WisDOT Law Enforcement and First Responder Connected and Automated Vehicle (CAV) training

for

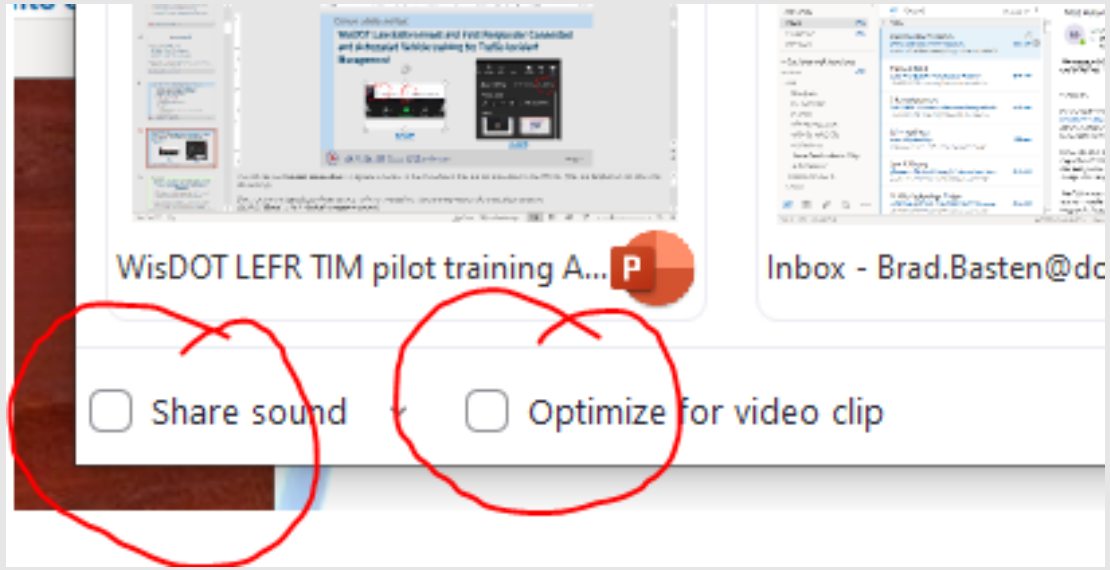
Traffic Incident Management (TIM)

Released December 2022

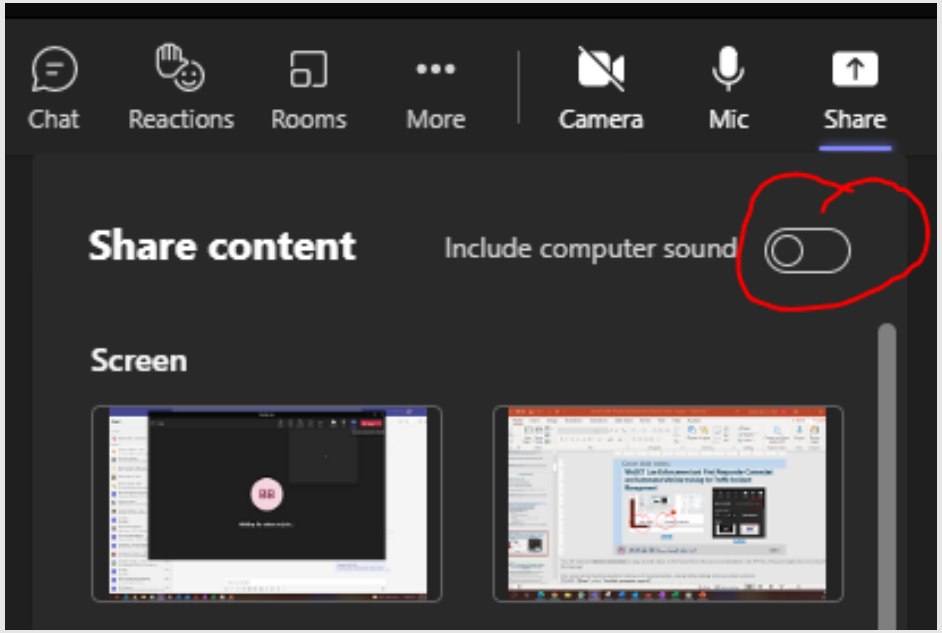
(WisDOT website preview version. Contact WisDOT for information about access to the full TIM training package)

Cover slide notes: TIM training module starts on next slide

Sound settings for videos and screen sharing



ZOOM



TEAMS

Introduction

Outline of training module	Slides
Introduction	3-6
General CAV Technology and Education	7-21
State Statutes	22-25
Scenarios – How to Manage a CAV • Law enforcement scenarios and laws for CAVs, including Rules of the Road • Crash scene First Responder information and scenarios for Law Enforcement, Fire and Emergency Medical Services (EMS), and Towing	26-35 36-43
Vehicle identification	45
Technologies on the road today	46-53
Racine Badger AV transit vehicle demonstration	54-56
State activities	57-58

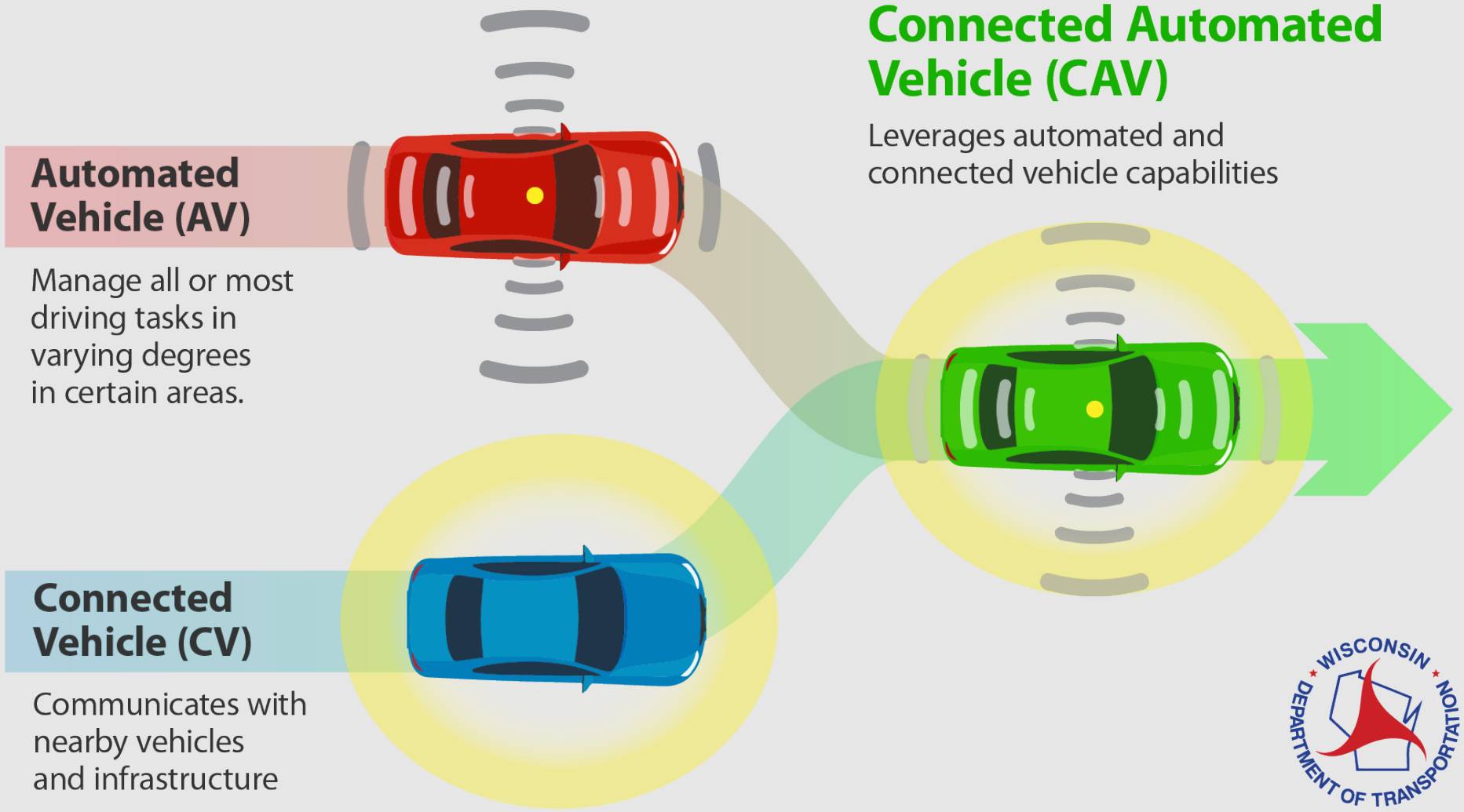
WisDOT Law Enforcement and First Responder Connected and Automated Vehicle training for Traffic Incident Management (TIM)

- WisDOT partners are committed to coordinating and preparing law enforcement and first responders for the safe introduction of CAVs
- Emerging technologies can enhance safety with necessary transportation improvements and proper management of operations
- Contact information is included at the end of the course for questions or comments

Training topics

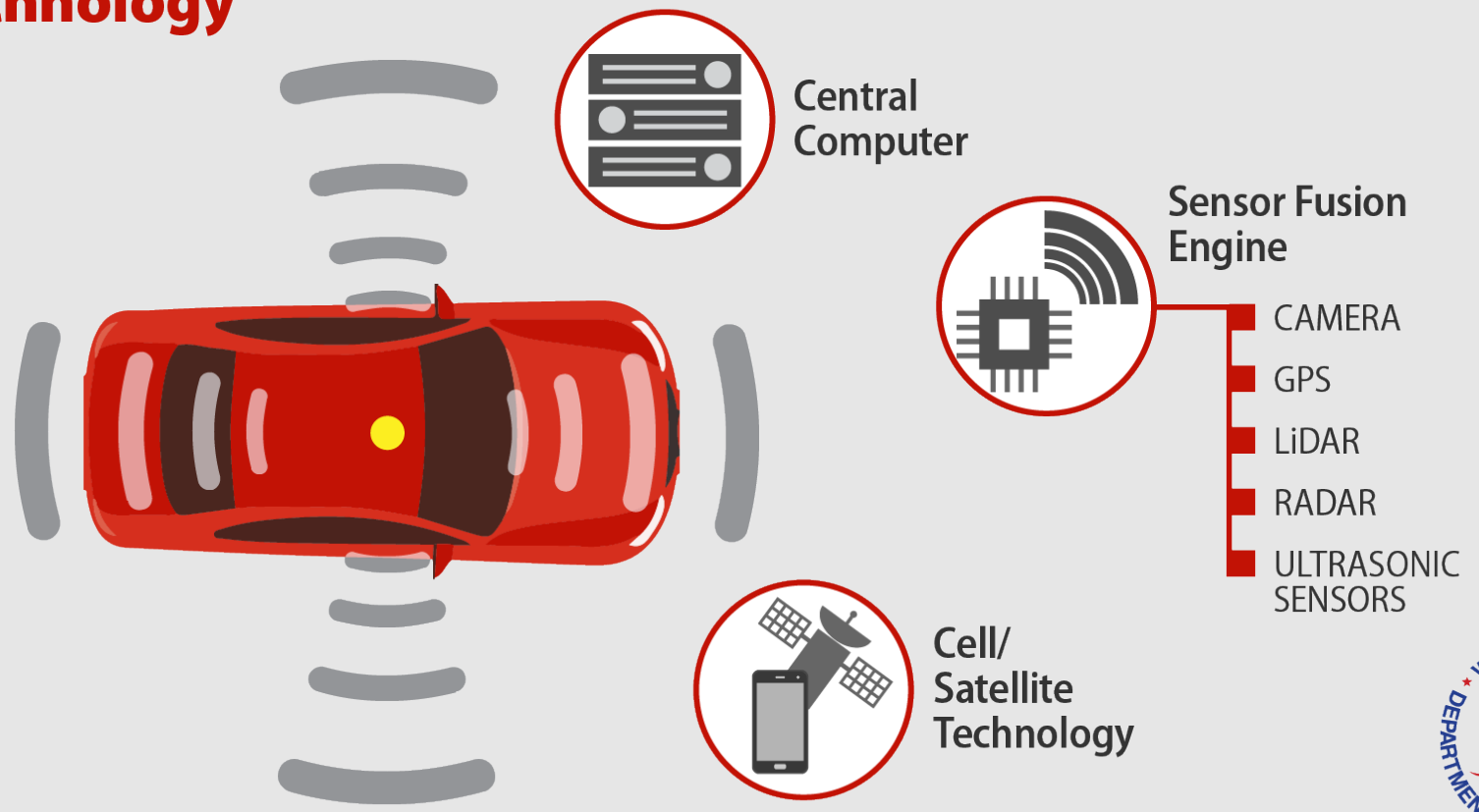
- What is connected and automated vehicle (CAV) technology?
- Why is CAV important for safe roads?
- Which CAV technologies are on Wisconsin roads right now?
- What is the legal status of this technology in Wisconsin?
- What is the future of this technology?
- Who can I contact if I have additional questions?
- Are there additional resources I can read or watch?

General CAV info



General CAV info

Automated Vehicle (AV) Technology

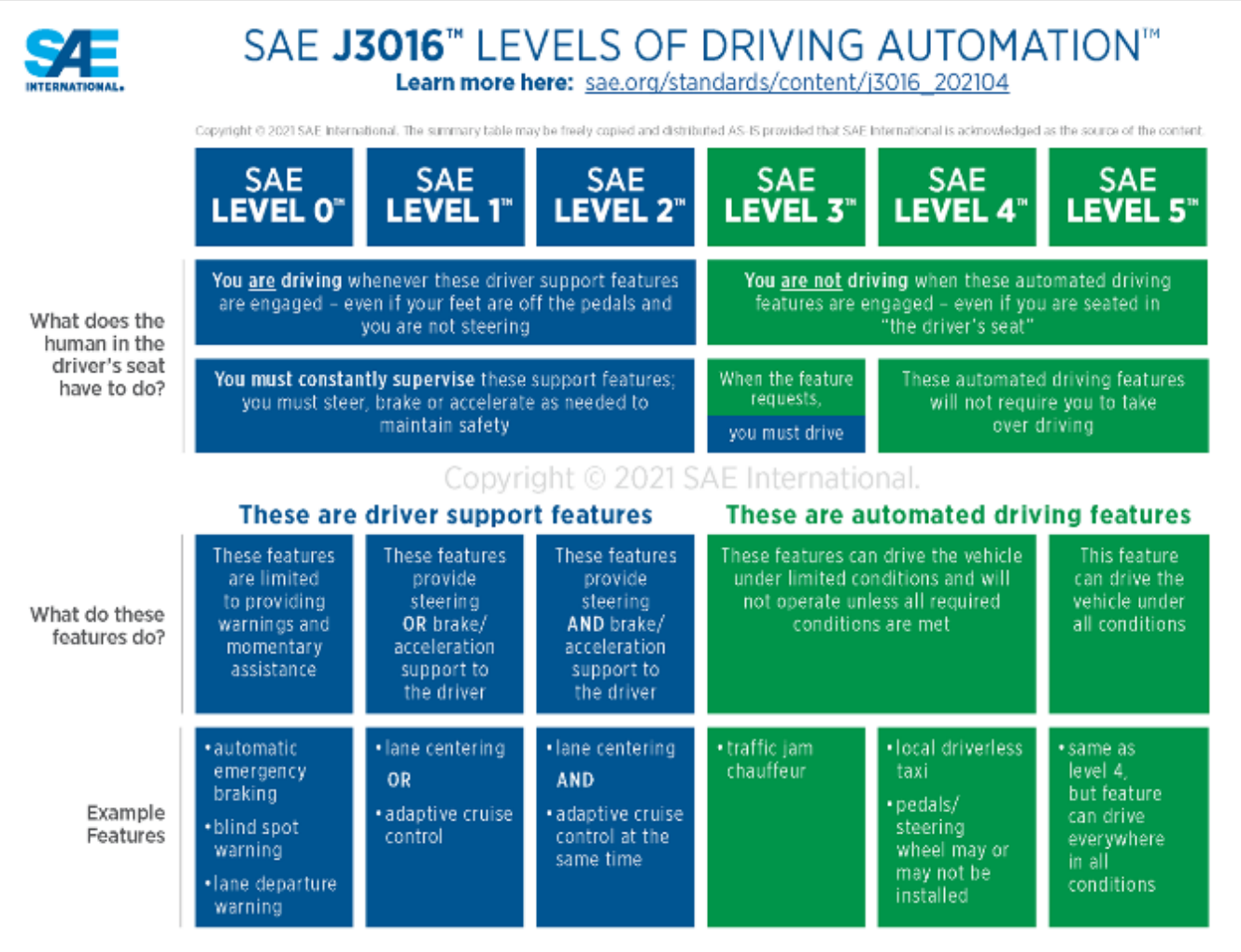


Automated technology

- Automated technology can perform some or all of the driving tasks to varying degrees.
- Helps drivers avoid drifting into adjacent lanes, make unsafe lane changes or can warn of pedestrians or cars when backing up.

General CAV info

Automated Vehicle Technology (AV)

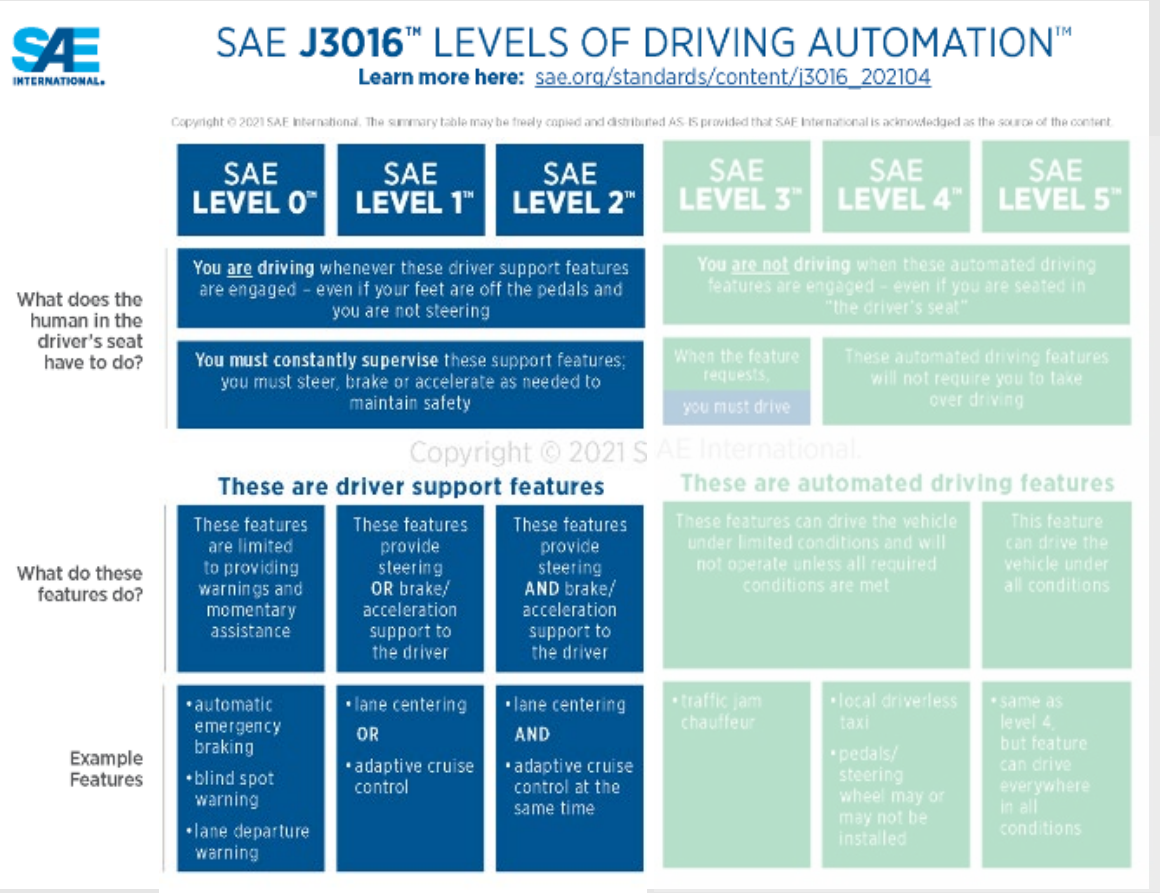


Automated technology

- can perform some or all of the driving tasks to varying degrees.

- helps drivers avoid drifting into adjacent lanes, make unsafe lane changes or can warn of pedestrians or cars when backing up.

Automated Vehicle Technology (AV) – with a driver



SAE J3016™ LEVELS OF DRIVING AUTOMATION™

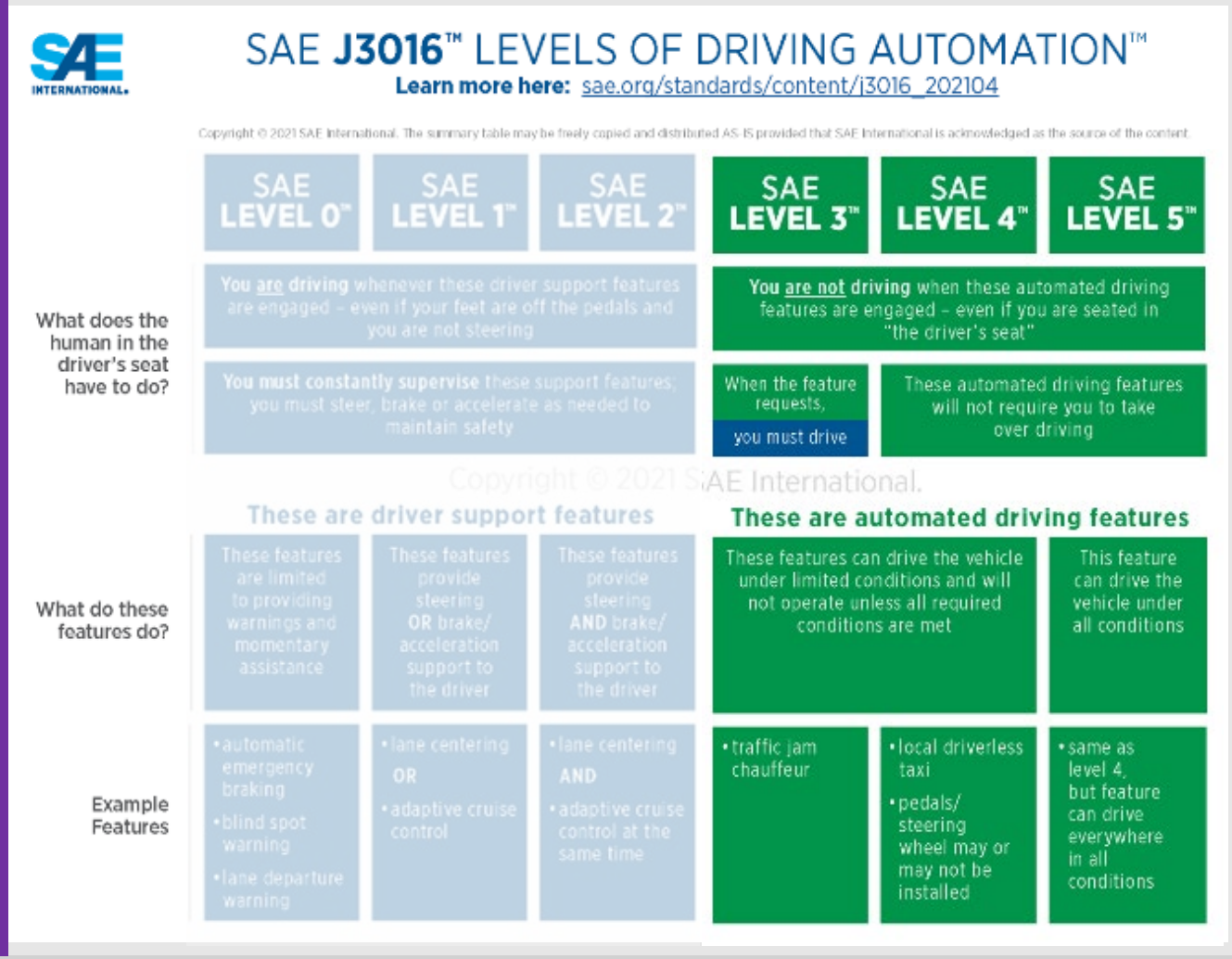
Learn more here: sae.org/standards/content/j3016_202104

	SAE LEVEL 0™	SAE LEVEL 1™	SAE LEVEL 2™	SAE LEVEL 3™	SAE LEVEL 4™	SAE LEVEL 5™
What does the human in the driver's seat have to do?	You are driving whenever these driver support features are engaged – even if your feet are off the pedals and you are not steering			You are not driving when these automated driving features are engaged – even if you are seated in "the driver's seat"		
	You must constantly supervise these support features; you must steer, brake or accelerate as needed to maintain safety			When the feature requests, you must drive	These automated driving features will not require you to take over driving	
	These are driver support features			These are automated driving features		
What do these features do?	These features are limited to providing warnings and momentary assistance	These features provide steering OR brake/ acceleration support to the driver	These features provide steering AND brake/ acceleration support to the driver	These features can drive the vehicle under limited conditions and will not operate unless all required conditions are met	This feature can drive the vehicle under all conditions	
Example Features	• automatic emergency braking • blind spot warning • lane departure warning	• lane centering OR • adaptive cruise control	• lane centering AND • adaptive cruise control at the same time	• traffic jam chauffeur	• local driverless taxi • pedals/ steering wheel may or may not be installed	• same as level 4, but feature can drive everywhere in all conditions

- Vehicles with *level 0* automation include a ***warning*** system such as blind spot **warning** or lane departure **warning**.
- At *level 1* automation, vehicles include at least **one** driver support system such as steering assistance **or** braking and acceleration assistance.
- Vehicles with *level 2* automation **synchronize** the functionality of steering, braking and acceleration, lane centering and adaptive cruise control.
- **You** are driving.

General CAV info

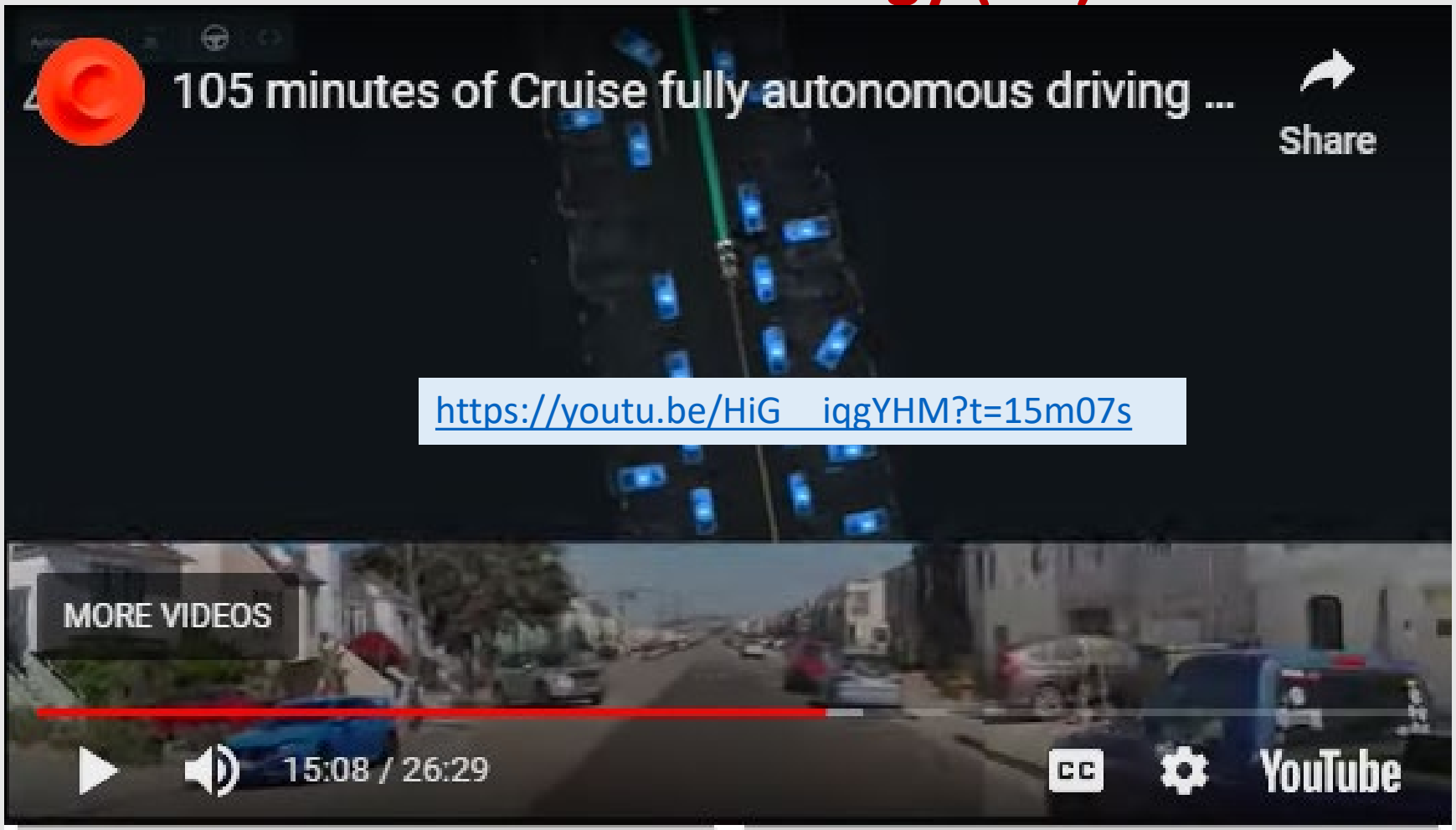
Automated Vehicle Technology (AV) – with a driver, without a driver



- At *level 3* the automated features can drive the vehicle however, it requires a person in the driver's seat ready to take over driving if necessary.
- *Level 4* vehicles can drive themselves within certain geographic, weather or conditional limits. Sometimes referred to as driverless or self-driving vehicles.
- *Level 5* vehicles can drive themselves without any limitations.

General CAV info

Automated Vehicle Technology (AV) – demonstration

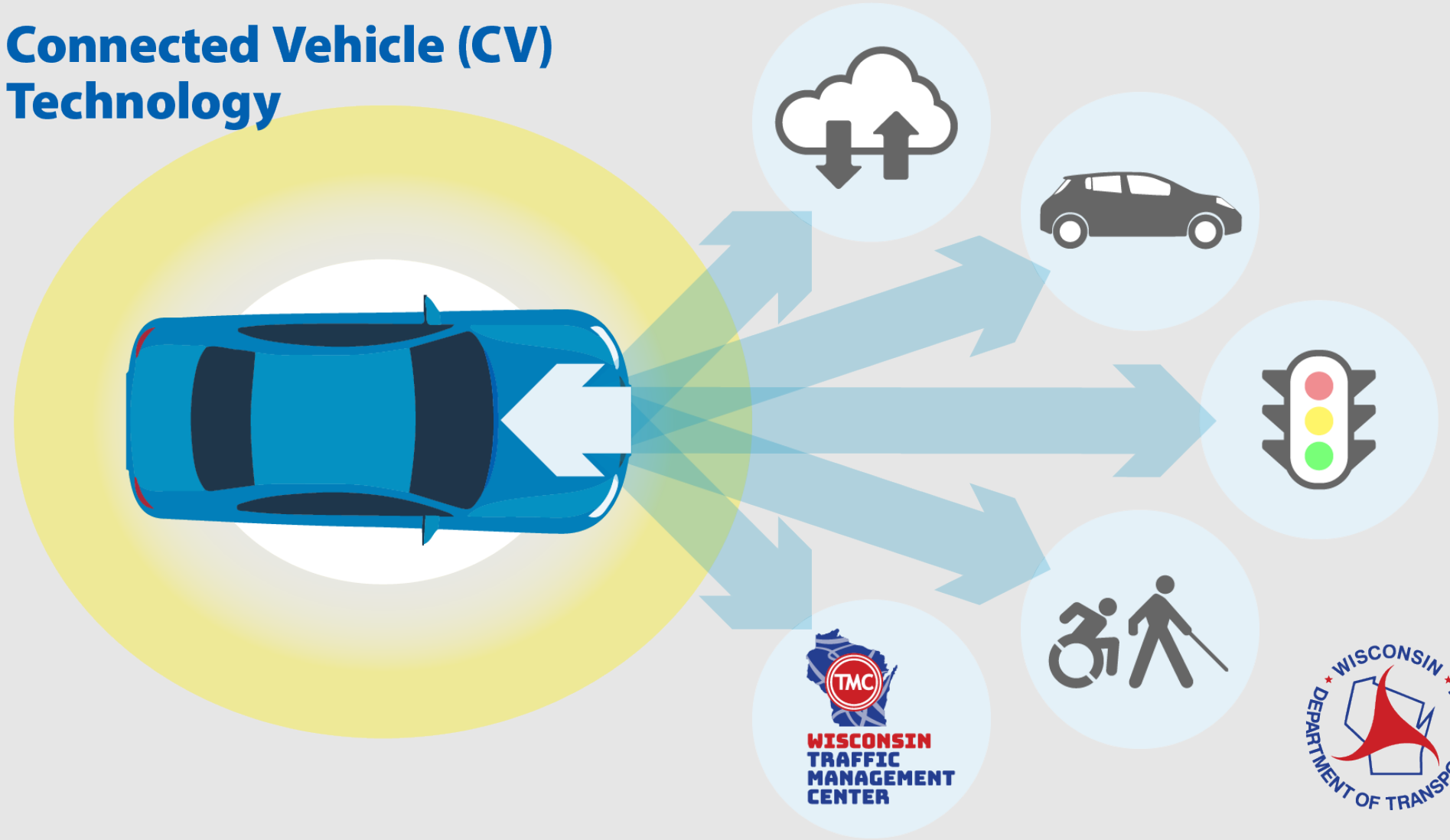


Video of Cruise fully autonomous vehicle driving in San Francisco

- Sensors have 360-degree view around vehicle
- Vehicle anticipates the movements of vehicles, pedestrians, bicycles and other obstacles, and adjusts course based on this data.

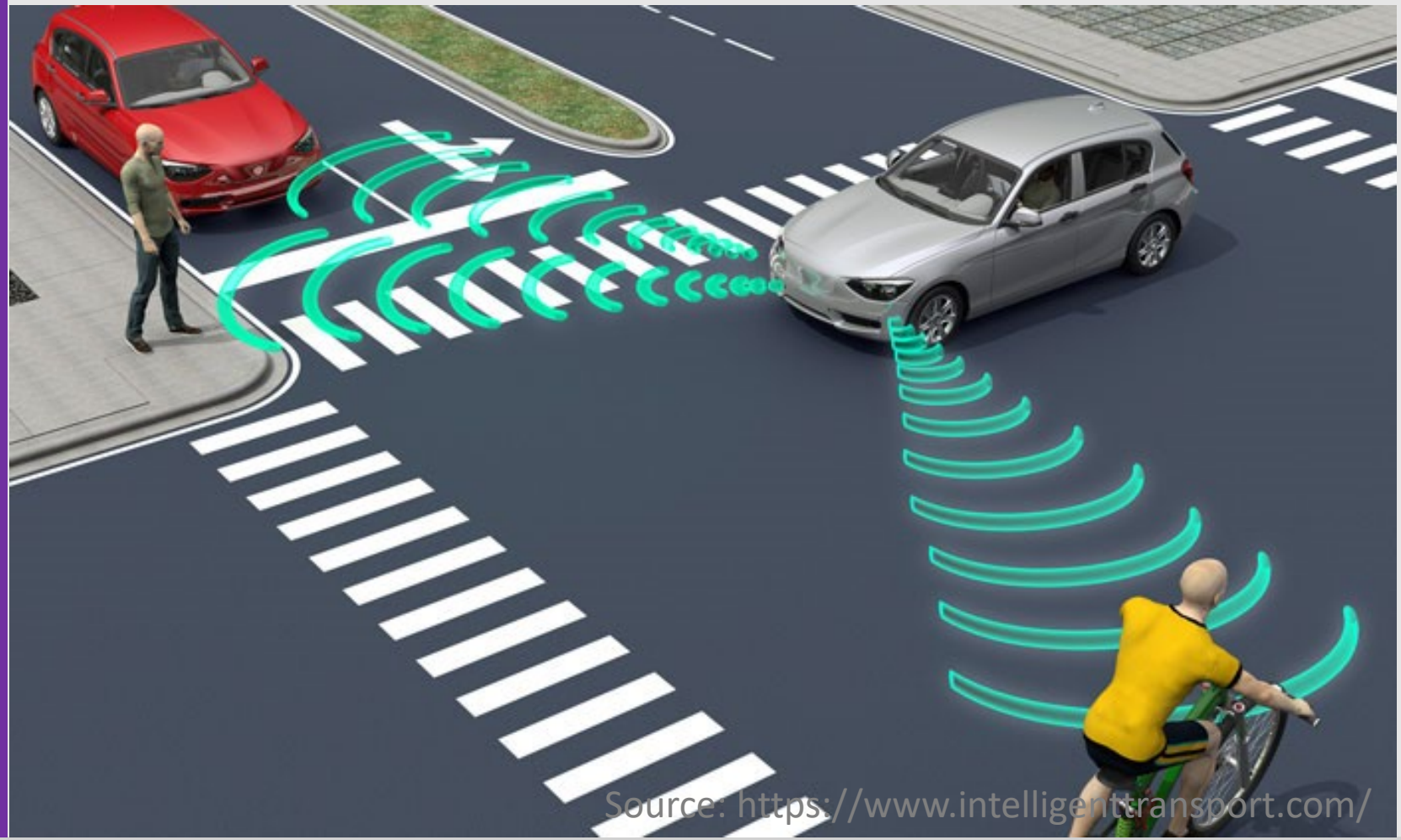
Source: https://www.youtube.com/user/Cruise/

General CAV info



General CAV info

Connected Vehicle (CV) Technology

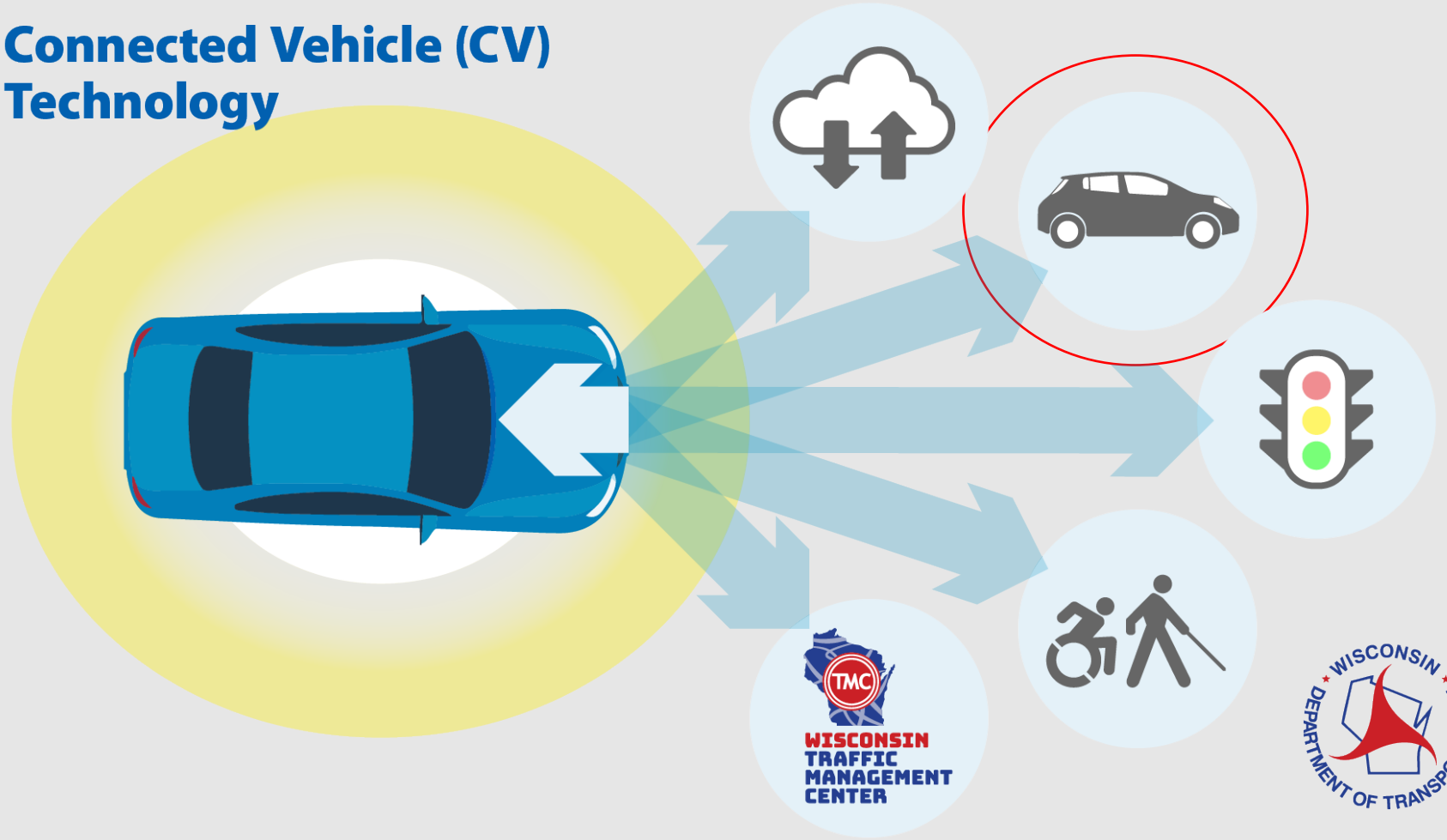


Connected vehicles will be able to communicate with, for example;

- other vehicles,
- pedestrians,
- bicyclists and
- intelligent traffic signals
- cloud services

General CAV info

Connected Vehicle (CV) Technology

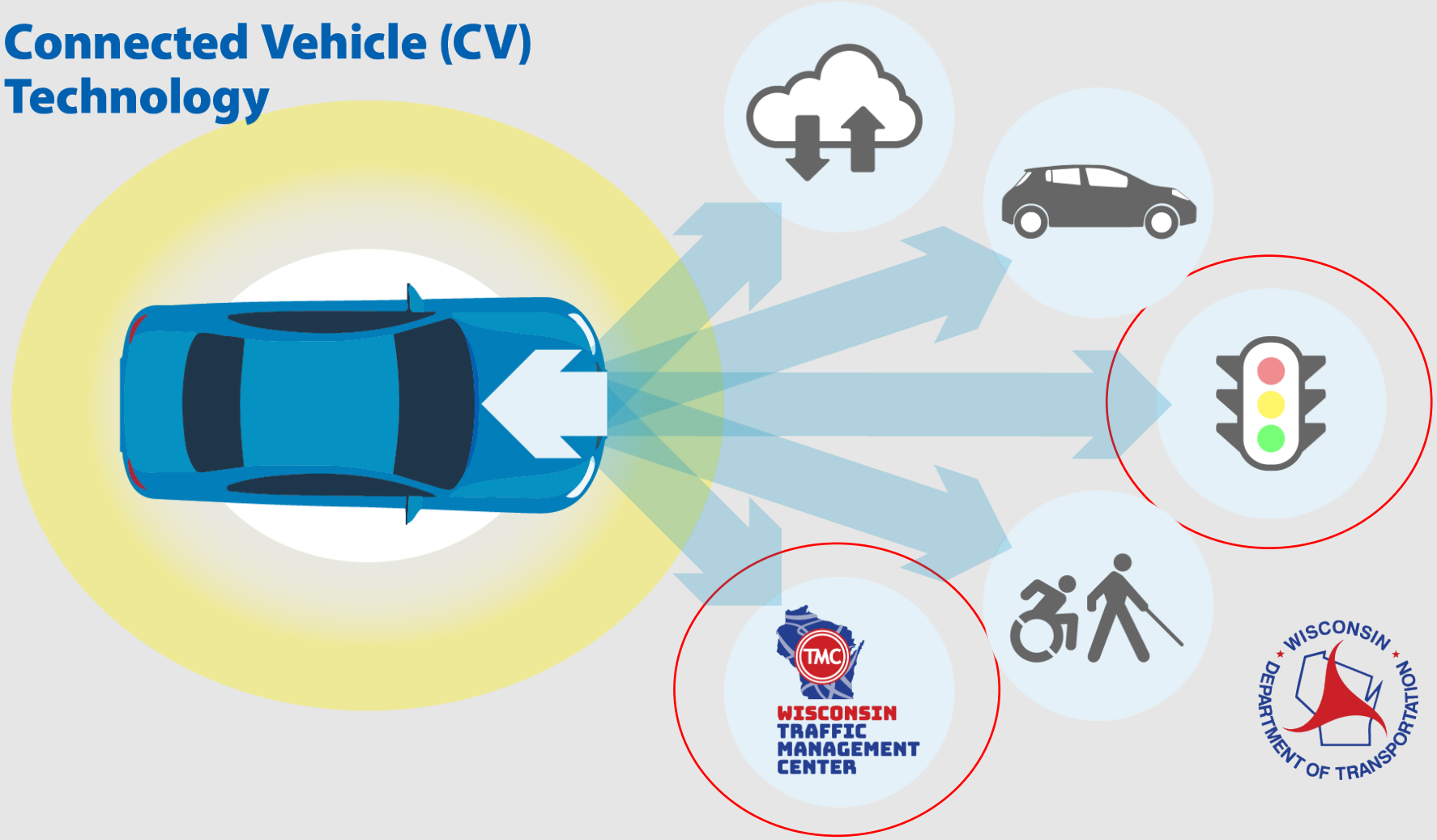


Vehicle to Vehicle (V2V)

- Allows vehicles to communicate with each other using radio or cellular communication.
- Vehicles can exchange critical information such as slippery pavement, emergency vehicle approaching, or emergency braking activation.

General CAV info

Connected Vehicle (CV) Technology

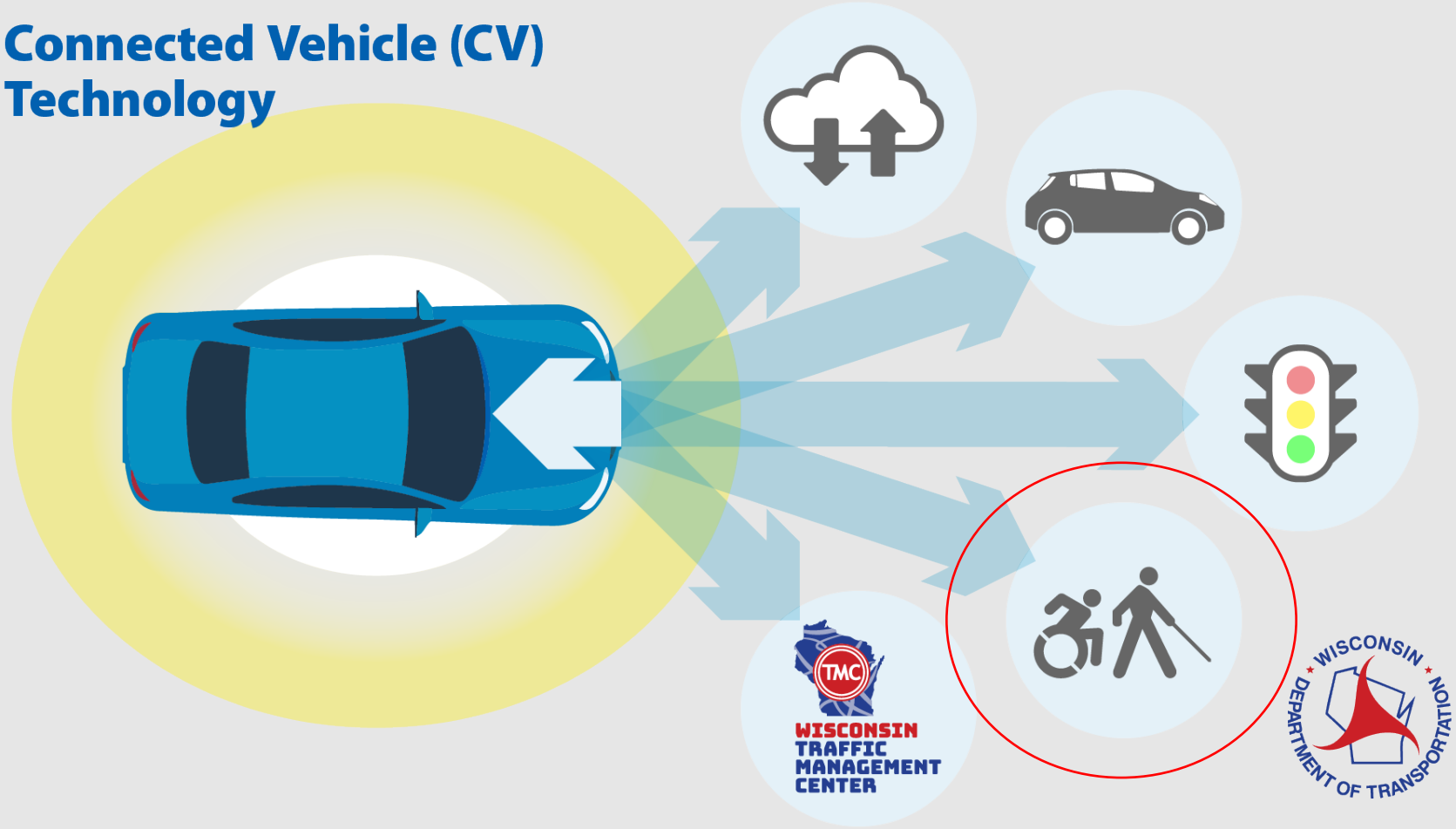


Vehicle to Infrastructure (V2I)

- Allows a vehicle to communicate with the system about what's going on in traffic and get messages about road conditions.
- Alerts vehicles to congestion, crashes or detours.

General CAV info

Connected Vehicle (CV) Technology

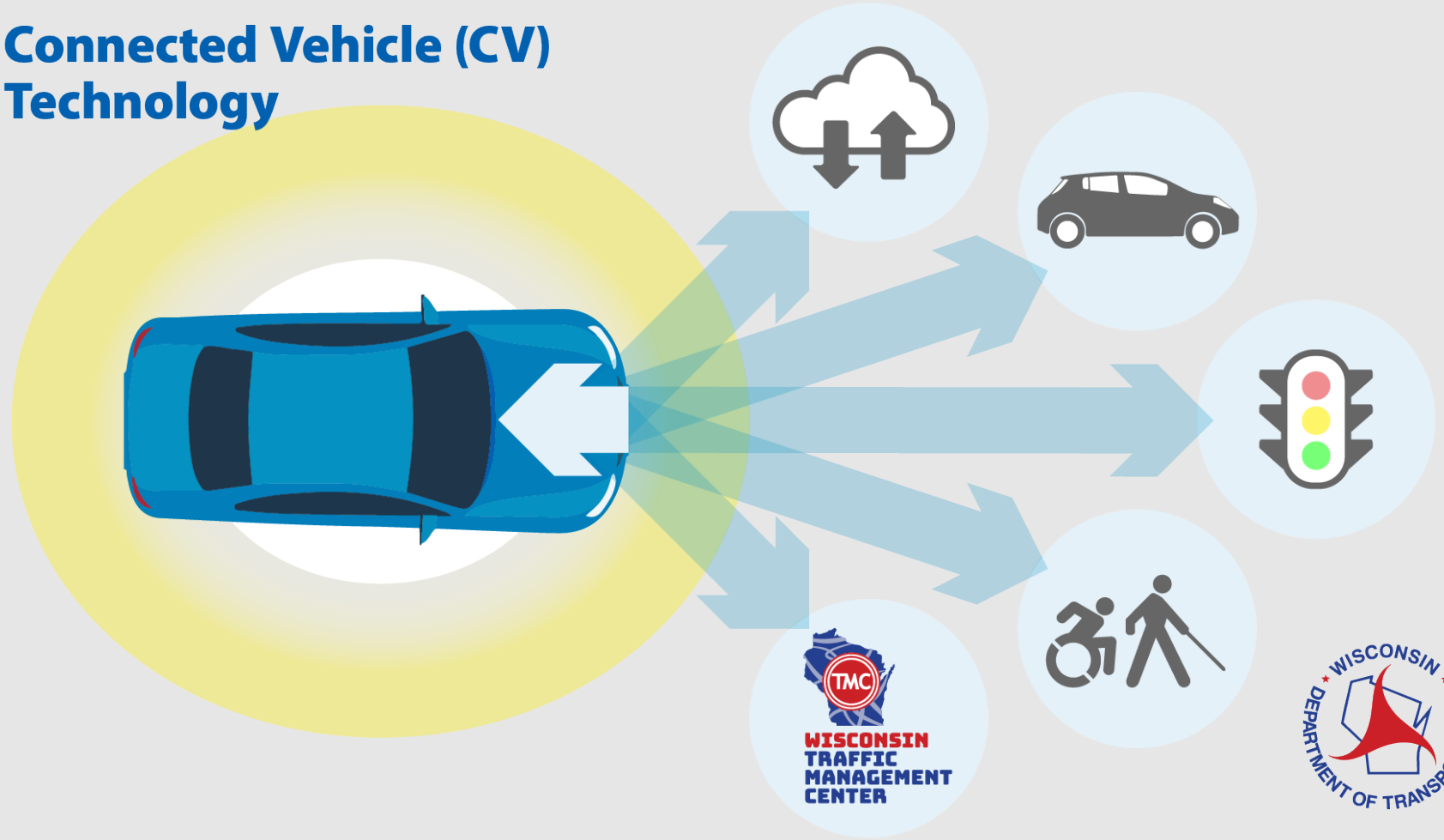


Vehicle to Pedestrian (V2P)

- Alerts vehicle to the presence of a pedestrian and pedestrian to the presence of the vehicle.
- Alerts pedestrian that a car driving too fast is coming into intersection or alerts vehicle of pedestrian in the intersection.

General CAV info

Connected Vehicle (CV) Technology

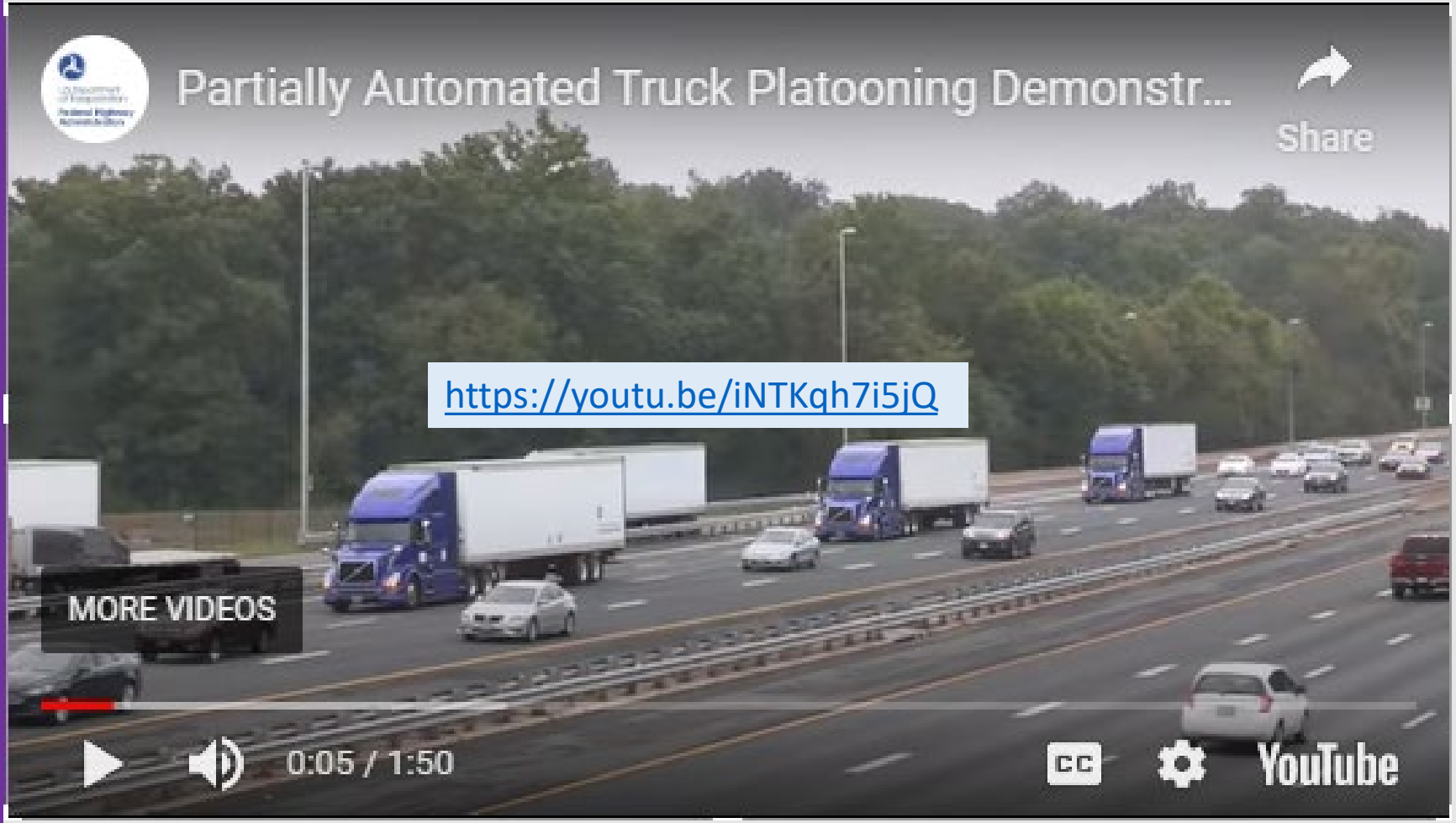


Vehicle to Everything (V2X)

- Encompasses all communication modes with dedicated short-range radio (DSRC) or cellular communication to provide a wide range of information.
- Provides updated maps, advance warning of upcoming road hazards, or improvements to vehicle software.

General CAV info

Platooning



Source: U.S. Department of Transportation, Federal Highway Administration

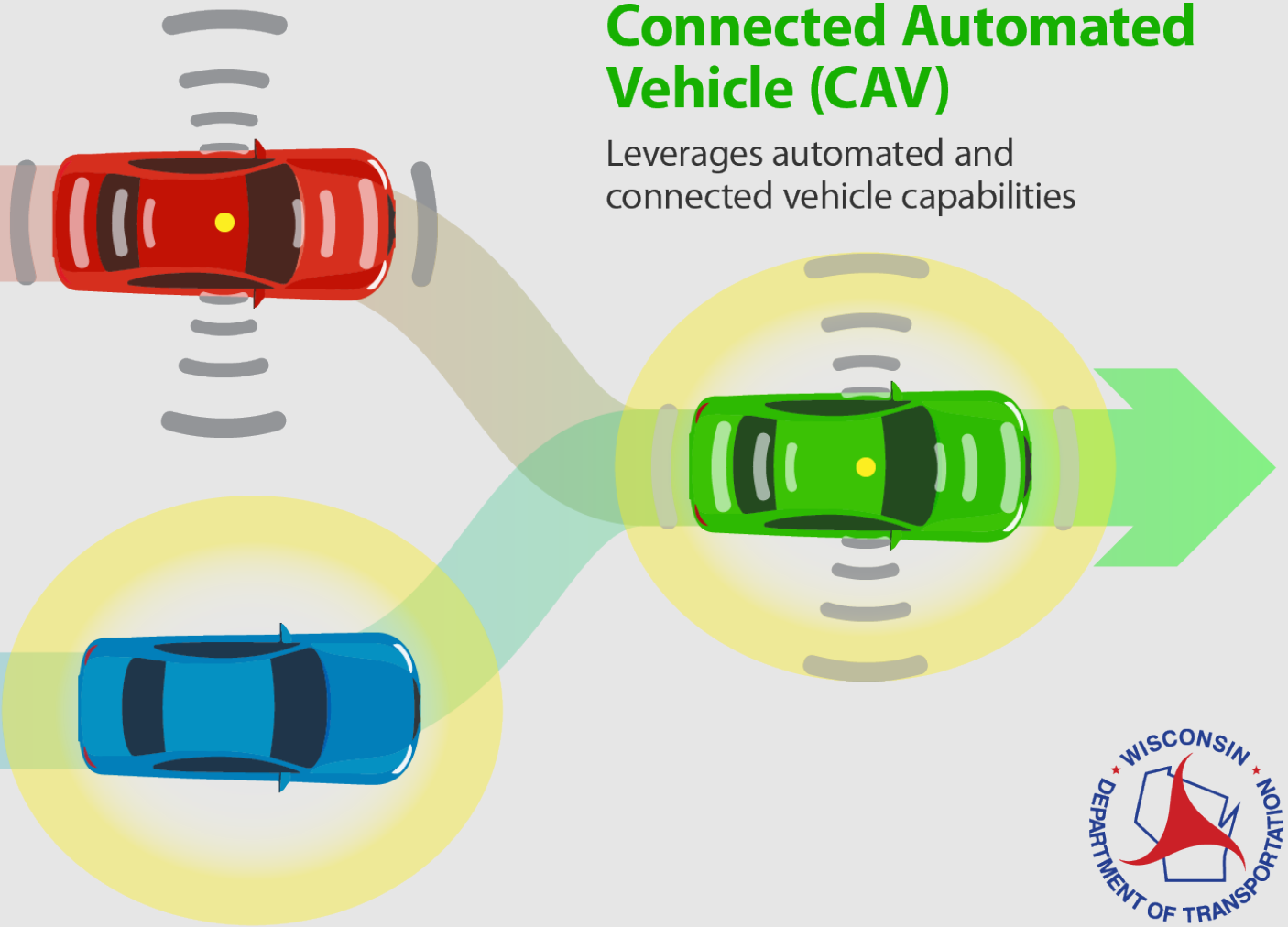
Truck Platooning is a specific vehicle-to-vehicle connected technology which allows vehicles to coordinate braking, acceleration and eventually steering.

Platooning

Platooning

- Platooning is legal in the state of Wisconsin with a driver in the driver's seat of each vehicle
- Platooning vehicles travel very closely together
- Platooning vehicles are not visibly marked
- Platooning vehicles always communicate with each other
- If a car or motorcycle slips between two platooning vehicles, the platooning vehicles adjust their distance until the car or motorcycle moves on.
- Passenger car platooning is also legal in Wisconsin but is not available on production cars at this time

General CAV info



Automated Vehicle (AV)

Manage all or most driving tasks in varying degrees in certain areas.

Connected Vehicle (CV)

Communicates with nearby vehicles and infrastructure

Connected Automated Vehicle (CAV)

Leverages automated and connected vehicle capabilities

Connected Automated Vehicle (CAV)

Combines connectivity and automated technologies to assist or replace humans in the task of driving.

State Statutes

Source: Vijay Kumar Koulampet/Wikipedia Commons

- Chapter 340.01 (41) “operator” means a person who drives or is in actual physical control of a vehicle.
- 343.305 (1)(b) “Drive" means the exercise of physical control over the speed and direction of a motor vehicle while it is in motion.
- 343.305 (1)(c) “Operate" means the physical manipulation or activation of any of the controls of a motor vehicle necessary to put it in motion.

Note: State statute references accurate as of publish date, 11/02/2022

State Statutes

Source: Vijay Kumar Koulampet/Wikipedia Commons

- A human being must be in actual physical control of a vehicle in order to control the speed and direction of the vehicle while it is in motion.
- Operator or driver is responsible for the appropriate and safe operation of the vehicle while driving the vehicle.
- This includes:
  - the use of any technology with which the vehicle is equipped
  - any malfunction of the vehicle
  - adherence with current state law and the Rules-of-the-Road

State Statutes

Source: Vijay Kumar Koulampet/Wikipedia Commons

- This analysis will likely not completely cover all future CAV scenarios given gaps in the Wisconsin Statutes relative to this emerging technology.
- Law enforcement contact with drivers will need to be handled on a case-by-case basis unless and until the Wisconsin Statutes are revised to address such technology.

State Statutes

Platooning

- Chapter 346.14, Distance between vehicles does not apply to an operator of a vehicle in a *platoon* other than the lead vehicle.

- Platoon - A group of individual motor vehicles traveling in a unified manner at ***electronically coordinated*** speeds.

Law Enforcement Scenarios

Source: Wisconsin State Patrol

Source: City of Kewaunee

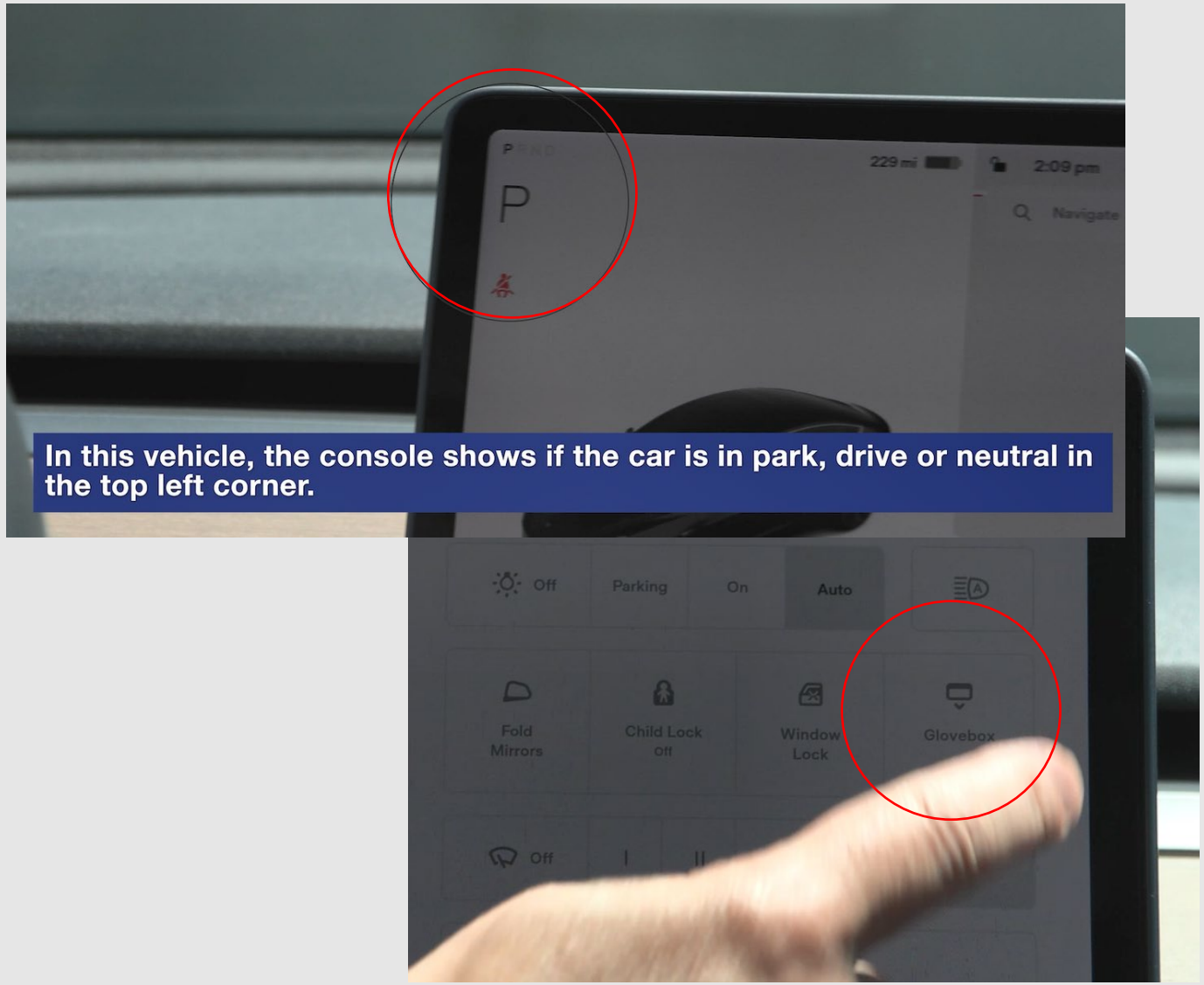
Source: Outagamie county

Automated technology components are present in many vehicles manufactured in the last five years **and are on the road right now.**

Law Enforcement Scenarios

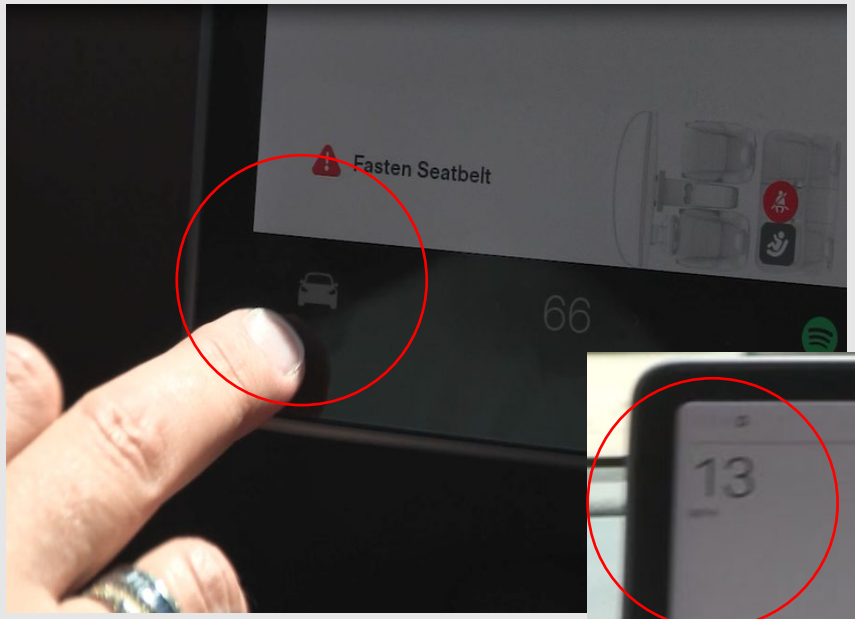
- Your general procedures for stopping a vehicle will not change.
- Chapter 346 refers to driver or operator in all relevant statutes.
- **The operator or driver is responsible for the appropriate and safe operation of the vehicle while driving it. This includes the use of any technology the vehicle is equipped with, any malfunctions of the vehicle, and adherence with current state law and the Rules-of-the-Road.**

Law Enforcement Scenarios

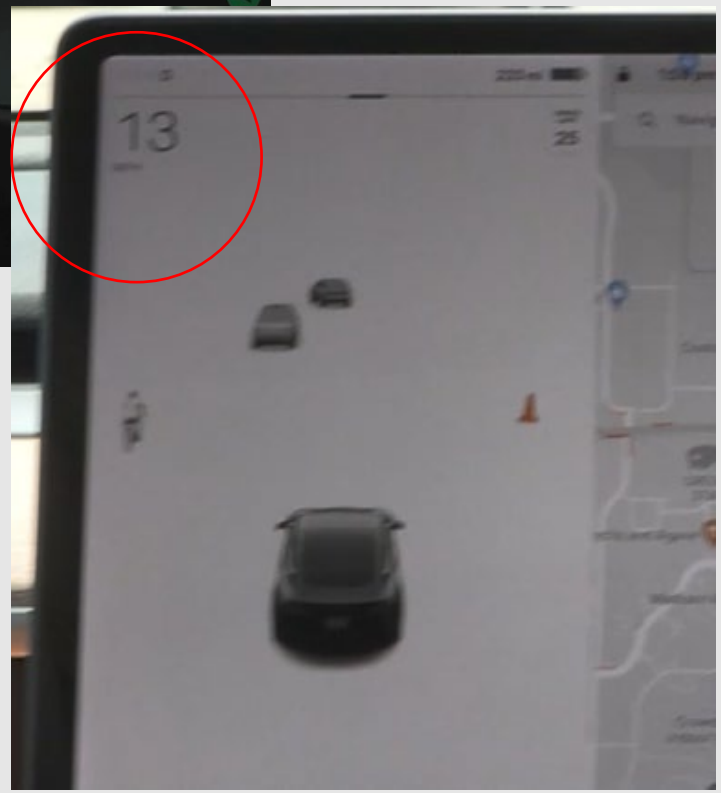


- Our general procedures for stopping a vehicle will not change.
- Vehicles may use different methods to be placed into PARK.
- Opening a glove box might also require the use of the touchscreen.

Law Enforcement Scenarios



Accessing vehicle settings



Speed and surrounding traffic

- The vehicle may **recognize** the **driver** walking up to the vehicle through a **cell phone or keycard,** important when securing a vehicle.
- Vehicle speed may be displayed on the touchscreen.
- Sensors can show a wide view around the vehicle even if the driver isn't looking at the side or rear-view mirror. The sensors can distinguish cars, people and traffic lights.

Law Enforcement Scenarios

Level 2 (legal in WI) **Automated Driving Assist Systems (ADAS)** - on the road today	**Level 4 (not legal in WI without a driver)** **Automated Driving Systems (ADS)** - not on the road in WI currently
Capabilities • adaptive cruise control (ACC) - keeps a set distance • acceleration • braking and emergency braking • lane keep	Capabilities of Level 2 plus: • navigation • lane changing • stop signs and stop lights • left and right turns • pedestrian recognition
Does NOT recognize emergency vehicles by design *The driver must watch for emergency vehicles*	**Recognizes** emergency vehicles by design *The vehicle ADS watches and responds to emergency vehicle lights*
Examples Tesla *Autopilot* GM *Super Cruise* Mercedes *Drive Pilot* Toyota *Advanced Drive*	Examples Tesla *Full Self-Driving beta* Waymo *One* - taxi Cruise (GM) - taxi Trucking: Waymo *Via* Embark Trucking Aurora Innovation

Note: Level 4 systems are usually restricted to a digitally mapped geo-fenced area or certain driving conditions like top speed or restricted access highways.

Note: Information may cease to be accurate due to future technological advances or legal changes.

Law Enforcement Scenarios

Source: WISN-TV Milwaukee, All Rights Reserved

The driver is responsible for the appropriate and safe operation of the vehicle.

This driver was cited for inattentive driving.

In Wisconsin, there must be a licensed driver behind the wheel and in control of the vehicle.

Law Enforcement Scenarios

Automated vehicles can:

- recognize emergency vehicles and pull over to yield as they pass
- recognize they are the subject of a traffic stop and pull over to a safe location

If the vehicle is open, the officer can communicate with the vehicle's remote support team through internal microphones.
Or, the manufacturer's remote support team phone number can be found on visor card – provided.

In Wisconsin there must be a licensed driver behind the wheel and in control of the vehicle.

Law Enforcement Scenarios

Platooning

- Commercial Motor Vehicle driver must hold a valid commercial driver license.
- If any commercial motor vehicle in a platoon violates rules of the road, you would stop the vehicle as usual.
- If you stop a vehicle following too closely, you can ask the driver if the vehicle is part of a platoon.
- **When in doubt, remember that all vehicles must follow rules of the road**

Law Enforcement Scenarios

AV commercial motor carriers

- Bill of Lading permits and certifications may be accessible by external lock-boxes on cabs.
- Manufacturer's operations support phone numbers may be listed on the outside of truck cabs.

Source: Embark Trucks, Embark - YouTube

Law Enforcement Scenarios

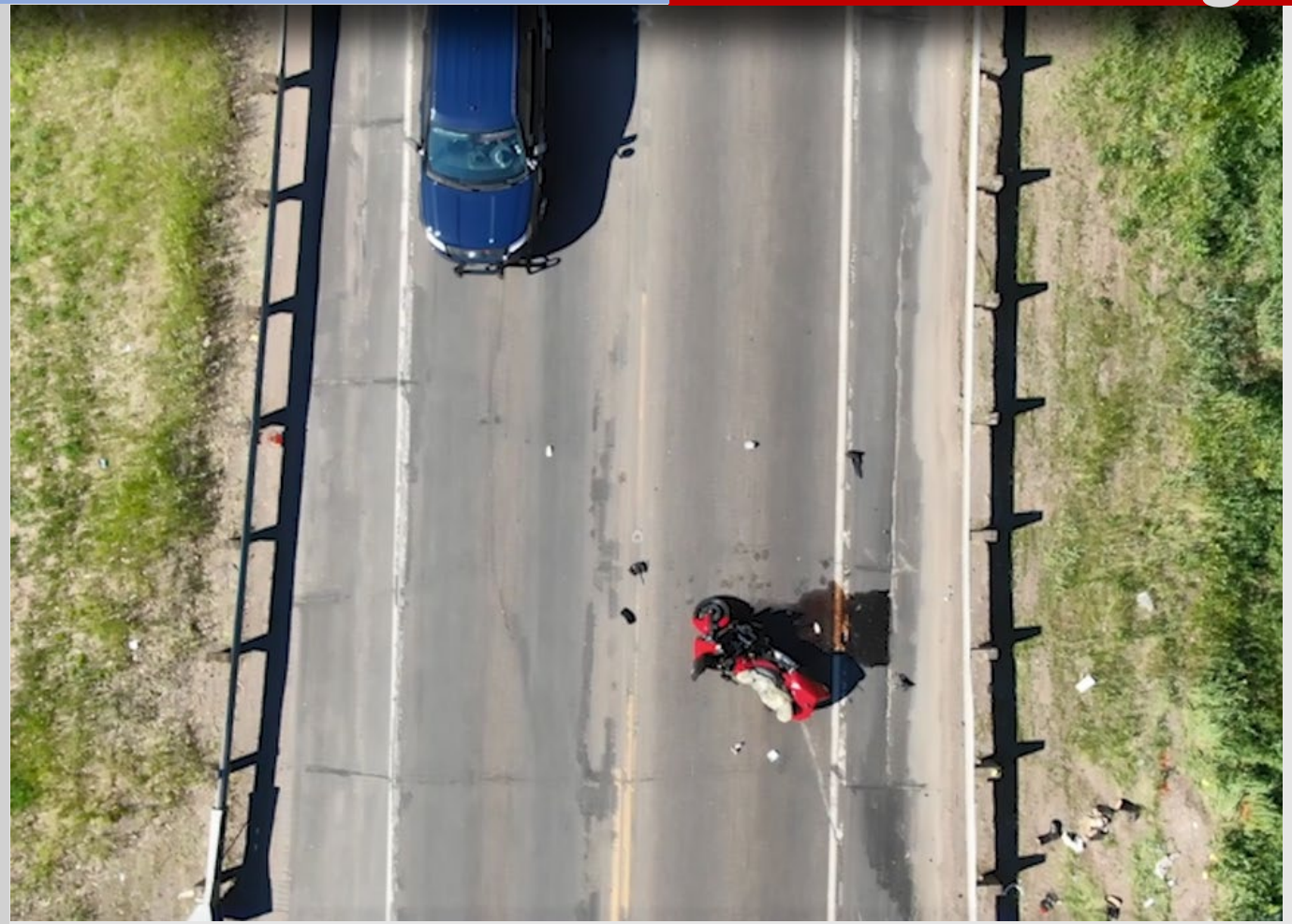
What we don't know…the technology and legal framework continue to advance

- How to track automated driving assist system (ADAS) features or automated driving systems(ADS) in Vehicle Identification Numbers
- How to record automated driving features on crash report formatted fields
- Comprehensive chart showing how to disengage ADS on every car model
- How to verify ADS was on during a crash vs ADS turned over control to driver
- Level 3: reasonable time needed to turn over driving functions from ADS to driver
- How to identify platooning trucks while in motion
- How to direct a driverless car with hand signals or verbal commands during traffic control

First Responder scenarios and process

- AVs will respond to emergency lights and sirens.
- AVs **WILL NOT** respond to hand gestures, flagmen signs, **impromptu** detour signs, audible commands (at this time).
- AVs **WILL** respond to large objects or persons placed in their path.

In Wisconsin there must be a licensed driver behind the wheel and in control of the vehicle.

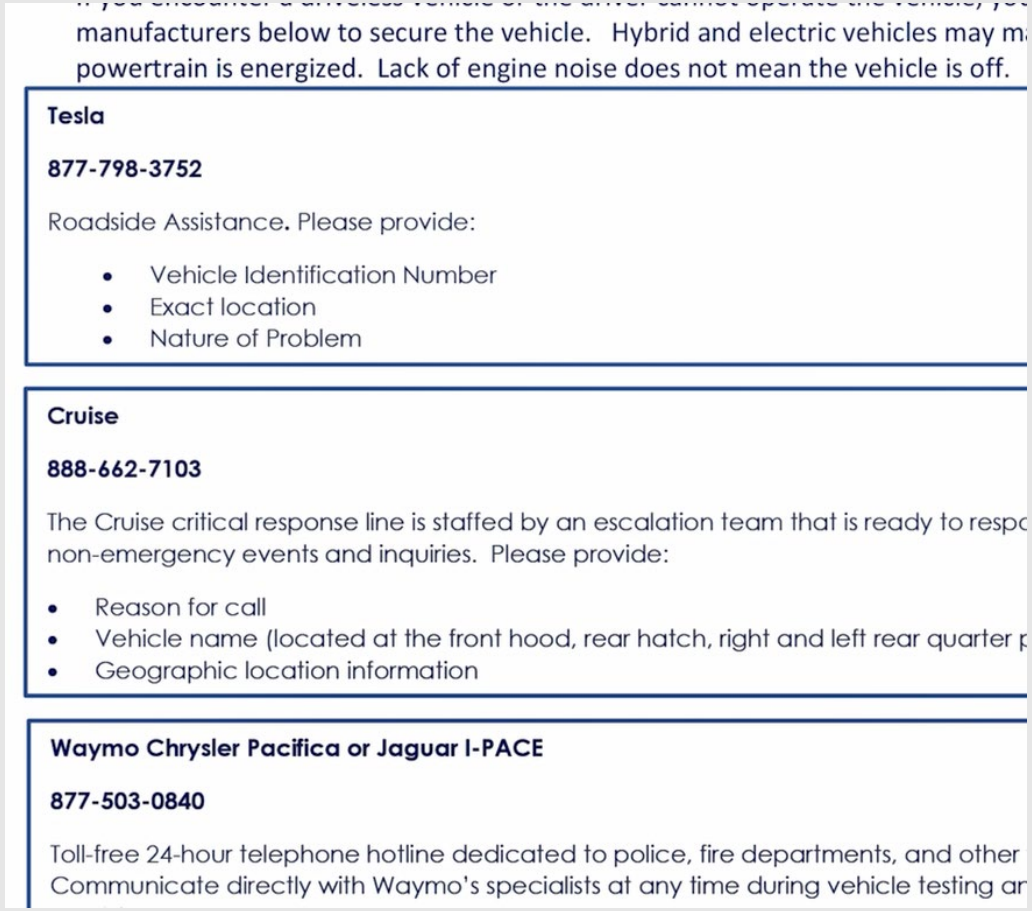


In Wisconsin there must be a licensed driver behind the wheel and in control of the vehicle.

What would you do if you encountered a driverless vehicle that has crashed?

- **If air bag is deployed or a door is open, vehicle will not move.**
  Note: most driverless taxis can automatically close their doors.
- Contact the vehicle manufacturer using the dedicated toll-free telephone number.
- Manufacturer will assist in securing the vehicle.
- Manufacturer telephone numbers are included in handouts.

Visor card of AV manufacturers



manufacturers below to secure the vehicle. Hybrid and electric vehicles may m
powertrain is energized. Lack of engine noise does not mean the vehicle is off.

Tesla

877-798-3752

Roadside Assistance. Please provide:

- Vehicle Identification Number
- Exact location
- Nature of Problem

Cruise

888-662-7103

The Cruise critical response line is staffed by an escalation team that is ready to respo
non-emergency events and inquiries. Please provide:

- Reason for call
- Vehicle name (located at the front hood, rear hatch, right and left rear quarter p
- Geographic location information

Waymo Chrysler Pacifica or Jaguar I-PACE

877-503-0840

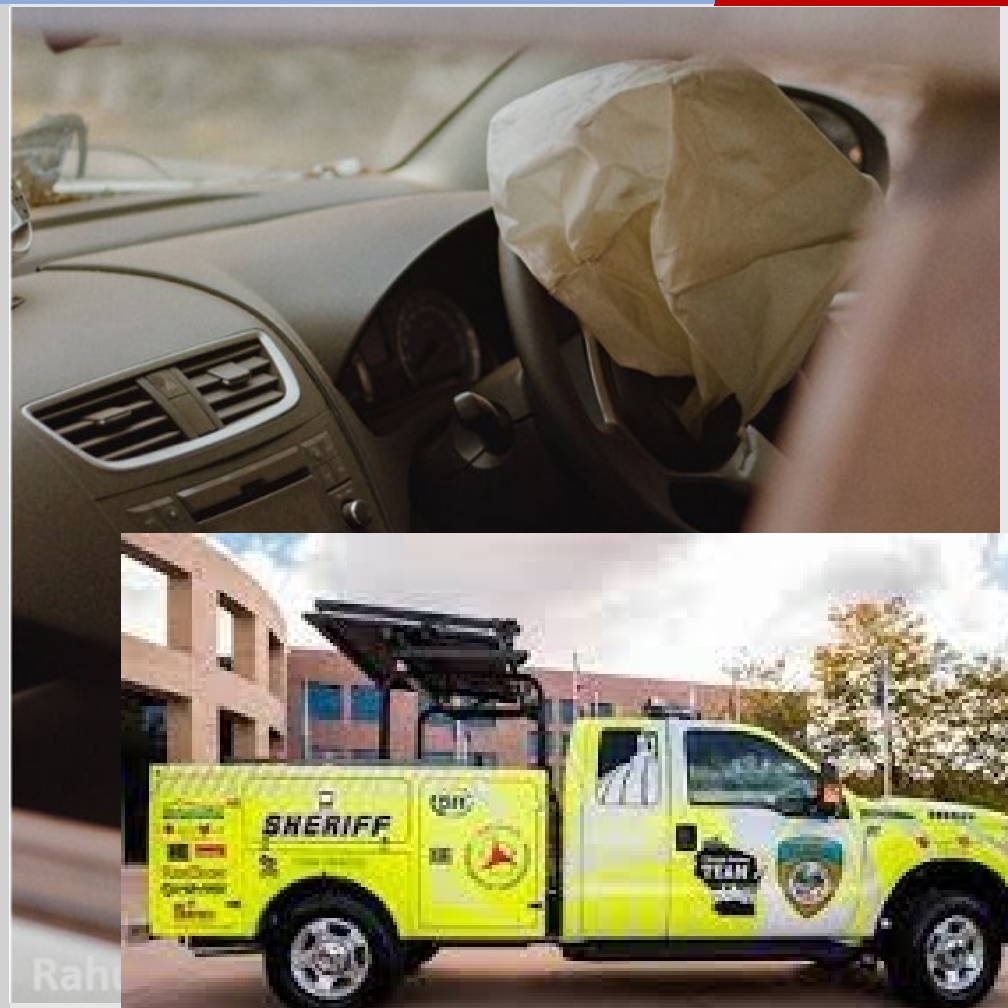
Toll-free 24-hour telephone hotline dedicated to police, fire departments, and other
Communicate directly with Waymo's specialists at any time during vehicle testing ar

What would you do if you encountered a semi-automated or driverless vehicle? e.g., a driver sleeping behind the wheel

- Automated vehicles in motion will respond to a car slowing down in front of them.
- If an AV doesn't stop, standard procedures can be used to stop the vehicle.

When stopped –

- **An open door will keep the AV system disabled. Note:** most driverless taxis can automatically close their doors.
- Officer or officer's dispatch center can contact the manufacturer directly.
- The manufacturer can assist in assessing the situation, virtually access the vehicle, place the vehicle in park, or power down the vehicle.



First Responder scenarios and process

- Some cars can be unlocked or activated by the presence of the owner's **cell phone** (or other authorized driver like a family member) or **key card** in the vicinity of the vehicle.

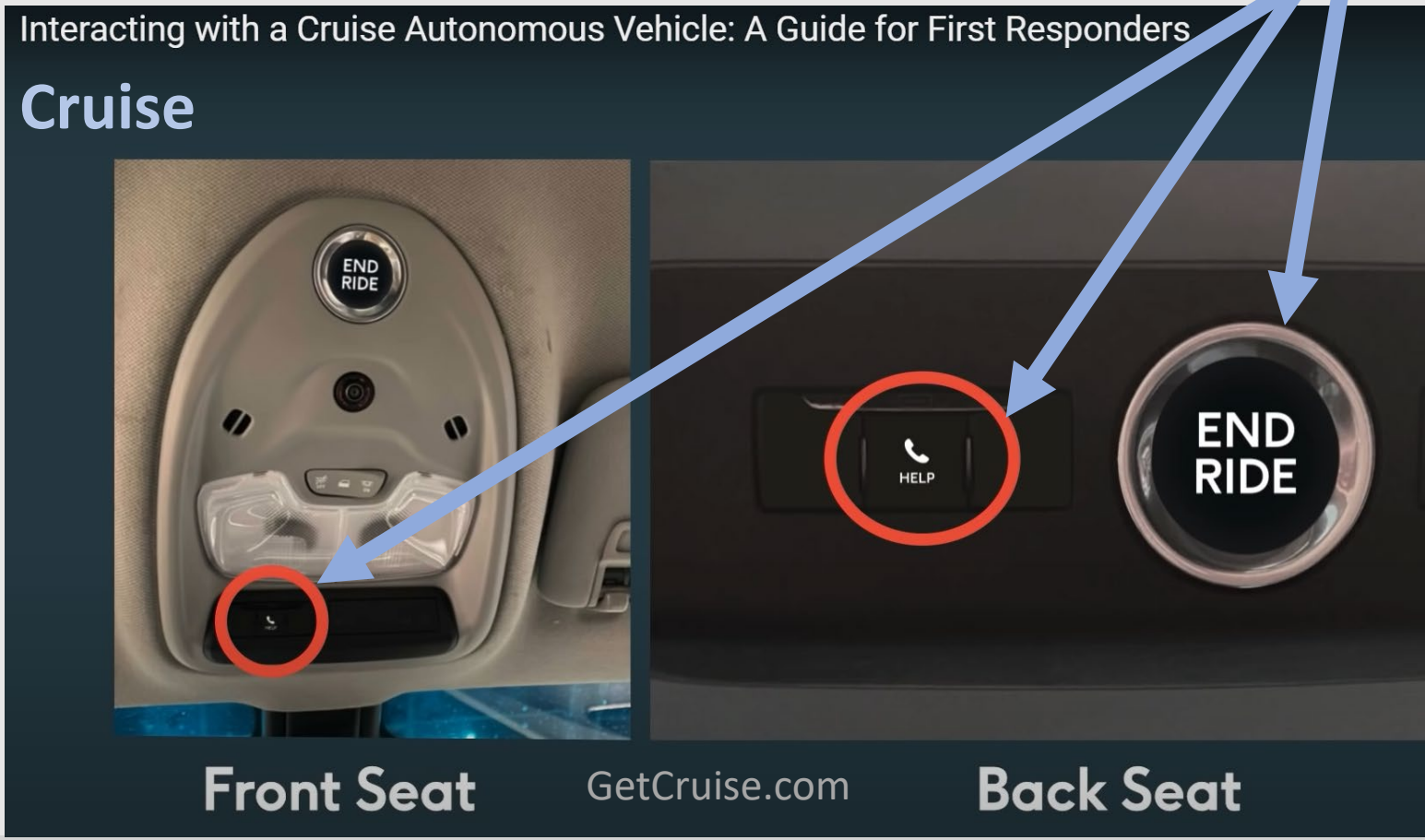
- An AV will not move if the **air bags are deployed**, or a **door is left open**.
  Note: most driverless taxis can automatically close their doors.

Disengaging an AV

If you have access to the interior of a functioning vehicle-

- Buttons inside GM Cruise and Waymo One vehicles can provide assistance from the remote support team.

  Use the interior “HELP” button or the manufacture phone numbers provided with this course.



Disengaging an AV

The manufacturer can help with:

- determining if the vehicle is in manual or AV mode,
- unlocking,
- placing in park or
- Can send an on-site support team for assistance.

These four buttons are the primary way passengers interact with the vehicle. A camera also allows Waymo reps to see the vehicle interior.

Waymo One

waymo.com/firstresponders/

When in doubt of the power or activation status of vehicle-

- Chock & Block the vehicle front and back before performing any emergency procedures.

First Responder scenarios and process

- Once taken out of AV mode, **all vehicles can be handled as any normal base model platform**: e.g., Chrysler Pacifica hybrid, Jaguar I-Pace, GM Bolt, Tesla.

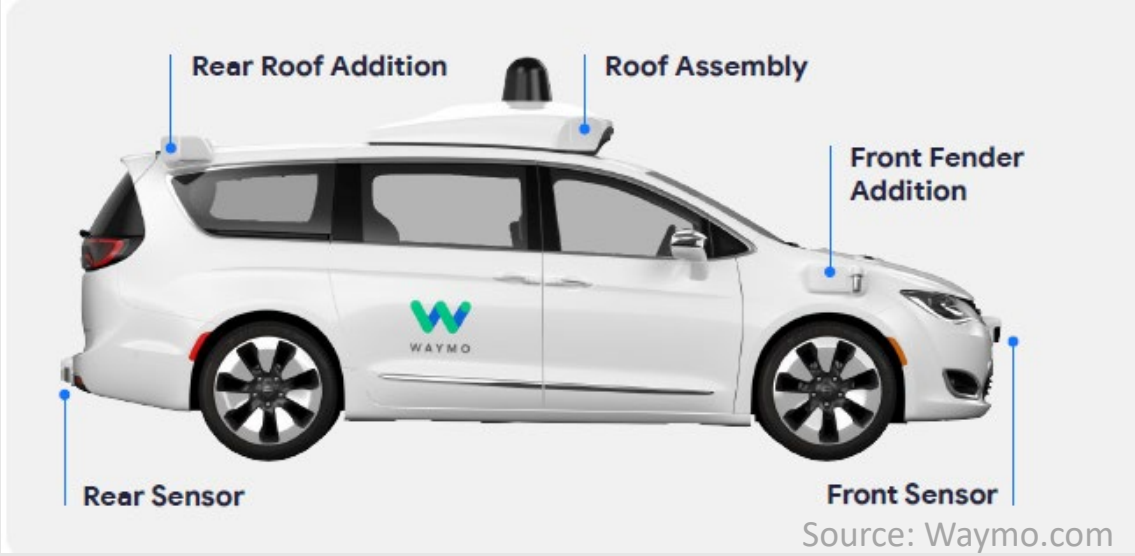
- *Connected and Automated Vehicle (CAV) handout* guide or CAV *Visor Card* contain links to detailed manufacturers resources, including electric vehicle considerations for leading model vehicles.

Vehicle Identification

How to identify an automated vehicle or semi-automated vehicle?

There is no one standard way to identify any of these classes of vehicles.

- **Automated driving options are not coded in the VIN.** See Cars.com article for list of available features by model.



Vehicle Identification

Many, but not all electric, hybrid-electric or gas vehicles have some automated capabilities.

Q: How to identify an electric vehicle or hybrid-electric vehicle?

A: <u>There is no one standard way to identify any of these classes of vehicles.</u>

- For EVs and hybrid identification and handling for fire and towing issues
  Contact ESA at 1-855-ESA SAFE , 24hrs

Development of Agency Expertise is Essential

- The time is now to start developing a heightened level of awareness/expertise for your organization.
- Attend WisDOT Regional TIME meetings (Spring & Fall) for CAV updates
- Review the Wisconsin Responder Newsletter provided by the WisDOT TIME Program on a quarterly basis for CAV updates
- Some organizations & auto manufacturers offer training for first responders, such as, EVsafe.org, energysecurityagency.com and the Tesla Owners Club Wisconsin.

In Wisconsin there must be a licensed driver behind the wheel and in control of the vehicle.

Technologies on the Road

Adoption

- Automated Driver Assist Systems (ADAS) are rapidly being purchased
- In 2020 50% of newly registered vehicles had level 1 automation
- Another 26% had level 2 driver assist technology installed at purchase

Source: Autonomous Travel - Rhode Island Rhode Island Department of Transportation (ri.gov)

Technologies on the Road

Adoption

- 94% have heard of automated vehicles
- 90% own a vehicle with driving assistance technology such as cruise control, blind spot detection and warning, and lane departure avoidance
- Nearly 80% would like more driving assistance technologies with their next car purchase
- UW-Eau Claire 2019 transit study

  https://www.eauclairewi.gov/home/showpublisheddocument/29466/637025945634070000

Autonomous testing and driverless taxis – where legal in other states


Source: Waymo.com

- More than 65 companies are testing various components of AV technologies in the US.
- Automated taxis have driven more than 20 million miles in testing with safety drivers, and companies like Waymo and GM Cruise have logged 25,000 miles in California and 65,000 miles in Arizona with no driver in the vehicle.

Source: Nuro.ai

- Nuro is an operational driverless delivery vehicle.

AV trucking

- Gatik driverless trucks are delivering goods 24/7 on pre-defined, short-haul routes across a network of 34 Sam's Club stores in the Dallas-Fort Worth metroplex.

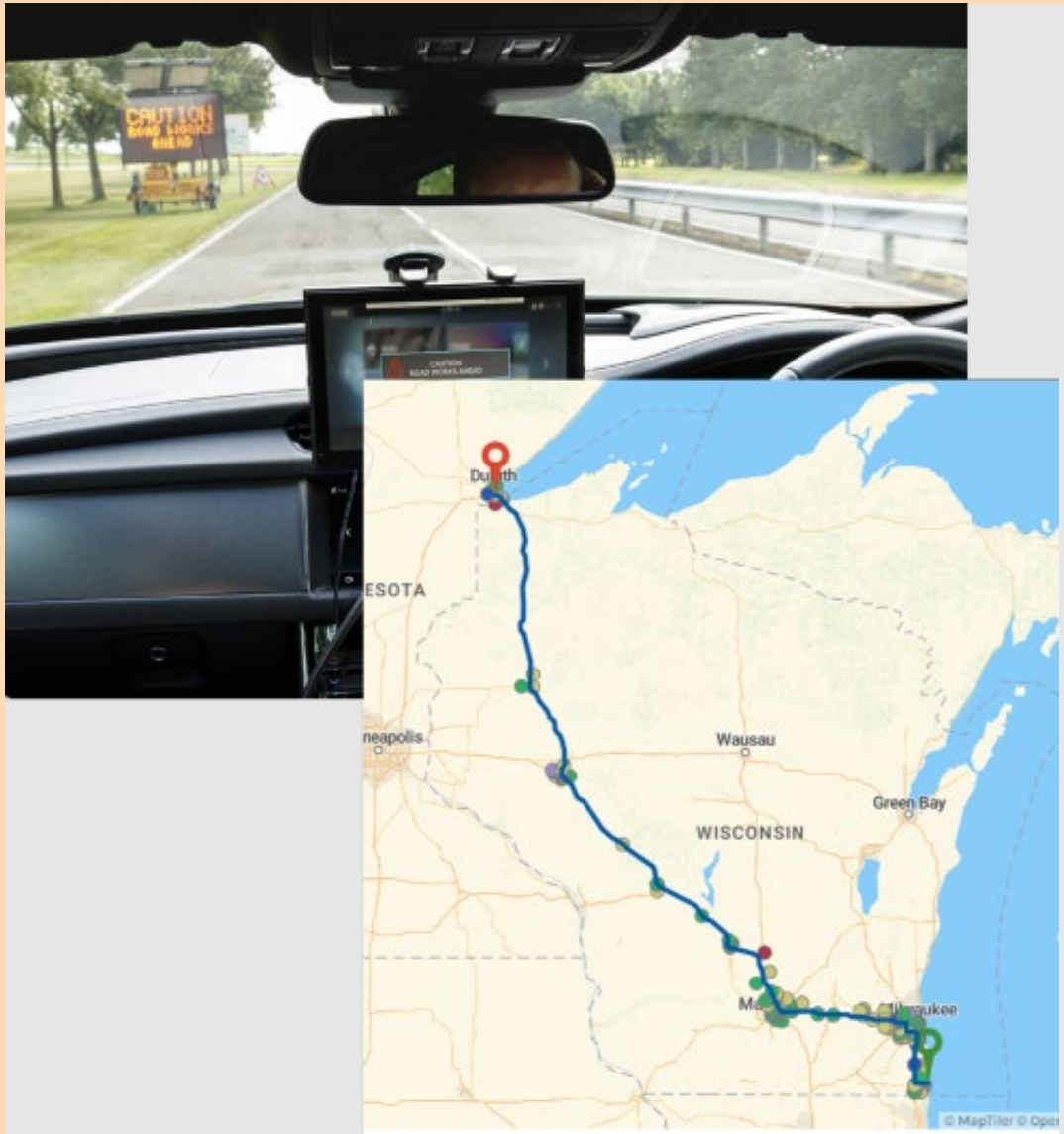
Source: Gatik


Source: Huston.org

- North Houston Interstate 45 driverless trucking corridor

These vehicle tests all rely on a safety driver at this time.

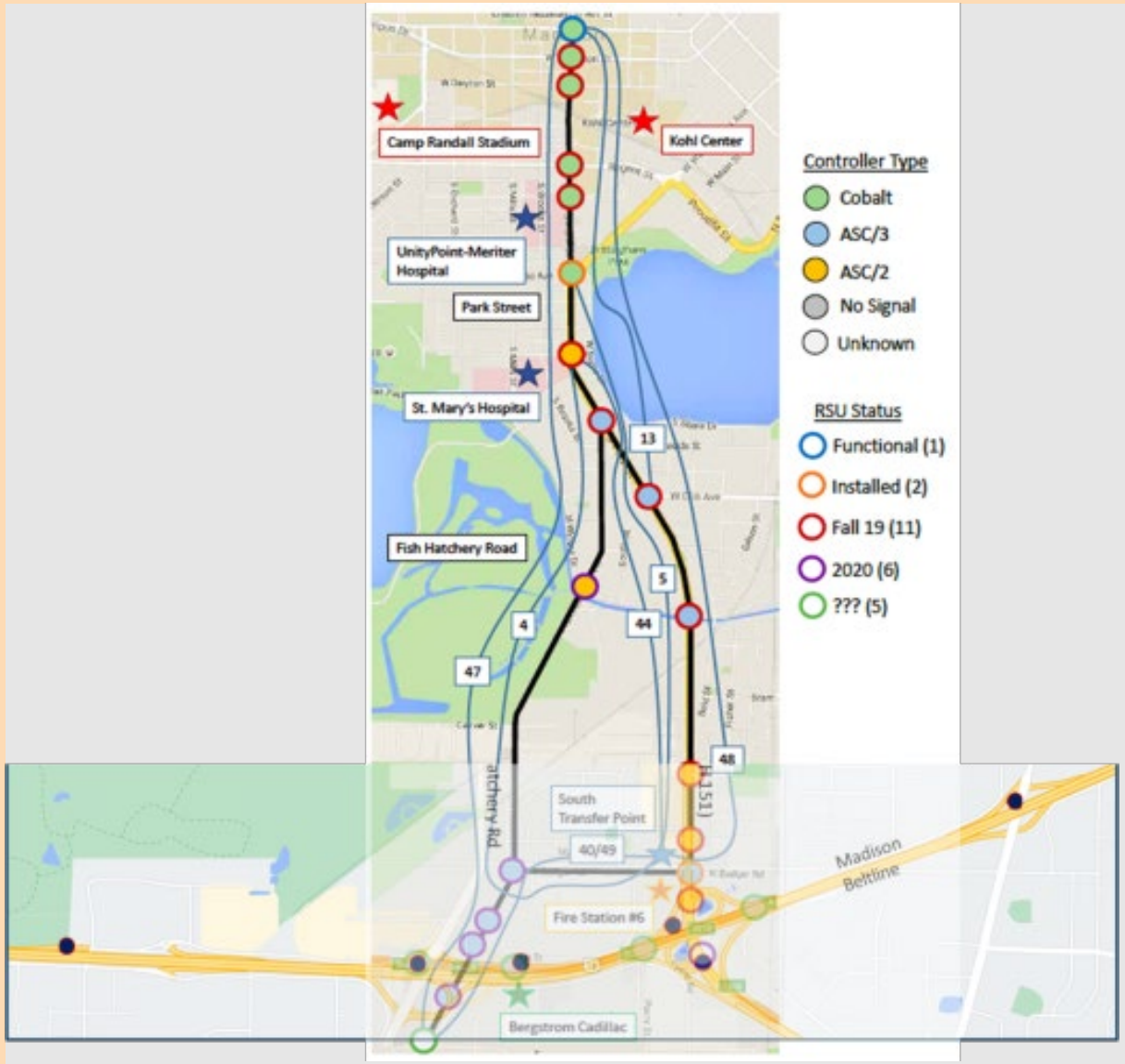
Technologies on the Road



Connected Technology

- Smart Corridors allow vehicles to interface with intelligent traffic signals (ITS) at intersections – these are under test in some national research projects including one research project in Wisconsin.
- Connected infrastructure could interface with vehicles, as well as bicycles and pedestrians, to provide warnings about red lights or roadside hazards
- Information can be displayed on dynamic message signs
- I-94 North-South corridor in the Milwaukee area has been equipped with microwave nodes and fiber optics for future connected vehicles

Technologies on the Road



Pilot infrastructure testing

- Wisconsin's first connected corridor in Madison created by UW-Madison TOPS Lab, city of Madison, and TAPCO
- Radios allow the roadside units to "talk" to vehicles as they move through the corridor.
- System transmits basic safety messages about traffic
- System sends support messages such as a map of the intersection to connected vehicles
- Beltline (US 12, 14, 18 and US 151) connection is testing the handoff of information from city system to state highway system

Technologies on the Road

Work zones and pavement

- 6-inch-high contrast pavement lane markings improve functionality of automated sensors
- ConnectedTech iPin or iCones can transmit the location of work zones to approaching traffic
- Smart arrowboards can be updated in real-time

These products are being tested or installed in limited areas of WI

Technologies on the Road

Source: Minnesota DOT

Source: Indiana DOT

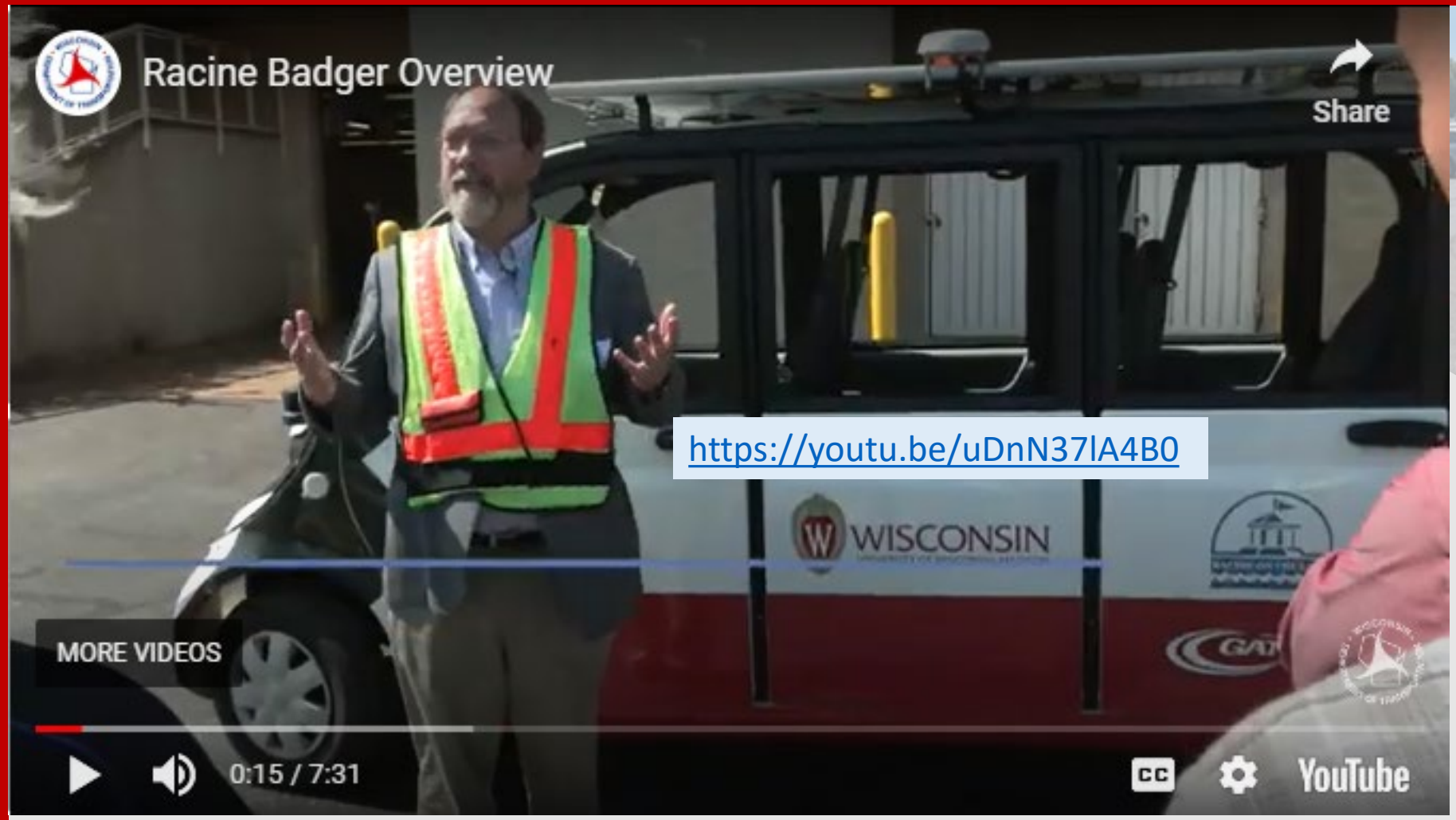
Work zones

- Autonomous truck mounted crash attenuator (ATMA) follows behind highway maintenance vehicles and absorbs impact of crash if vehicle accidentally enters work zone
- ATMA removes the driver from a hazardous situation
- ATMA are not currently being tested or operated in WI

Law Enforcement and First Responders Automated Vehicle Demonstration, September 2022

- WisDOT sponsored training event with UW-TOPS lab and the Racine Badger shuttle was held at Gateway Technical College, Racine, WI
  - UW TOPS Lab review and demonstration for LE&FRs discussion
    - Review CAV training information with actual vehicle
    - Discussion and demonstration of the vehicle and operations
    - Safety driver roles and responsibilities
    - Towing procedures
    - Racine Badger contact information
    - Demonstration rides

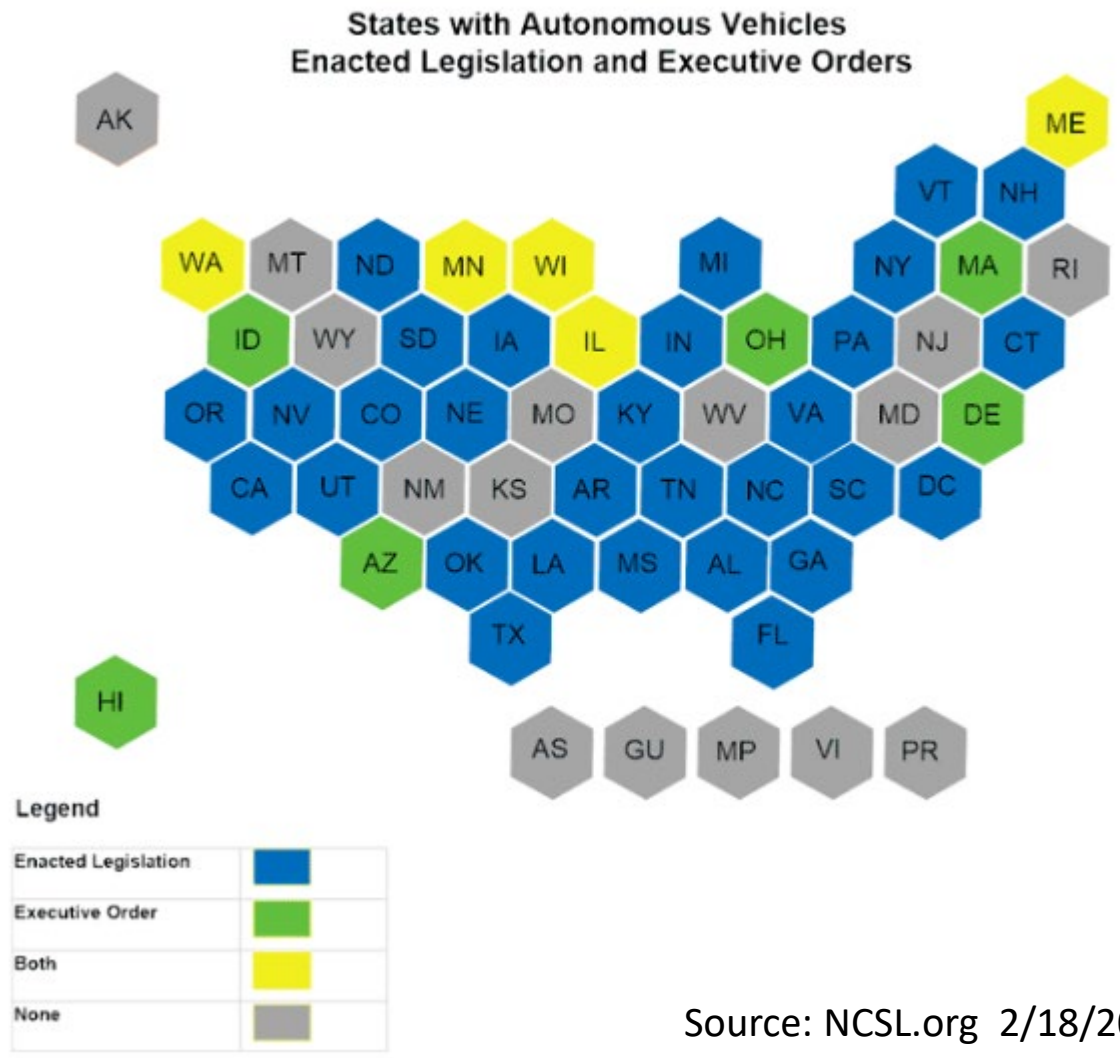
Racine “Badger”



Badger demonstration video topics:

- Operations with safety driver
- Sensor functions
- Towing procedures
- Battery information
- Research at UW-TOPS Lab and GTC.

State Actions



Source: NCSL.org 2/18/2020

Legislation

- 41 states have some kind of legislation or executive orders in place related to automated, self-driving, driverless or autonomous vehicles.
- We expect legislative or regulation changes at the national and state level in the future.

State Actions

Source: Vijay Kumar Koulampet/Wikipedia Commons

Collaboration

Wisconsin Department of Transportation, along with partners in industry, academia and local government, is focusing on the needs of law enforcement and first responders.

Questions and Contacts

Questions, Comments, Feedback?

Brad Basten
WisDOT, Strategic Initiatives Officer
Brad.Basten@dot.wi.gov

Hannah Brown
WisDOT, Strategic Initiatives Officer
Hannah.Brown@dot.wi.gov

Andi Bill
Associate Director, UW-Madison TOPS lab
bill@wisc.edu

Rebecca Szymkowski
Traffic Operations Supervisor
Rebecca.Szymkowski@dot.wi.gov

Marquis Young
WisDOT, Statewide Traffic Incident Management Engineer
Marquis.Young@dot.wi.gov

- Email: wiscav@dot.wi.gov
- Website: wisconsindot.gov/cav