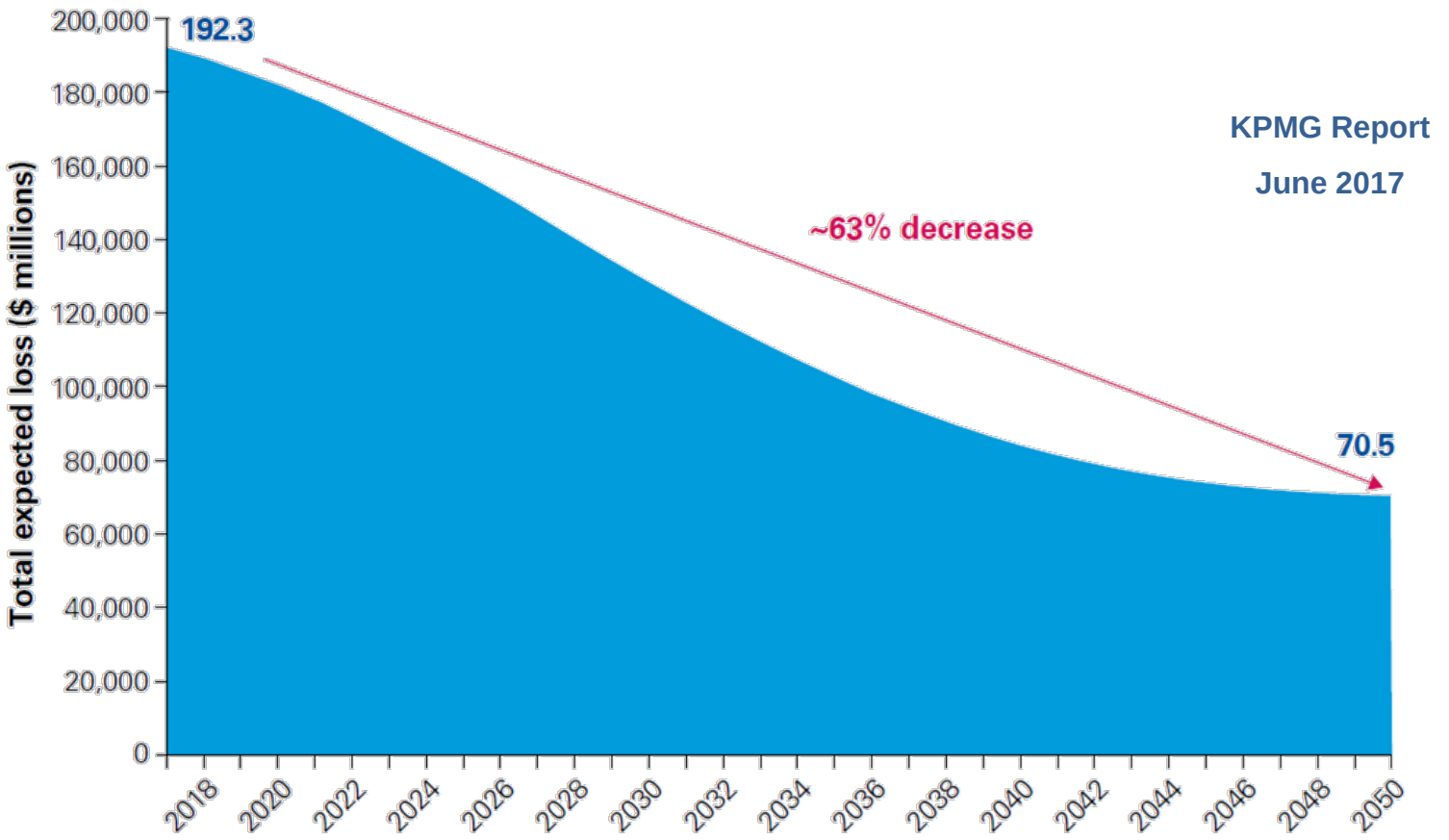
Pedestrian deaths now up to 15% of all traffic deaths

Sources: National Highway Traffic Safety Administration, National Safety Council, and Wisconsin DOT

Motivations and Opportunities

- Safety
  - ~90% of crashes attributable to human error
  - Distracted driving continues to worsen
  - Need to carefully navigate the era of partial automation
- Equity
  - Accessibility
  - First mile / last mile
- Many other motivations:
  - Economic development, startup and tech jobs
  - Underutilized vehicles
  - Efficient use of infrastructure and land
  - Health care, agriculture, and other sectors

Projected Auto Insurance Sector

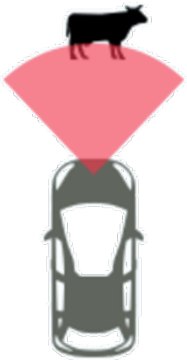


What is an AV?

"Personal
Delivery
Device".

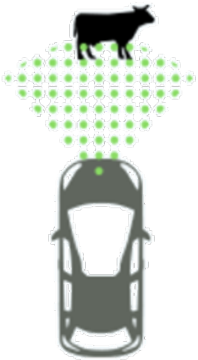
Very Active Industry Development

How AVs Operate



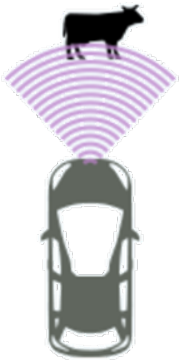
CAMERAS

Cameras gather visual information from the road and traffic control and send them to the controller for processing.



LIDAR

LiDAR sensors bounce lasers off of detected objects. LiDAR can detect road lines and assets and differentiate objects.



RADAR

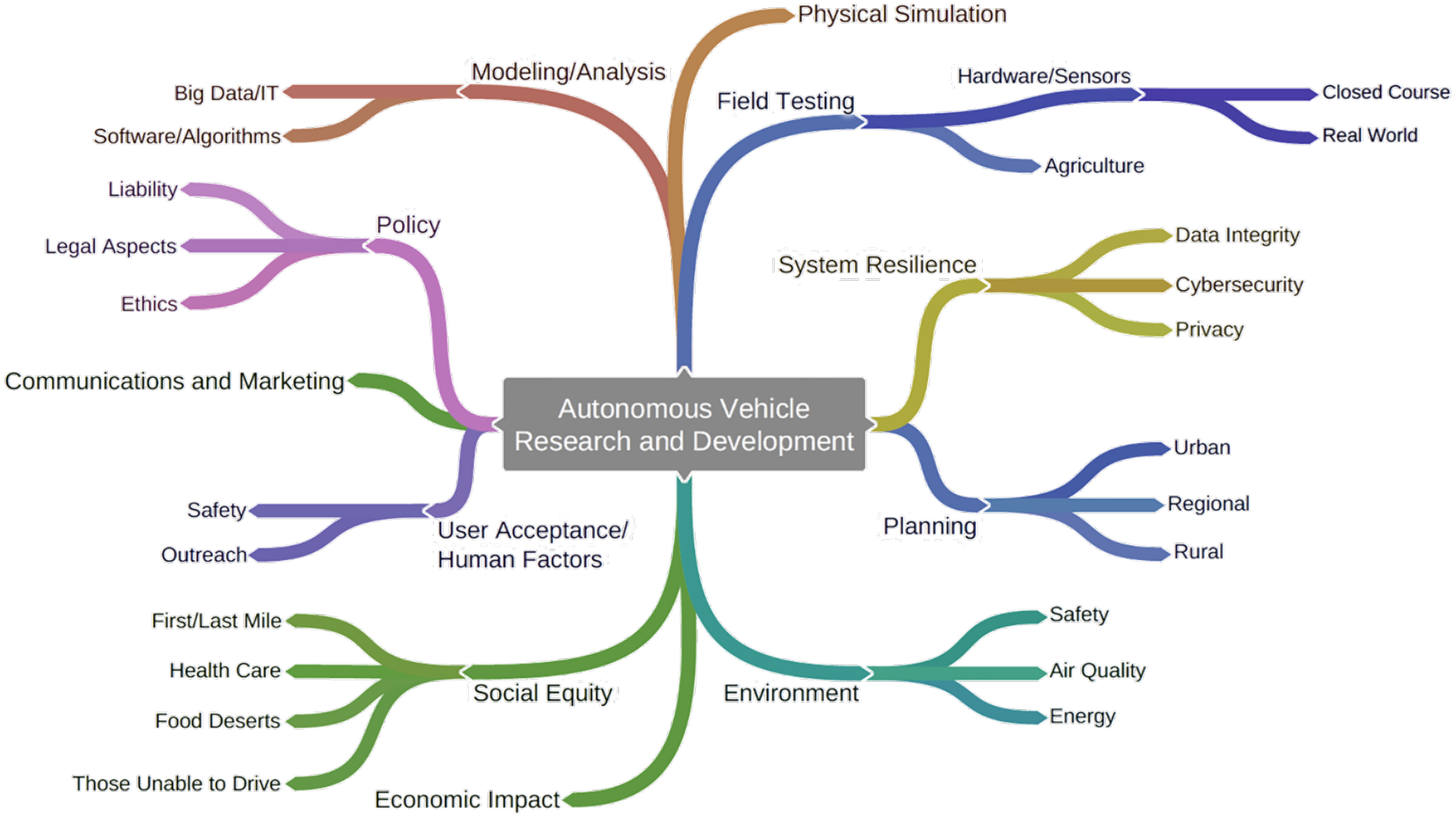
Radar sensors bounce radio waves off detected objects. Radar cannot differentiate objects.

GPS UNIT

The GPS unit identifies the precise position of the vehicle and aids in navigation.

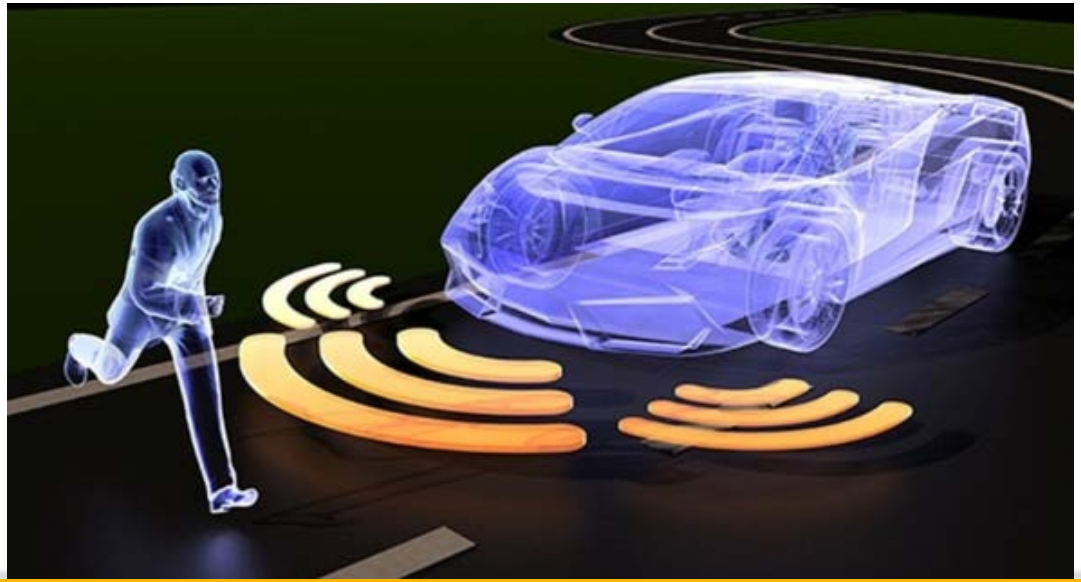
How They See…

Breadth, Complexity, Edge Cases



How Pedestrians Will Defeat Autonomous Vehicles

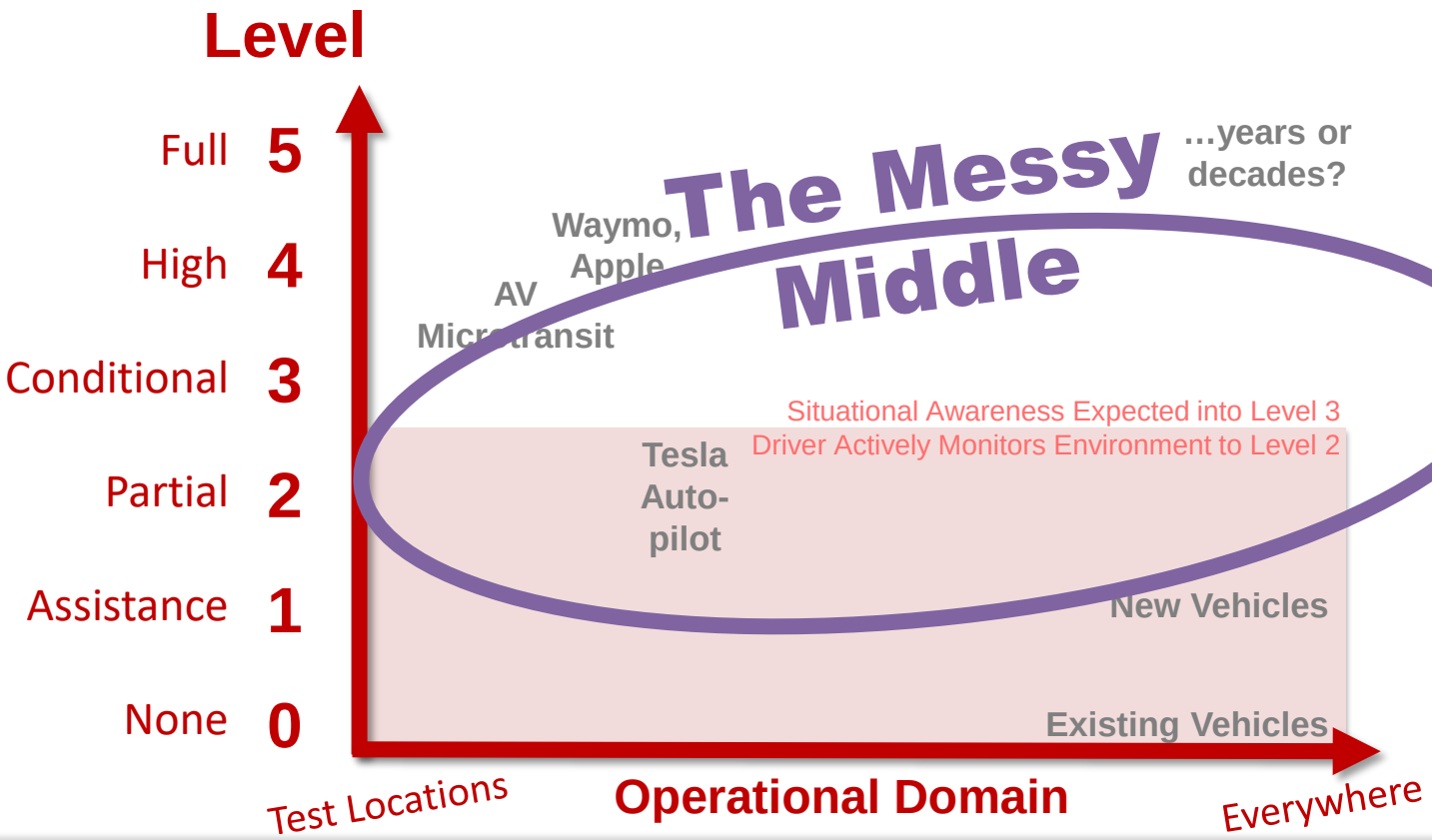
The ‘game of chicken’ which could be a serious problem for driverless cars



SAE Levels of Automation

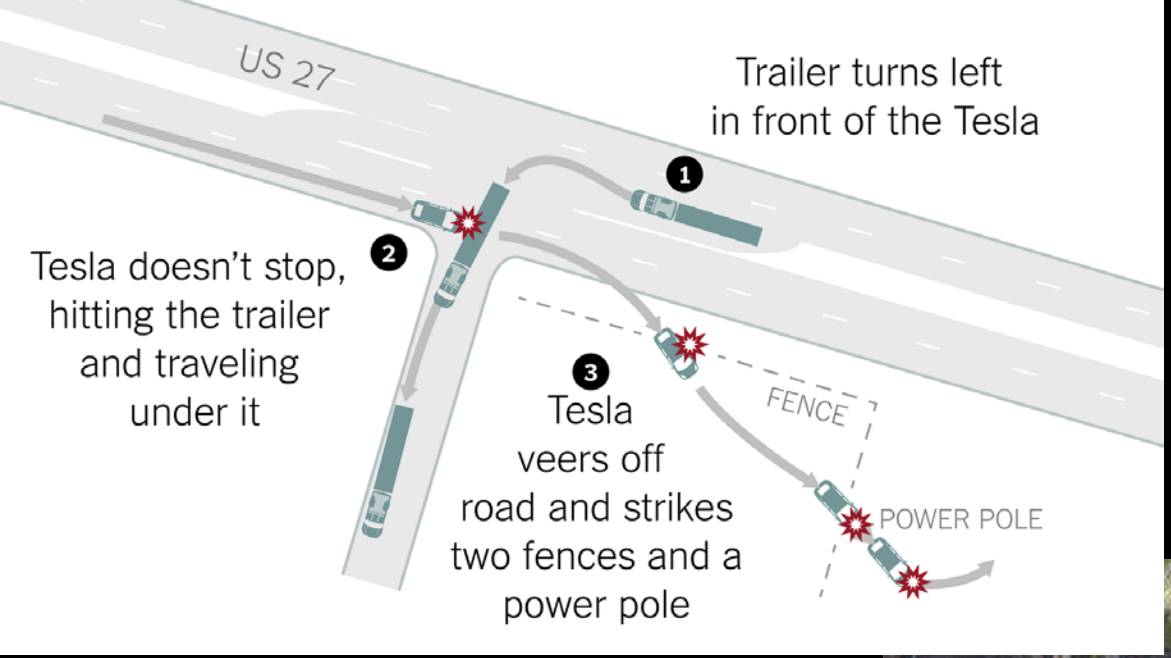
SAE level	Name	Narrative Definition	Execution of Steering and Acceleration/ Deceleration	*Monitoring* of Driving Environment	Fallback Performance of *Dynamic Driving Task*	System Capability *(Driving Modes)*
***Human driver* monitors the driving environment**						
0	**No Automation**	the full-time performance by the *human driver* of all aspects of the *dynamic driving task*, even when enhanced by warning or intervention systems	Human driver	Human driver	Human driver	n/a
1	**Driver Assistance**	the *driving mode*-specific execution by a driver assistance system of either steering or acceleration/deceleration using information about the driving environment and with the expectation that the *human driver* perform all remaining aspects of the *dynamic driving task*	Human driver and system	Human driver	Human driver	Some driving modes
2	**Partial Automation**	the *driving mode*-specific execution by one or more driver assistance systems of both steering and acceleration/ deceleration using information about the driving environment and with the expectation that the *human driver* perform all remaining aspects of the *dynamic driving task*	**System**	Human driver	Human driver	Some driving modes
***Automated driving system* ("system") monitors the driving environment**						
3	**Conditional Automation**	the *driving mode*-specific performance by an *automated driving system* of all aspects of the dynamic driving task with the expectation that the *human driver* will respond appropriately to a *request to intervene*	System	**System**	Human driver	Some driving modes
4	**High Automation**	the *driving mode*-specific performance by an automated driving system of all aspects of the *dynamic driving task*, even if a *human driver* does not respond appropriately to a *request to intervene*	System	System	**System**	Some driving modes
5	**Full Automation**	the full-time performance by an *automated driving system* of all aspects of the *dynamic driving task* under all roadway and environmental conditions that can be managed by a *human driver*	System	System	System	**All driving modes**

Levels Depend on Circumstances

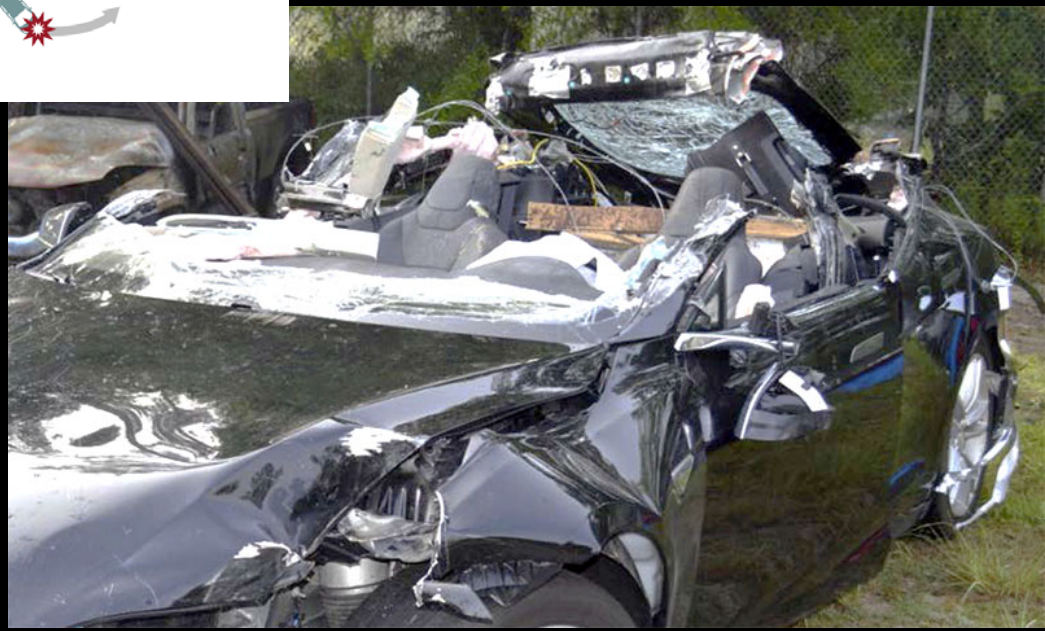


Critical implications for:

- Human operator expectations
- Where certain vehicles can safely operate



Tesla
Florida
May 2016



June 17, 2017

Destroyer Fitzgerald and ACX Crystal

Tesla, March 2017

Uber, March 2017

(An) AV Timeline

2015
- driver assistance common
- some partial automation available to consumers

2020
- limited / conditional AVs widely available to consumers

2025
- autonomous shared mobility fleets

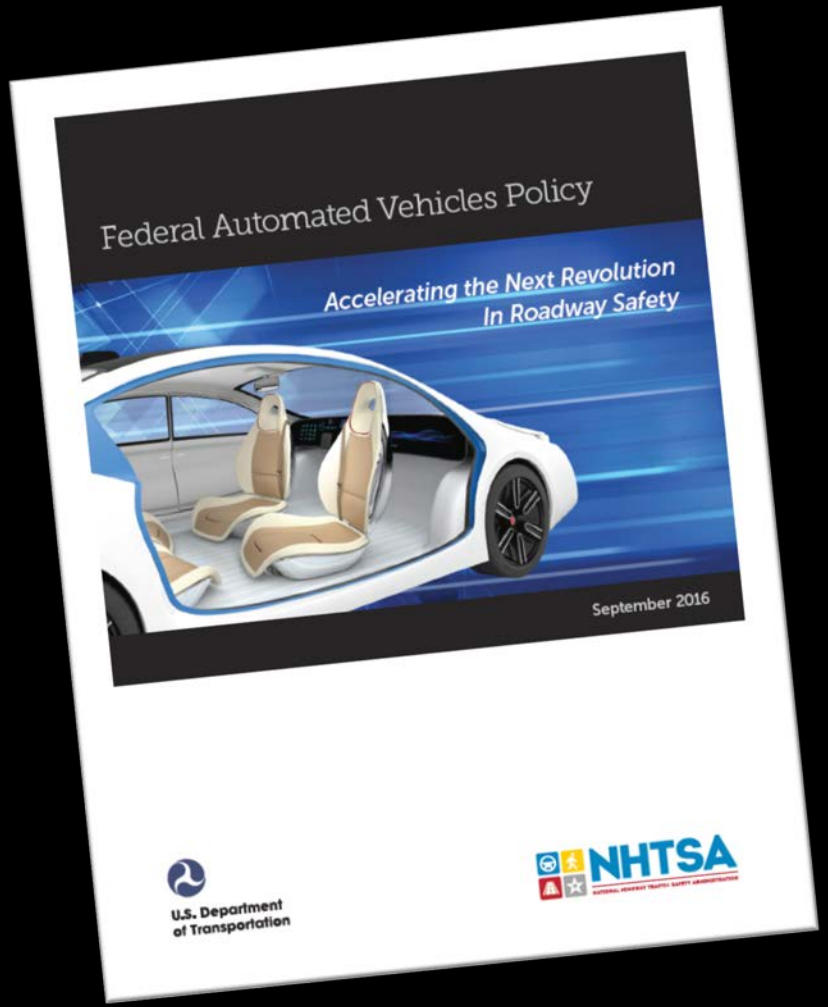
2030
- high automation required in all new vehicles

2035
- human operation is the exception in many places

2040
- transition to driverless largely complete
- fleet turnover continues…

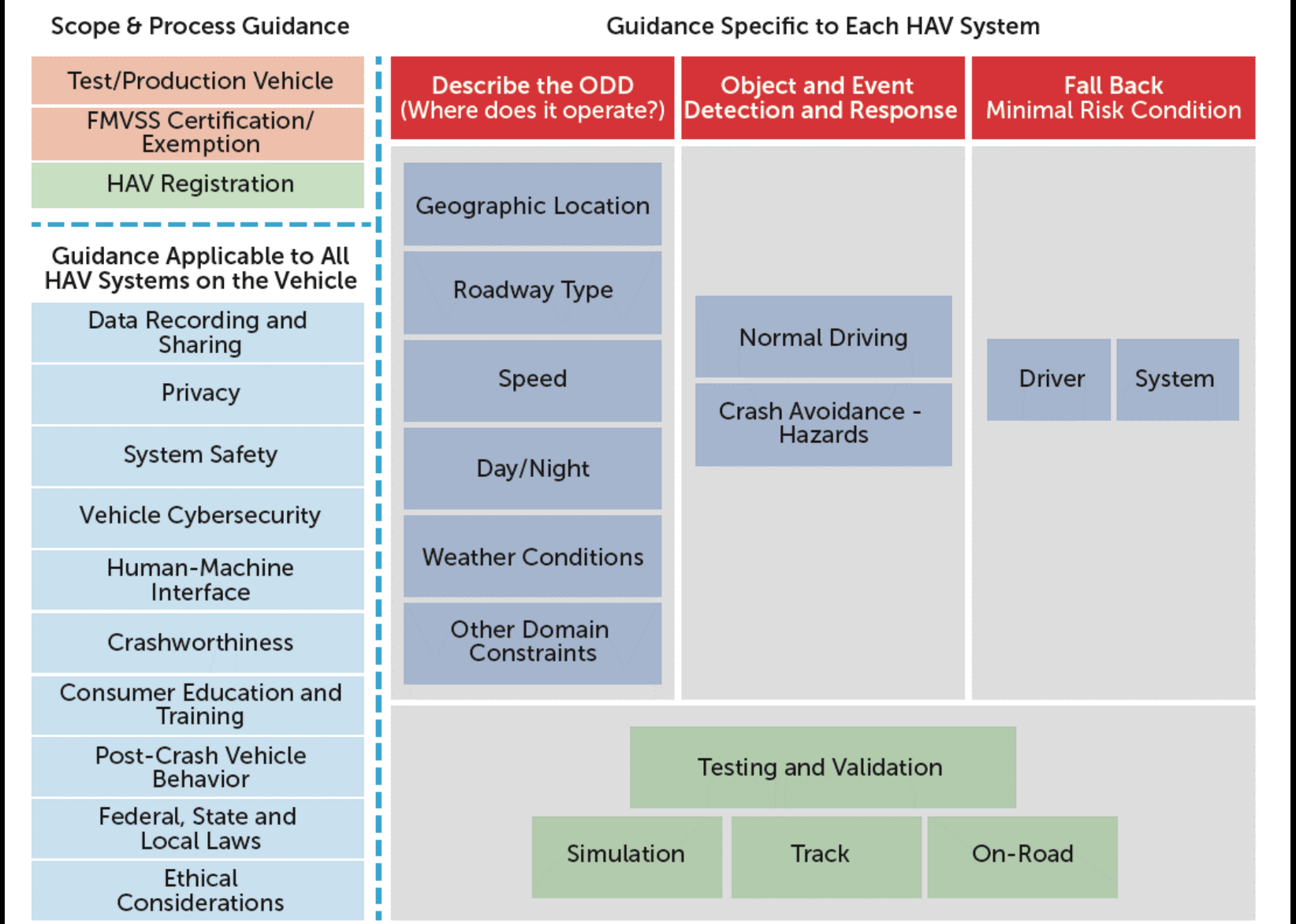
2100

- Any estimate is debatable
- We are only at the beginning of a long transition period



Federal AV Policy

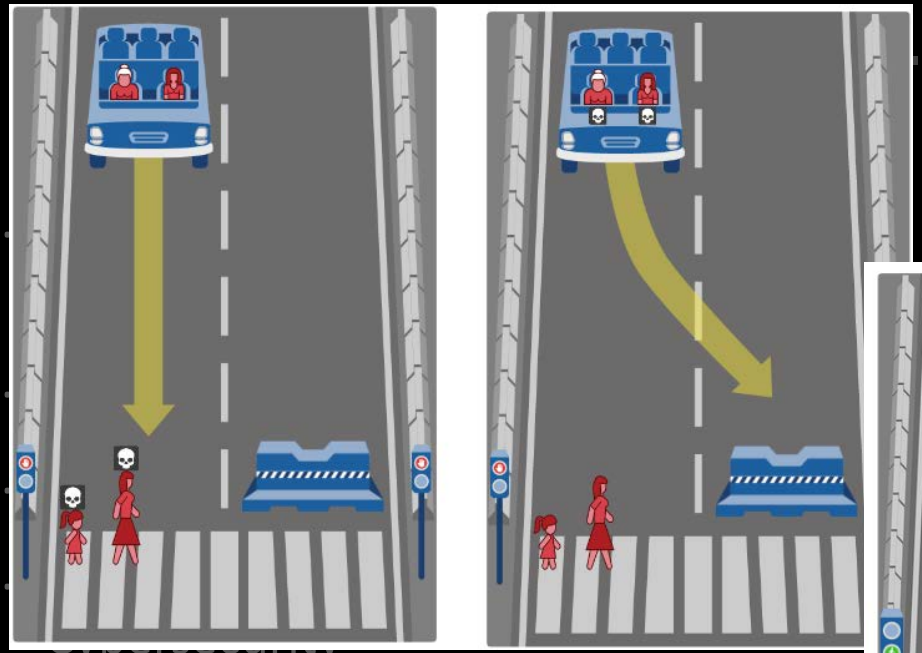
- Released September 20, 2016
- Guidelines, not regulations
- Proposes a 15-point safety assessment
- Model State Policy


Scope & Process Guidance
Guidance Specific to Each HAV System
Test/Production Vehicle
FMVSS Certification/ Exemption
HAV Registration
Guidance Applicable to All HAV Systems on the Vehicle
Data Recording and Sharing
Privacy
System Safety
Vehicle Cybersecurity
Human-Machine Interface
Crashworthiness
Consumer Education and Training
Post-Crash Vehicle Behavior
Federal, State and Local Laws
Ethical Considerations
Describe the ODD (Where does it operate?)
Object and Event Detection and Response
Fall Back Minimal Risk Condition
Geographic Location
Roadway Type
Speed
Day/Night
Weather Conditions
Other Domain Constraints
Normal Driving
Crash Avoidance - Hazards
Driver
System
Testing and Validation
Simulation
Track
On-Road

NHTSA's 15-Points

1. Data Recording and Sharing
2. Privacy
3. System Safety
4. Vehicle Cybersecurity
5. Human Machine Interface
6. Crashworthiness
7. Consumer Education and Training
8. Registration and Certification
9. Post-Crash Behavior
10. Federal, State and Local Laws
11. Ethical Considerations
12. Operational Design Domain
13. Object and Event Detection and Response
14. Fall Back (Minimal Risk Condition)
15. Validation Methods

-Points



1.

2.

3.

4.

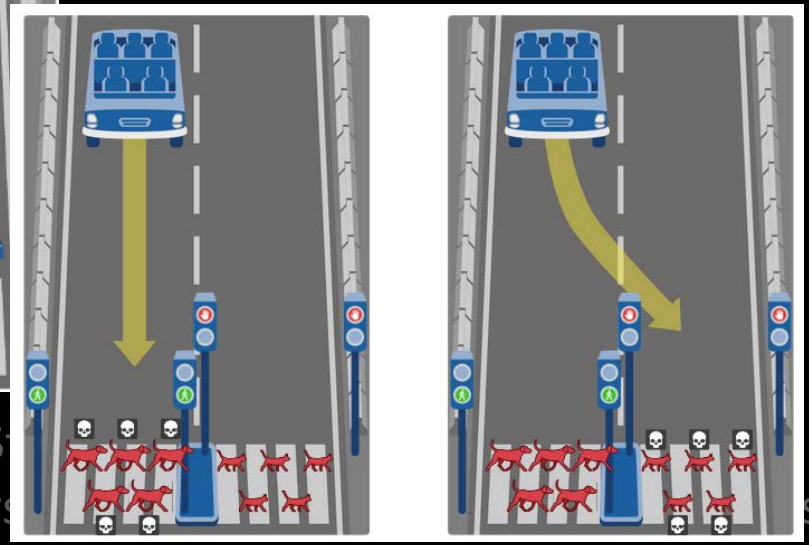
5. Human Machine Interface

6. Crashworthiness

10. Federal, St
Local Laws

11. Ethical Considerations

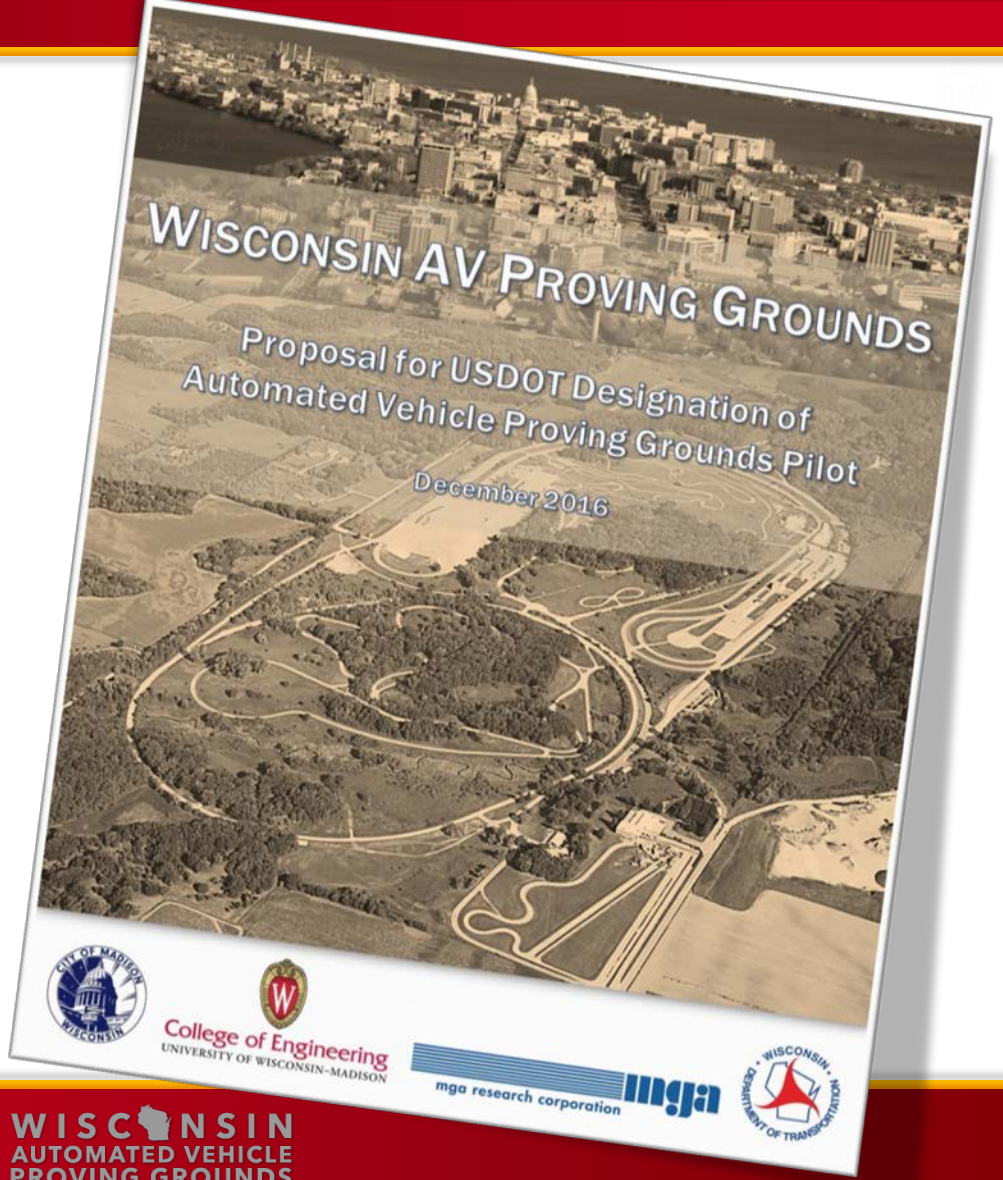
12. Operational Design



moralmachine.mit.edu

USDOT Solicitation

- December 2016
- Peer network
- No funding



Ten Designated AV Proving Grounds

Wisconsin Facilities

MGA Research Facility - Burlington, WI

Early Stage | Closed Track | Low Speed
Safety | Durability | Transit

Road America - Elkhart Lake, WI

Early Stage | Closed Track | High Speed
Mobility | Long Distance | Freight

UW-Madison / Epic Campus

Mid-Stage | Limited-Use Facility | Low Speed
Safety | Durability | Transit

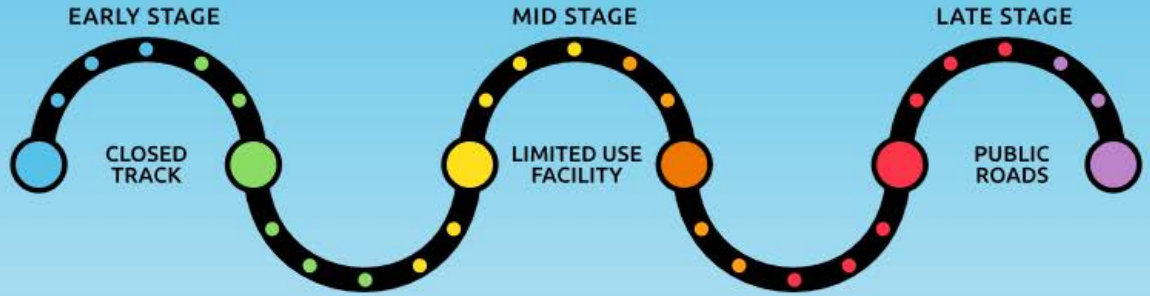
City of Madison

Mid/Late-Stage | Public Roads | Low Speed
Safety | Mobility | Durability | Transit

Wisconsin DOT (W-Highway)

Late-Stage | Public Roads | High Speed
Mobility | Long Distance | Freight

GLTEI



MANDLI COMMUNICATIONS
FITCHBURG, WI

MGA RESEARCH
BURLINGTON, WI

ROAD AMERICA
ELKHART LAKE, WI

UW – MADISON
MADISON, WI

EPIC
VERONA, WI

CITY OF MADISON
MADISON, WI

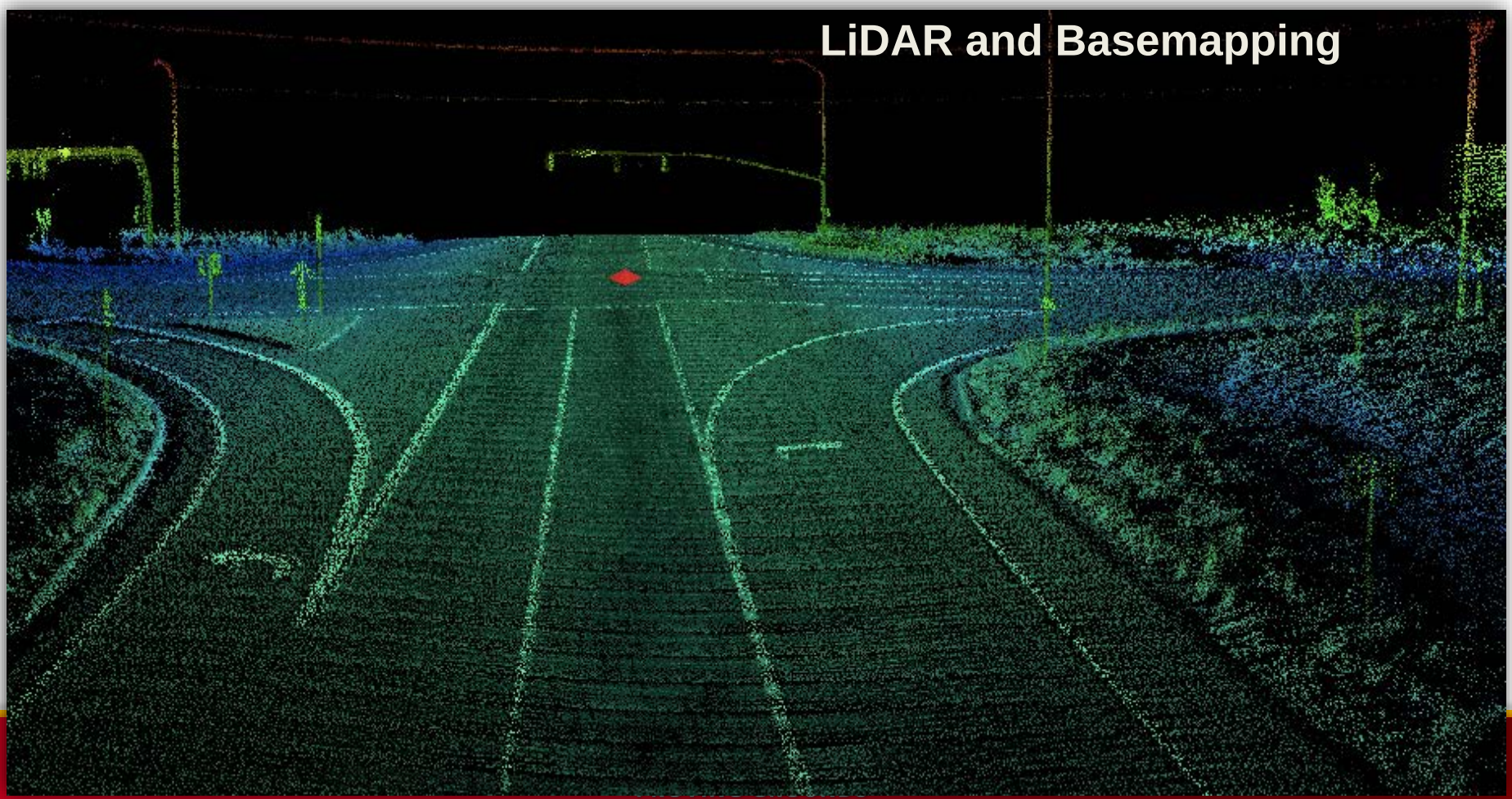
GTiMA

ROADVIEW

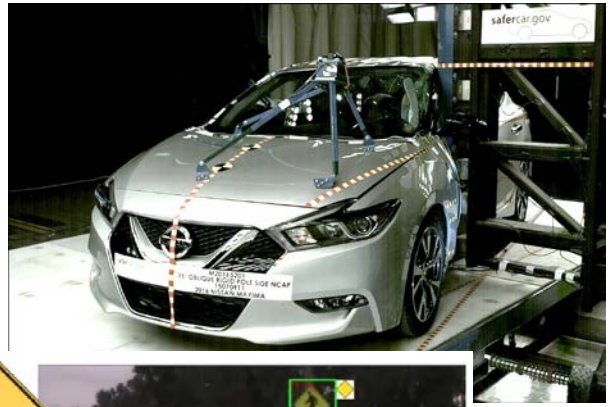
Transportation Services
University of Wisconsin–Madison

Wisconsin Facilities

Mandli / Roadview



Wisconsin Facilities



MGA Research, Burlington

400 acres, private and secure, numerous testing capabilities

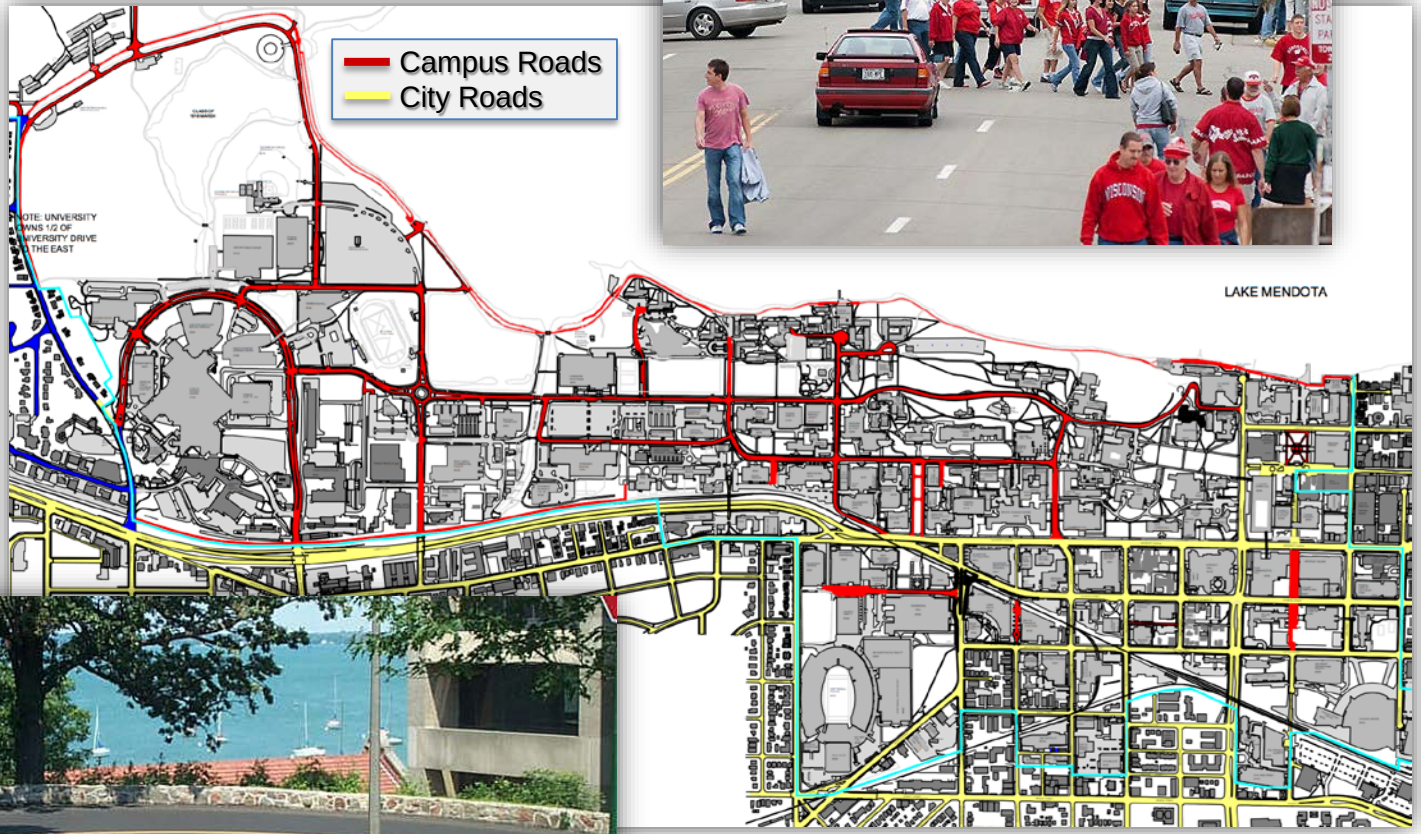
Wisconsin Facilities

Road America, Elkhart Lake

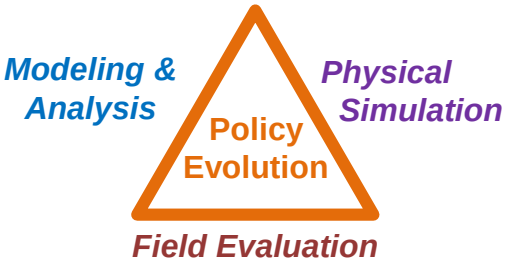
- Road track: 4.05-mile length, 30-foot width
- 1-mile combo paved-dirt track
- 12+ miles off-road
- 10+ miles access roads
- Major race events and media presence

Wisconsin Facilities

UW-Madison Campus and City of Madison



Focus Areas



Data and sensing—including LIDAR, GPS, cameras, communications, and other sensors.

Vehicle operations—including speed, acceleration and deceleration, performance on grades and curves, and electric vehicle range and charging time.

Inclement weather operations—including snow, ice, fog, and high winds.

Human-machine interfaces—such as sensors, communications, and responses.

Interaction with surroundings—including pedestrians, bicycles, mopeds, cars, and traffic control devices.

User acceptance—Passenger comfort, public perception, safety, and ethics.

System resilience—Advancing standards, safety protocols, and security.

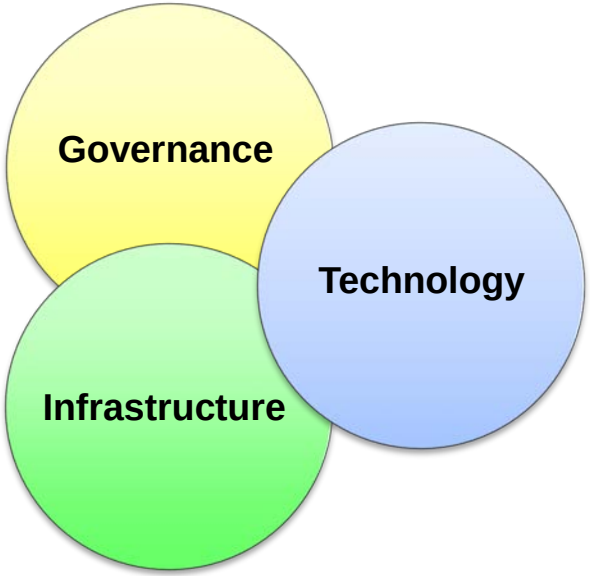
Shared mobility—Automated vehicle microtransit developments, enhancements, and testing.

Committee on Automated and Connected Vehicles

"the removal of barriers to the testing and deployment of automated and connected vehicle technology in Wisconsin"

- May 2017 EO #245
- Sept 2017 Kickoff
- June 2018 Report Due
- Members:
  - Government: WisDOT, WSP, WEDC, Assembly, Senate, Iowa Co Sheriff, Insurance Commissioner
  - Academic/Nonprofit: UW-Madison, Tech Council
  - Industry: MGA, Roadview, Waymo, Uber, Tesla, AAM, Global Automakers, Dealers Assn, Harley, Schneider, HNTB

AVPG Program Areas

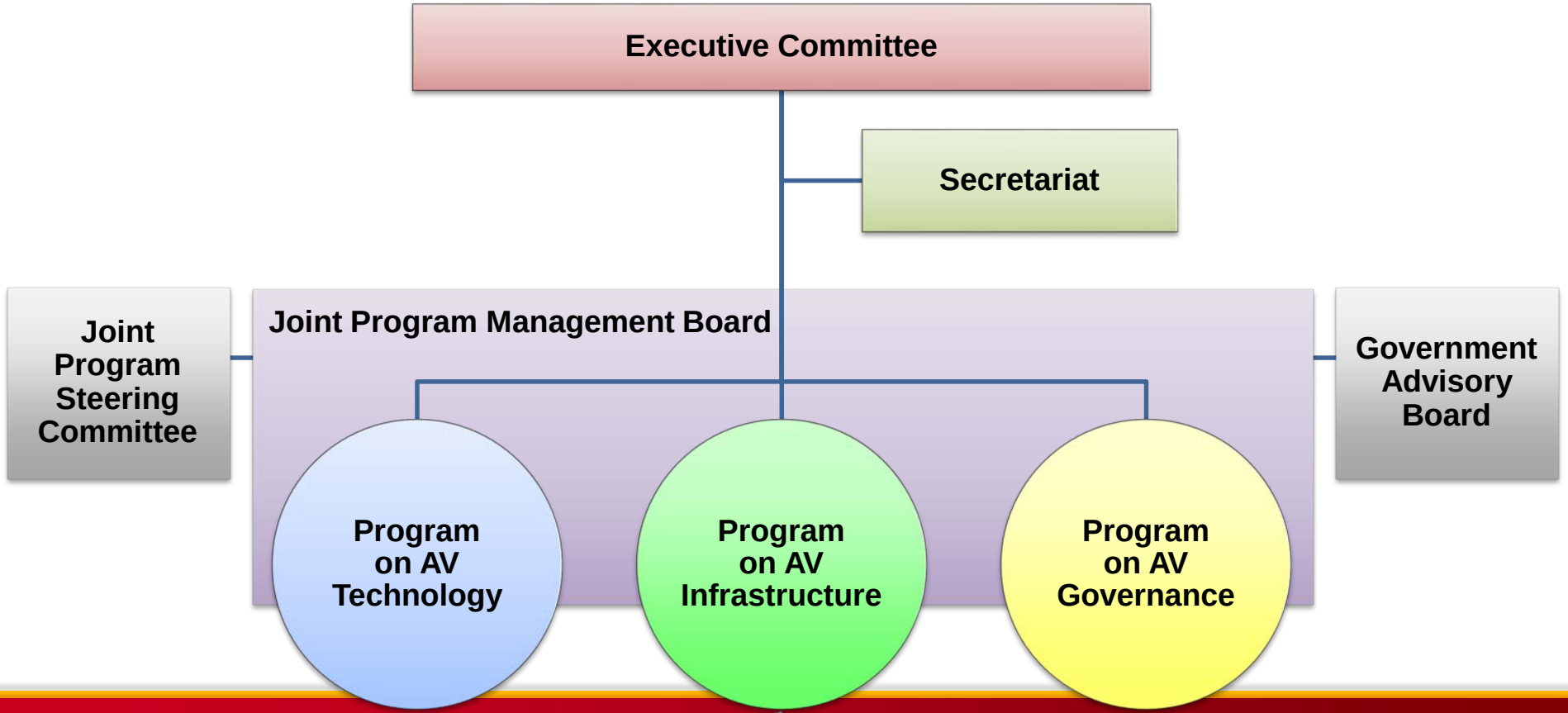


Technology: test environments, vehicles, sensors, hardware, software

Infrastructure: connected data, basemapping, exchange protocols, interactions

Governance: policy, regulations, standards, acceptance, certification

AVPG Management Structure



Thank You

Stay Engaged

Visit: **WiscAV.org**

Email: **Feedback@WiscAV.org**

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College of Engineering
UNIVERSITY OF WISCONSIN–MADISON