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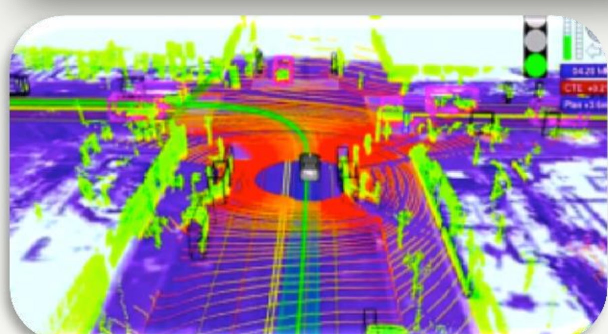
House Committee on Transportation and Economic Development
February 24, 2014

Discussion of Potential Future Developments in Connected + Autonomous Vehicles in Oregon



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Connected Vehicles 101

Photo Source: Thinkstock and Wikimedia Commons

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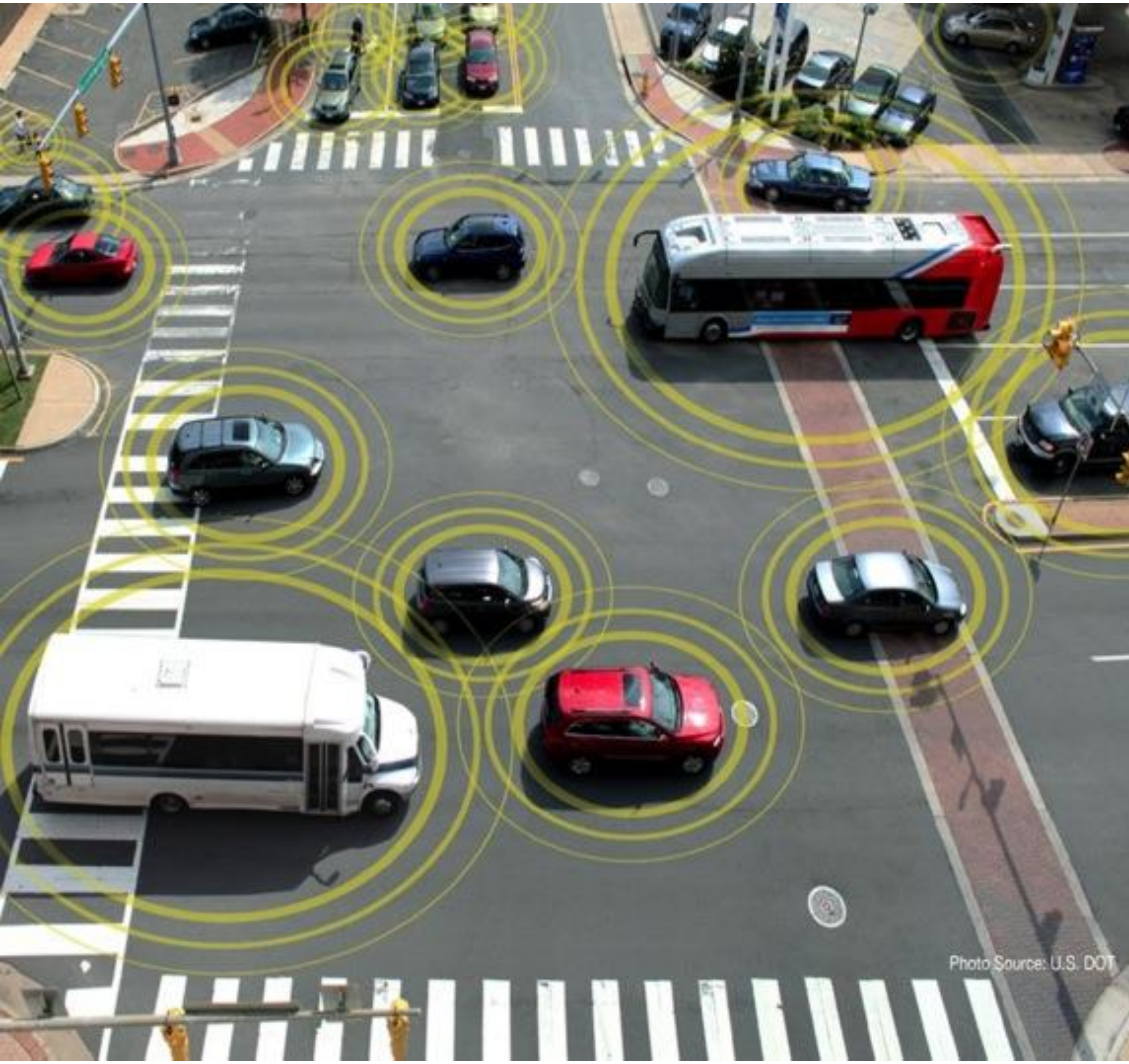
Connected vehicles can help.

They use wireless communication between vehicles and infrastructure to help prevent crashes, make travel easier, and curb pollution.

All vehicles, regardless of type, will communicate with each other using a wireless technology called Dedicated Short-Range Communications (DSRC).



Connected vehicles have the potential to address up to 81% of unimpaired crash scenarios.

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Connected vehicles will provide drivers with warnings to help them avoid crashes.

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Imagine your car informing you of available parking on the next block, your cell phone telling you a cab or bus or train is approaching, or your car helping you find a rideshare partner.

Consider the ways in which increased travel information can help the environment. *Connected vehicles can help.*

http://www.youtube.com/watch?v=Zuf2VNWGMnY

Intelligent Vehicle in 2014

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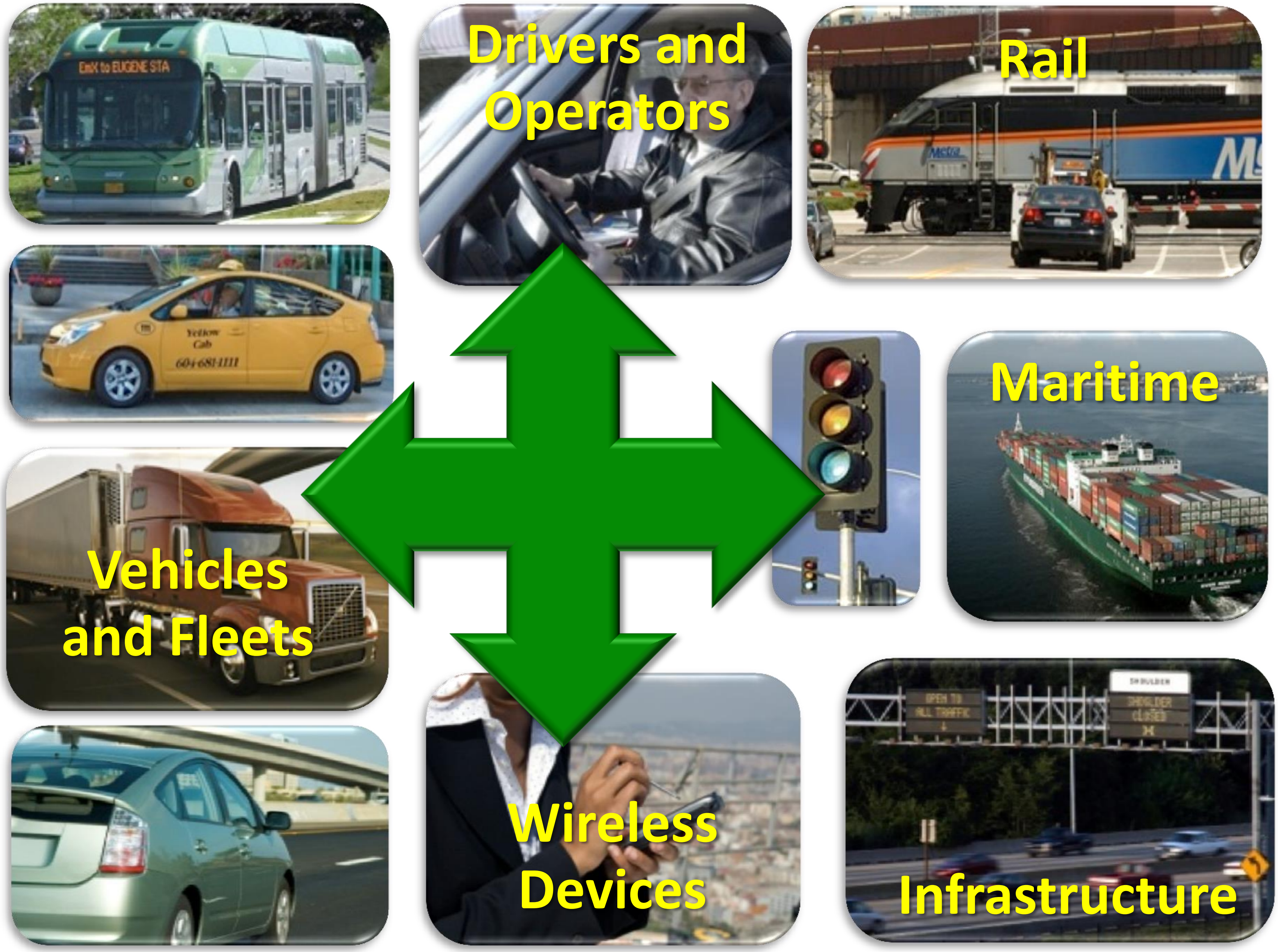
- 2014 Ford Focus
  - $21,900
  - EPA Rating 22 City/34 Highway
  - Adaptive Cruise Control with Forward Collision Warning
  - Blind Spot Information System (BLIS) with Cross-Traffic Alert
  - Rear View Camera
  - Lane-Keeping System
  - Active Park Assist
  - 911 Assist
  - Traffic Sign Recognition
  - Driver Alert
  - Pedestrian Alert Kit and Active City Stop

Vision for Connected Future



Safety Pilot – 2836 Vehicles

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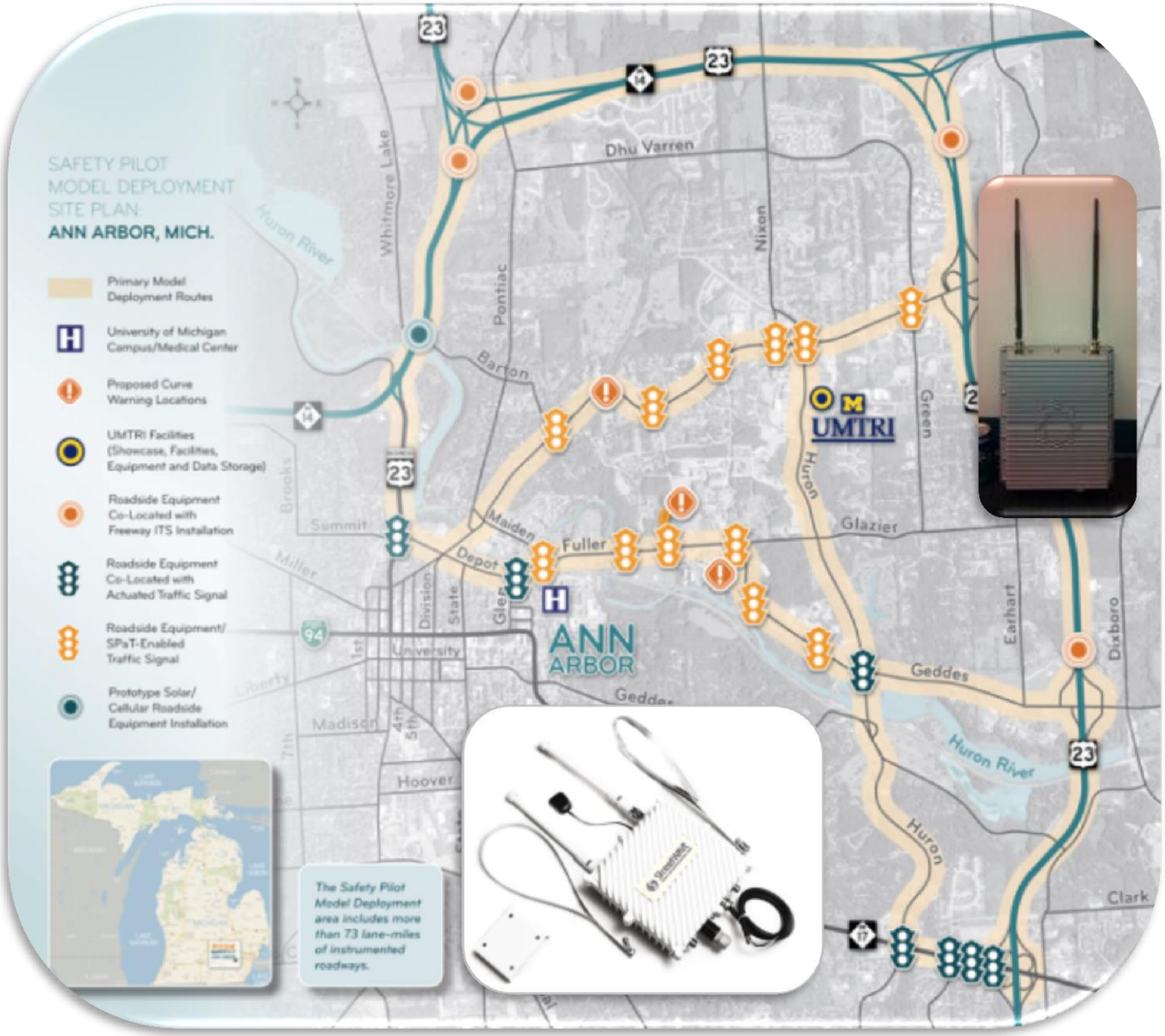
V2V

Forward Collision Warning
Emergency Electronic Brake Light
Intersection Movement Assist
Blind Spot Warning/Lane Change Warning
Do Not Pass Warning
Left Turn Across Path/Opposite Direction
Right Turn in Front

V2I

Signal Phase and Timing
Curve Speed Warning
Railroad Crossing Warning
Pedestrian Detection



Informed NHTSA Decision February 2014

What is DSRC?

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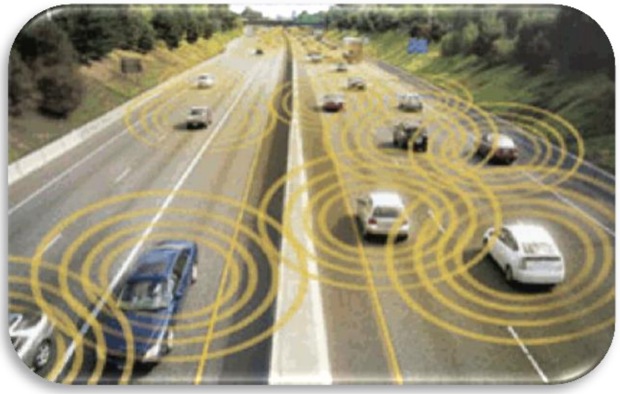
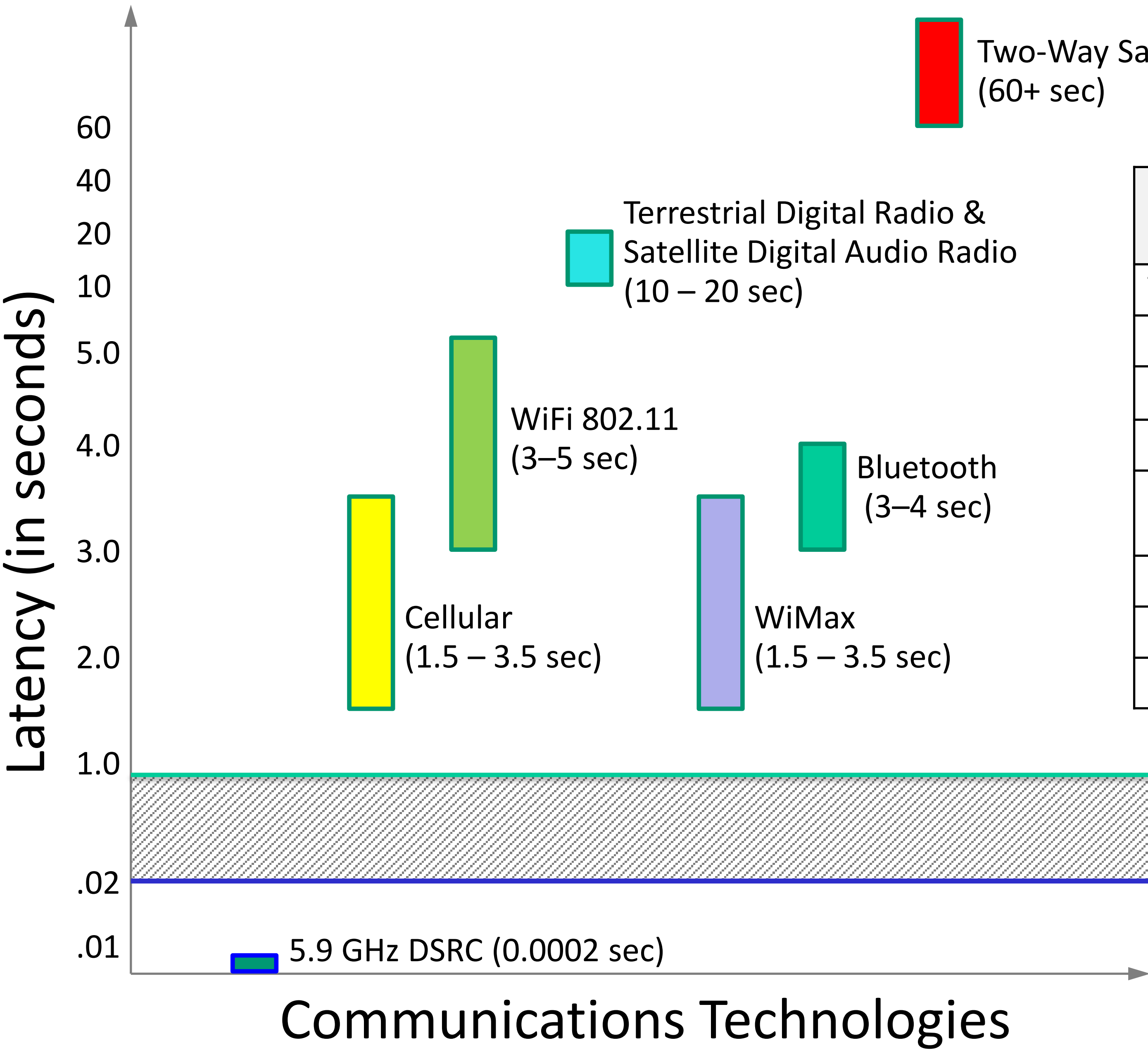
- “Dedicated Short Range Communications”
- Short to medium range communications service
- FCC authorized spectrum at 5.9 GHz for safety applications in 1999
- Europe allocated 5.9 GHz and Japan uses the 5.8 GHz
- Key ingredients: **standardization** and **interoperability**
- Other applications and other wireless technologies can be accommodated
- Older DSRC systems such as toll tags operate at 900 MH: no standard, several proprietary systems are in place
- Both vehicle to infrastructure and vehicle to vehicle communication environments
- **Complementary** to cellular communications
- Very high data transfer rates & minimal latency
- Range up to 1000 m
- Data Rate – 6 to 27 Mbps
- Channels – 7 Licensed Channels



Communications Technologies



Active Safety Latency Requirements (sec)	
Traffic Signal Violation Warning	0.1
Curve Speed Warning	1.0
Emergency Electronic Brake Lights	0.1
Pre-Crash Sensing	0.02
Cooperative Forward Collision Warning	0.1
Left Turn Assistant	0.1
Lane Change Warning	0.1
Stop Sign Movement Assistance	0.1

Least Stringent Latency Requirement for Active Safety (1.0 sec)

Most Stringent Latency Requirement for Active Safety (0.02 sec)

Note: *y*-axis not to scale for illustration purposes
Data source: Vehicle Safety Communications Project – Final Report

Solutions for 80% of Crashes

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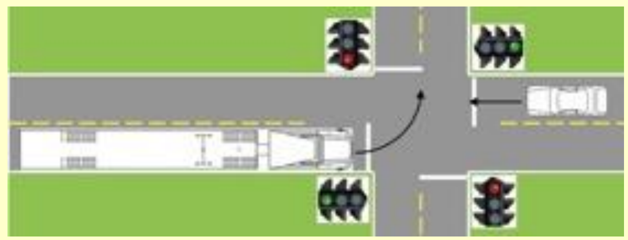
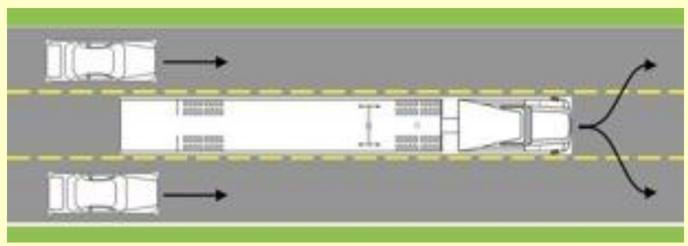
Rear End Warning 28%

Lane Departure 23%

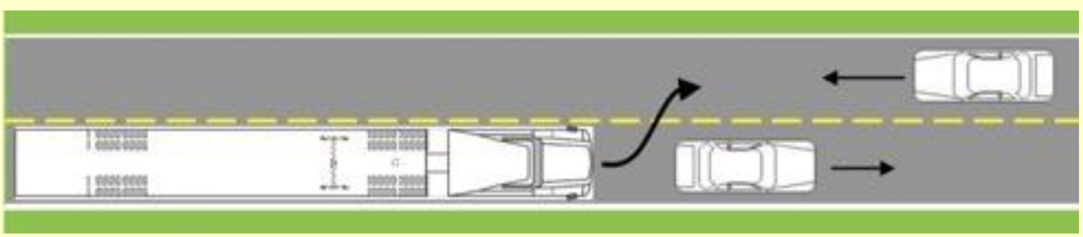
Intersection 25%



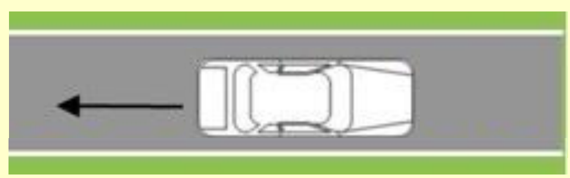
Lane Change 9%



Opposite Direction 2%



Backover 2%

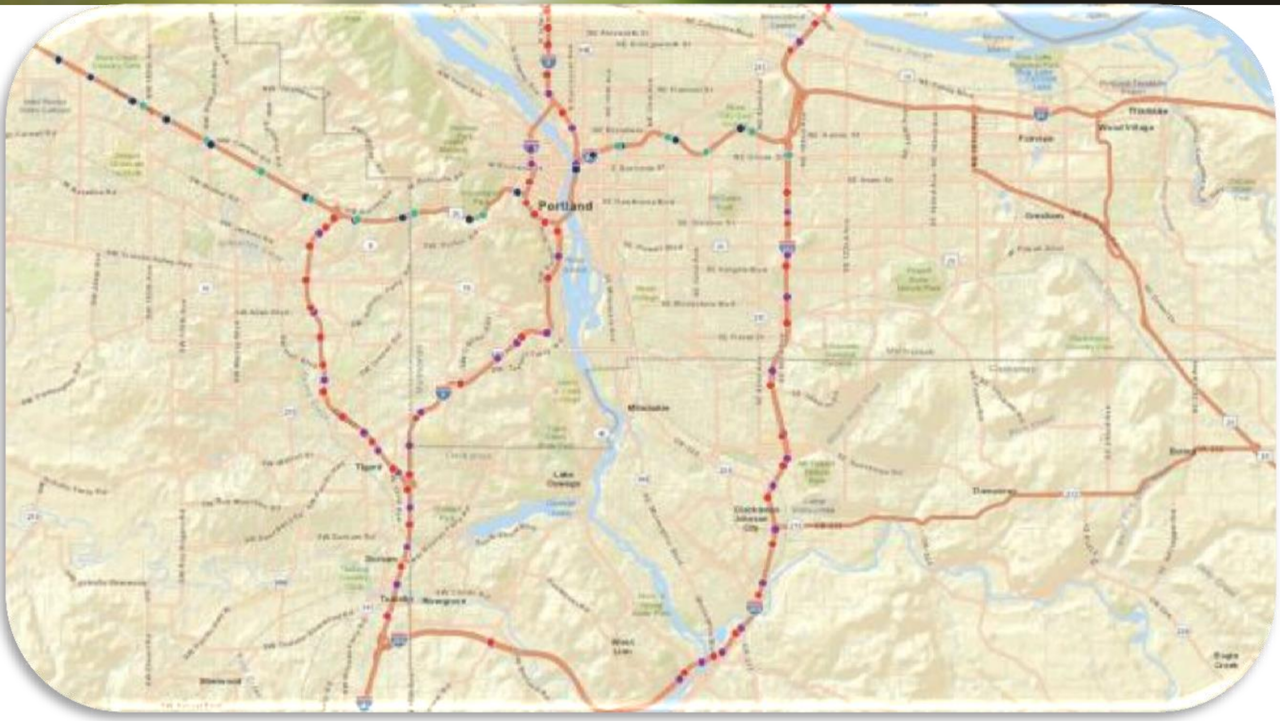


SAE J2735 Basic Safety Message

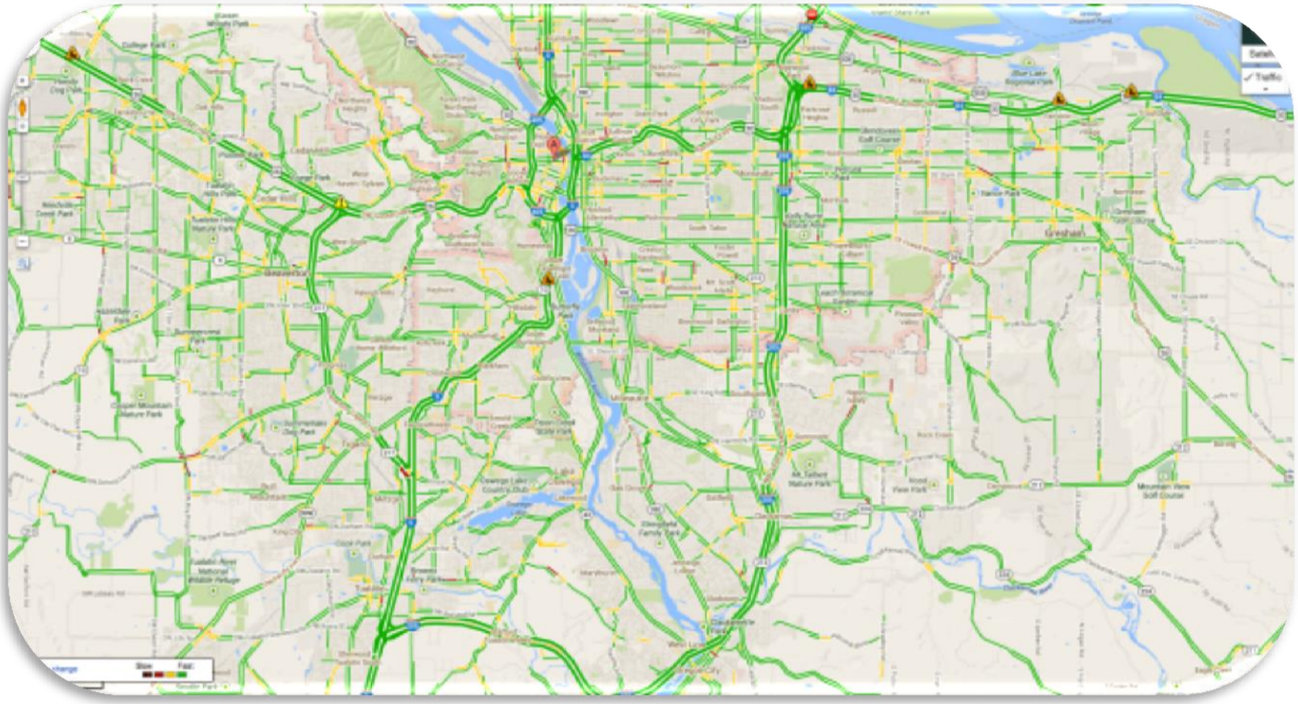
Basic Safety Message
Temporary ID
Time
Latitude
Longitude
Elevation
Speed
Heading
Acceleration
Brake System Status
Vehicle Size

A Data Revolution

From a desert…



…to an ocean!



Data Environment Evolution

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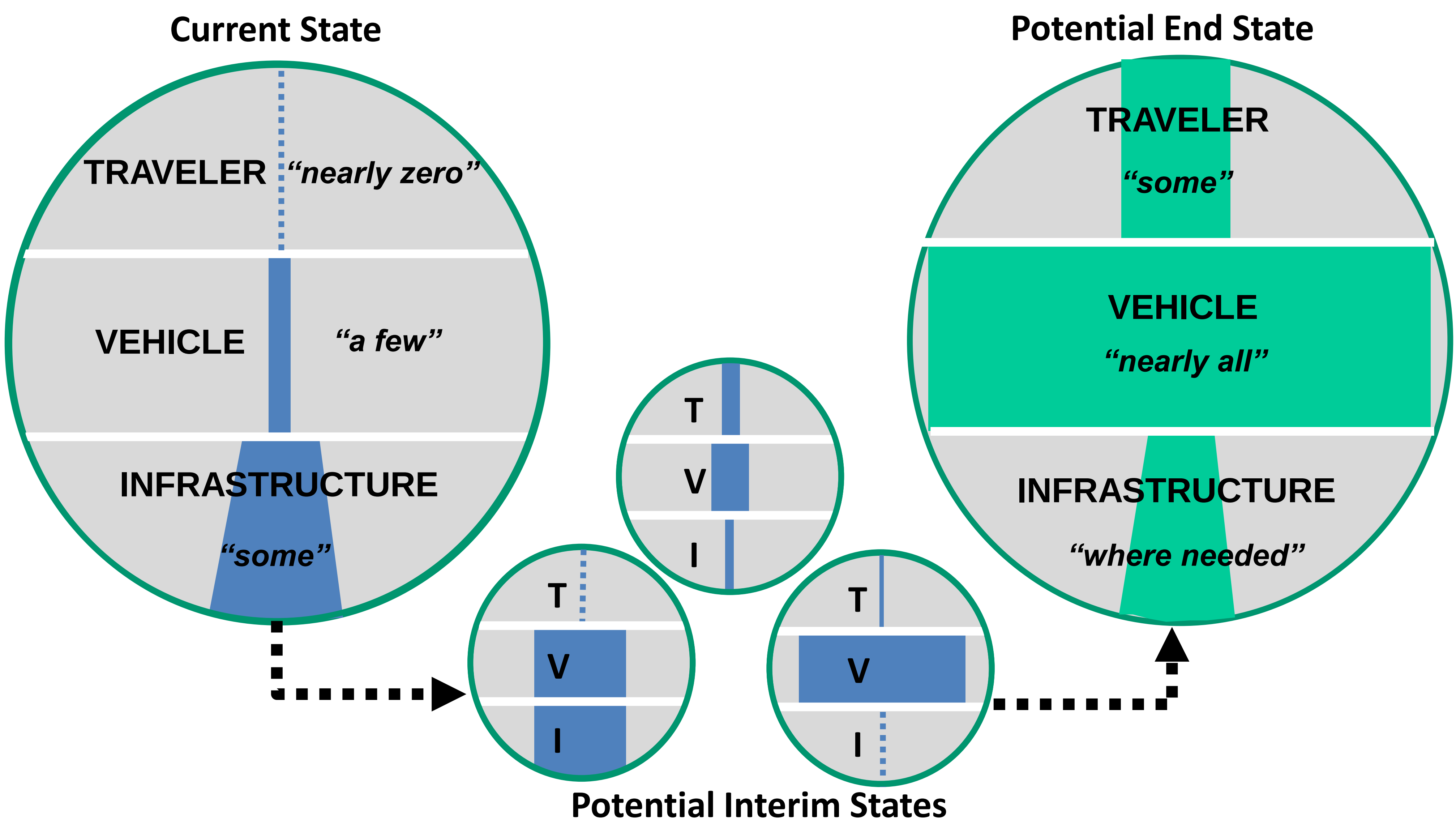

Mobility Program

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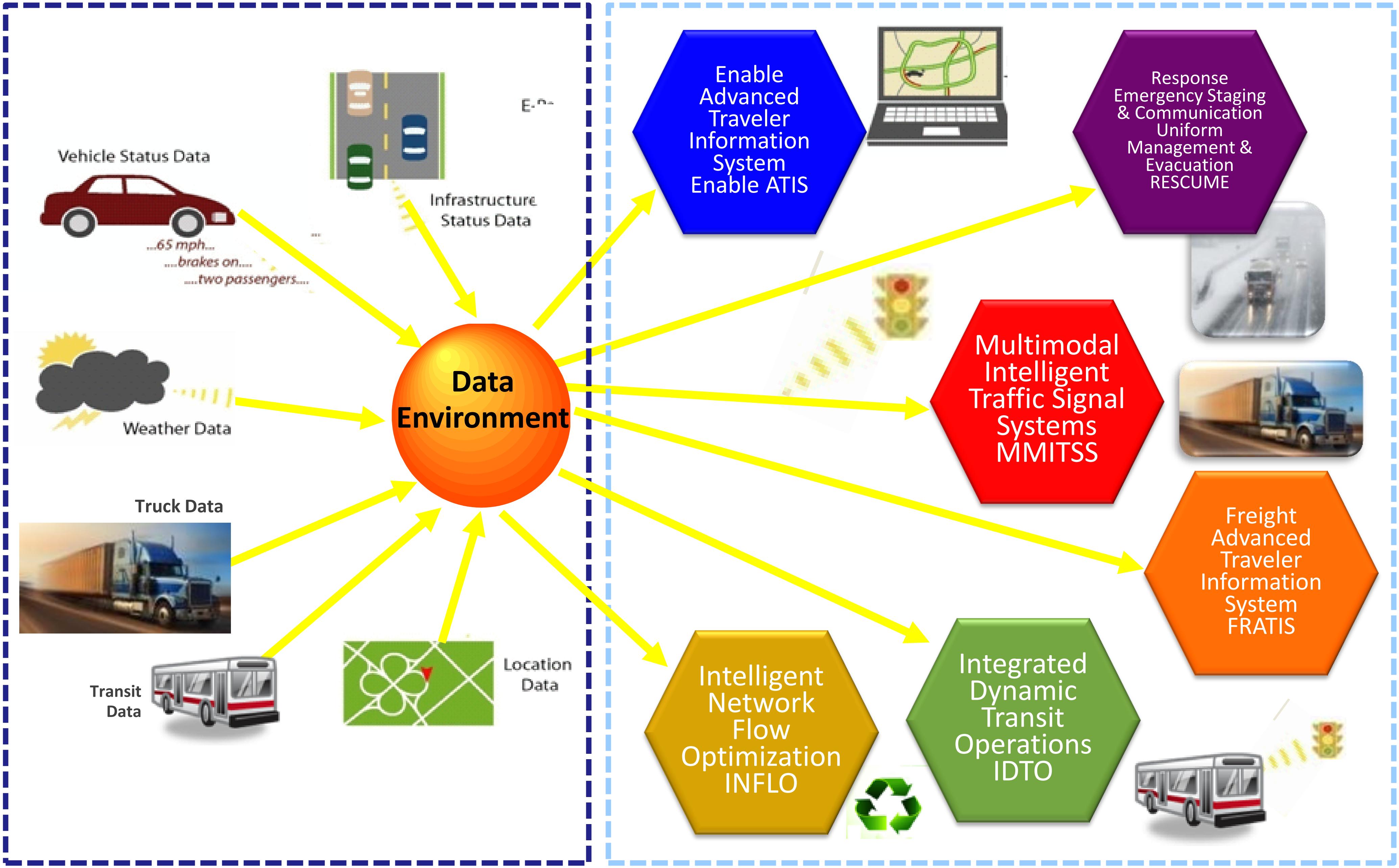
Real-time Data Capture & Management

Mobility Applications



Policy Issues

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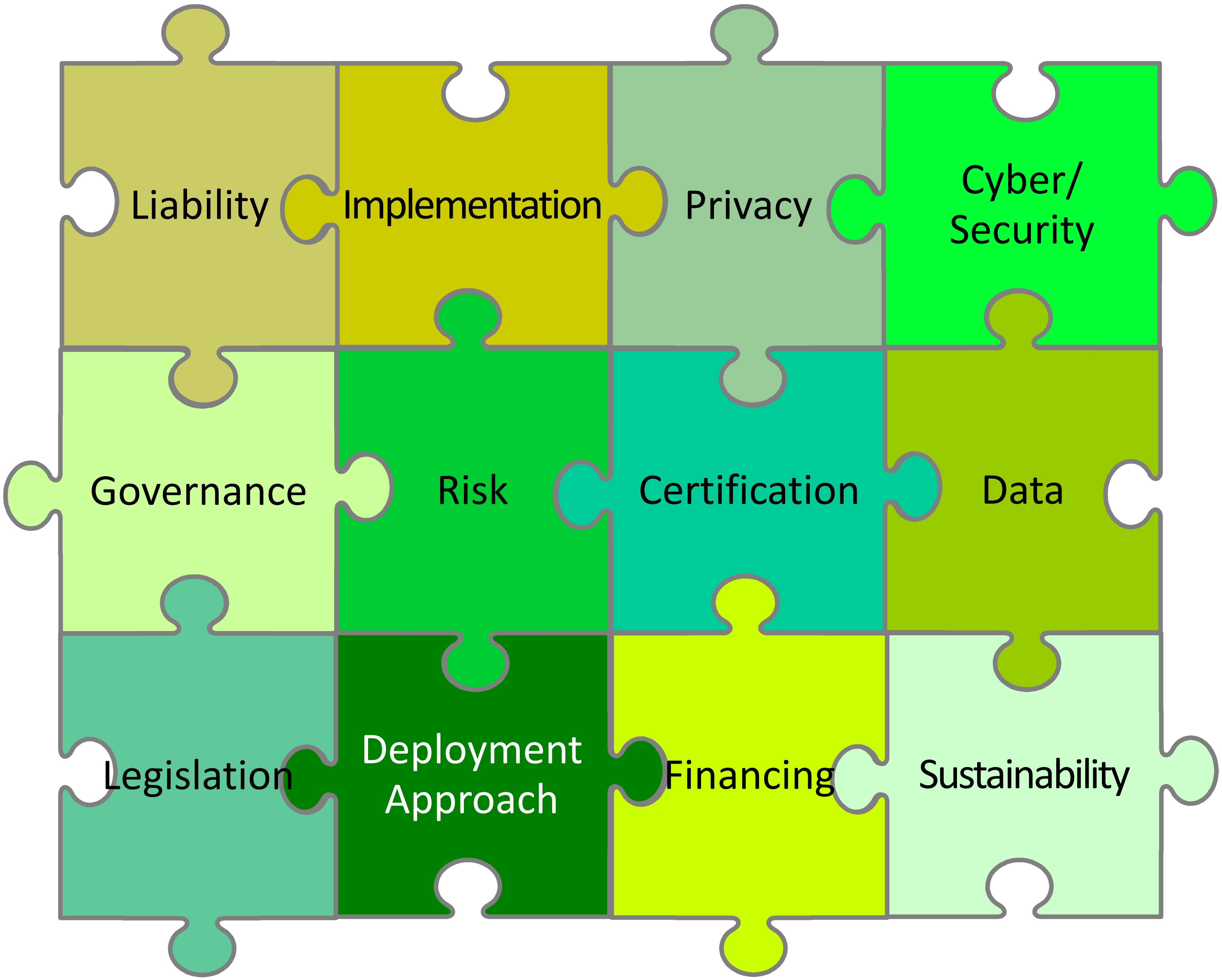

Autonomy vs. Cooperation

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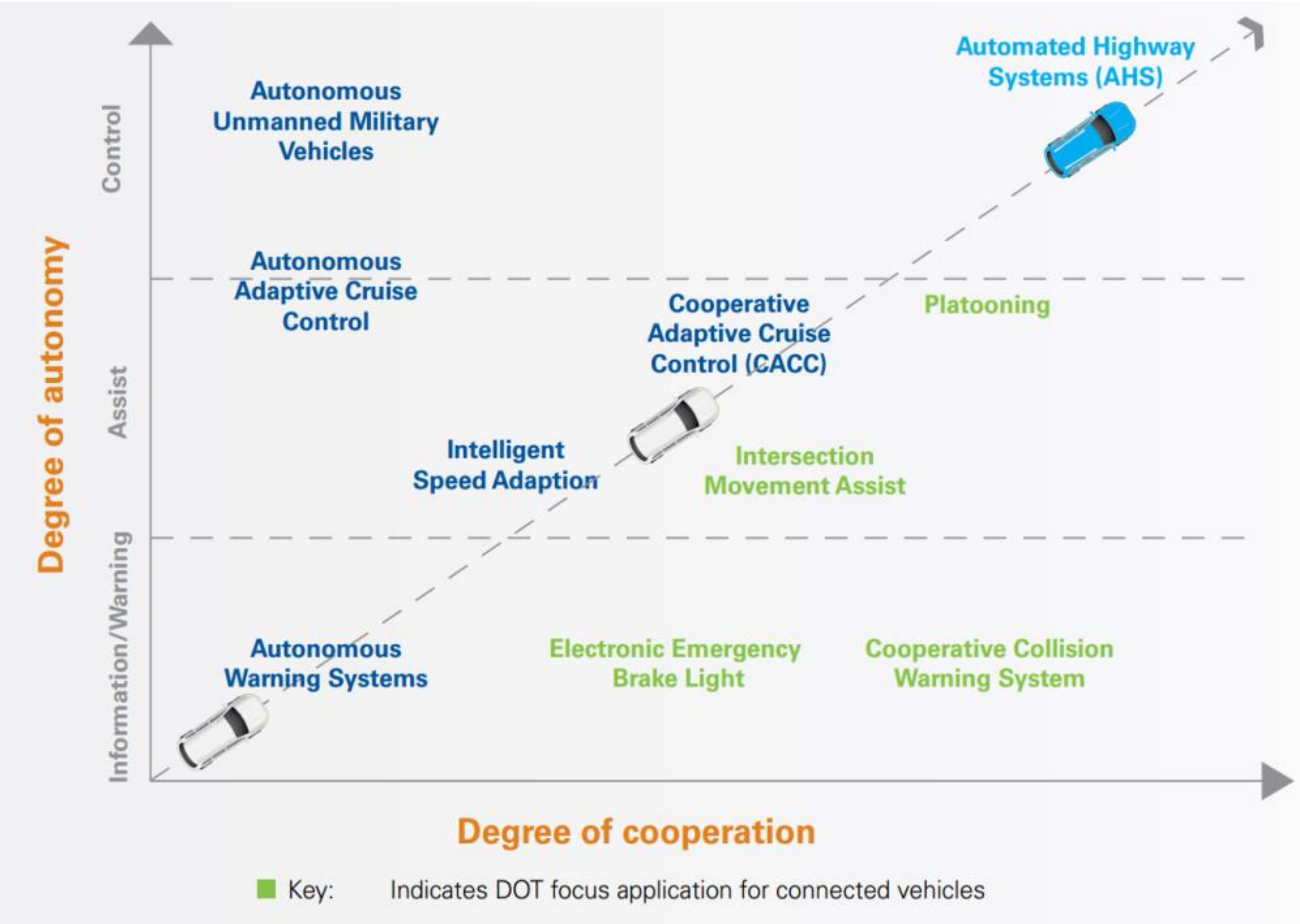

Driverless Car History

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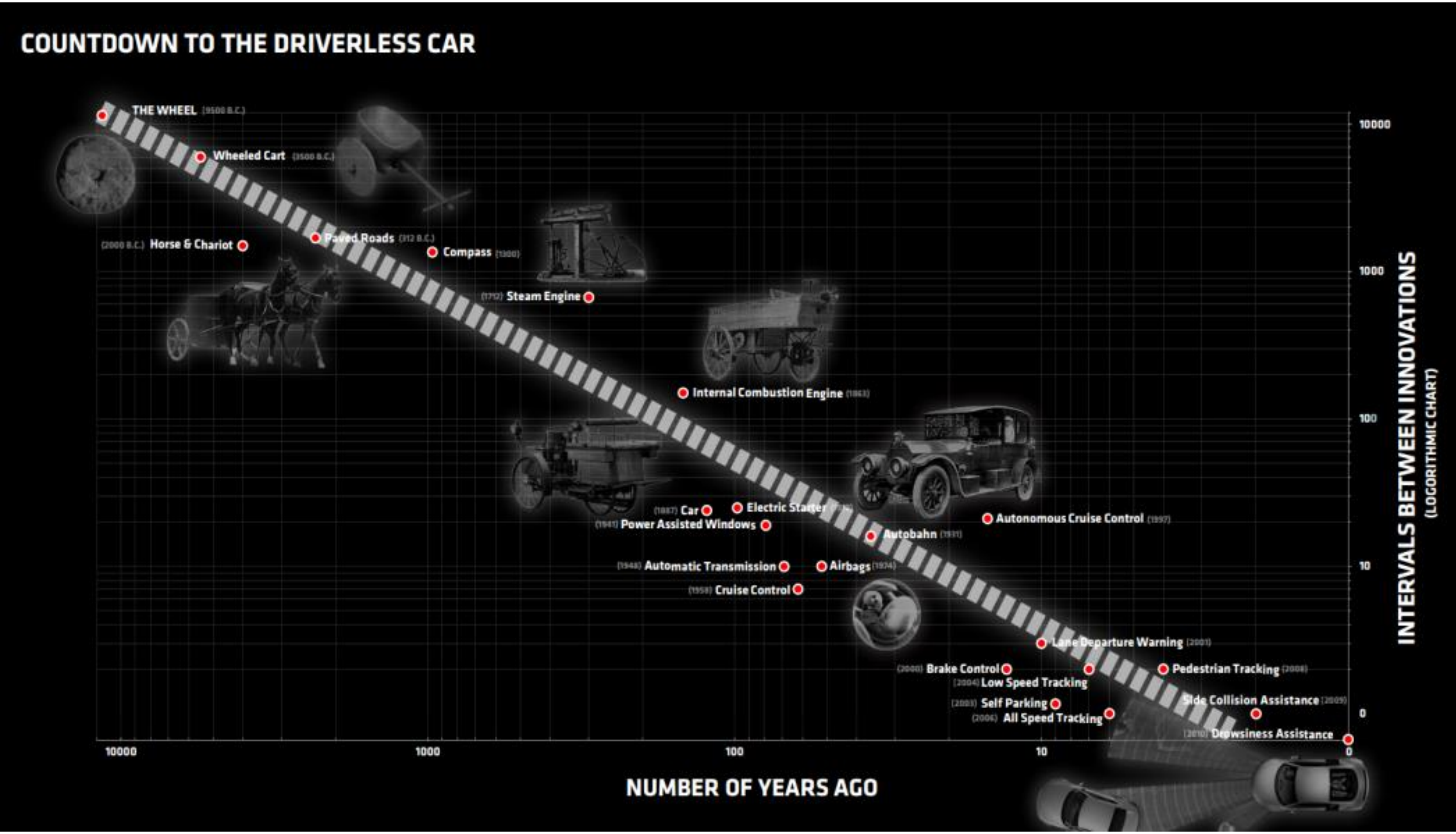

Levels of Automation

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NHTSA level	SAE level	SAE name	SAE narrative definition	Execution of steering and acceleration/ deceleration	Monitoring of driving environment	Backup performance of *dynamic driving task*	System capability (*driving modes*)
	***Human driver* monitors the driving environment**						
0	**0**	**Non-Automated**	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	**1**	**Assisted**	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	**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	**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	**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**

Taxonomy

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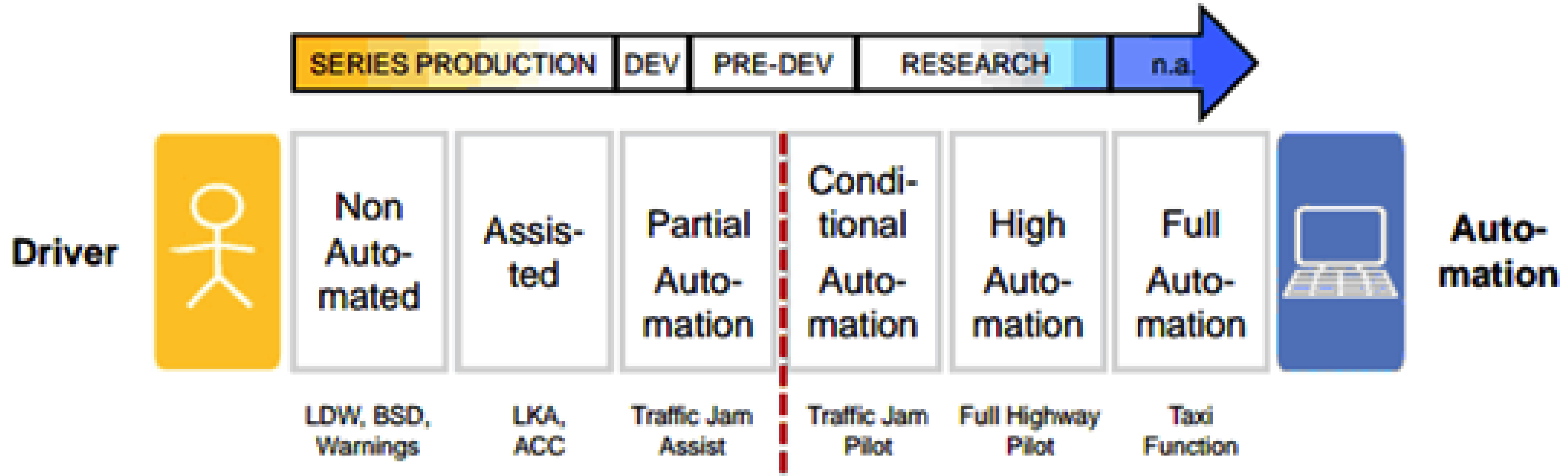
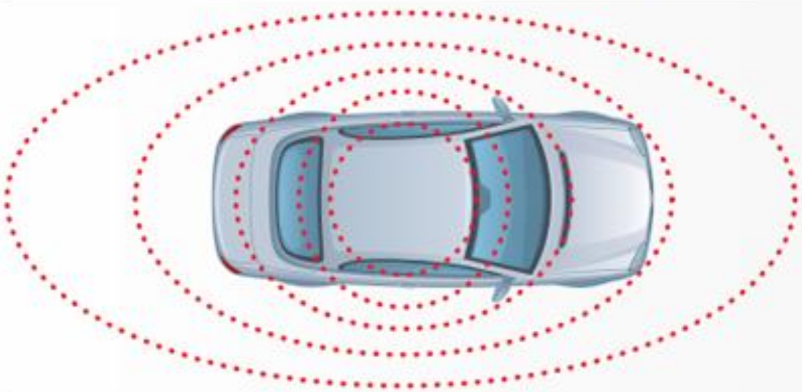


Driver in the loop	*yes (must!)*	*no*	
Reaction time	*~ 1 s*	*~ 10 s*	*~ 10 min*
Secondary tasks	*none*	*texting*	*sleeping*
Minimal Risk Cond.	*none*	*some*	*always (must!)*

Autonomy + Connectivity

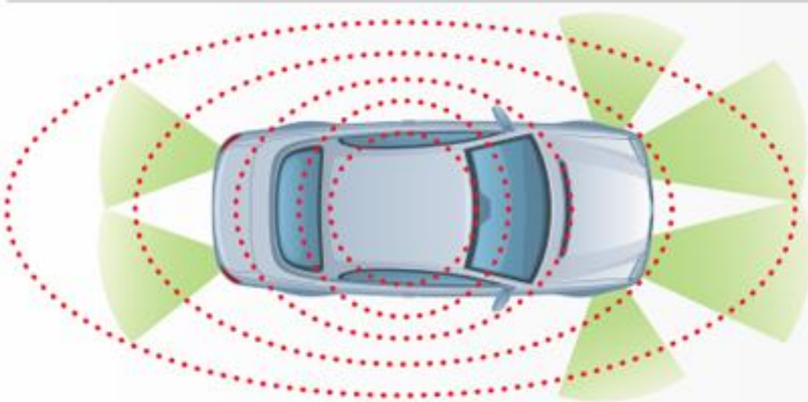
Sensor-Based Solution Only

- Cannot sufficiently mimic human senses
- Not cost-effective for mass market adoption
- Lack of adequate 360° mapping of environment in urban grids



Connected Vehicle Solution Only

- DSRC does not currently work with pedestrians, bicyclists, etc.
- DSRC-based V2I might require significant infrastructure investment
- V2V requires high market penetration to deliver value reliably



Converged Solution

- Convergence will facilitate adequate mimicking of human senses
- Convergence will reduce need for an expensive mix of sensors and reduce the need for blanket V2I investment
- Convergence will provide the necessary level of functional redundancy to ensure that the technology will work 100 percent of the time

Predictions

- 2015: Audi plans to market vehicles that can autonomously steer, accelerate and brake at lower speeds, such as in traffic jams.
- 2015: Cadillac plans vehicles with "super cruise": autonomous steering, braking and lane guidance.
- 2015: Nissan expects to sell vehicles with autonomous steering, braking, lane guidance, throttle, gear shifting, and, as permitted by law, unoccupied self-parking after passengers exit.
- Mid-2010's: Toyota plans to roll out near-autonomous vehicles dubbed Automated Highway Driving Assist with Lane Trace Control and Cooperative-adaptive Cruise Control.
- 2016: Tesla expects to develop technology that operates autonomously for 90 percent of distances driven.
- 2018: Google expects to release their autonomous car technology.
- 2020: Volvo envisages having cars in which passengers would be immune from injuries.
- 2020: Mercedes-Benz, Audi, Nissan and BMW all expect to sell autonomous cars.
- 2025: Daimler and Ford expect autonomous vehicles on the market.

New ODOT Research Project

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Preparing a Possible Oregon Road Map for Connected Vehicle/Cooperative Systems Deployment Scenarios

October 1, 2013 – June 1, 2015

Objective: lay groundwork for Oregon to be prepared for future implementation of connected vehicle/cooperative systems transportation portfolio, consider whether to take an early national leadership role and/or to avoid being caught by surprise as developments in this area evolve quickly.

- *Assess ODOT Connected Vehicle Position*
- *Autonomous Vehicle Desk Scan*
- *Inventory of Global and State Level*
- *Connected Vehicle Applications & Capacity*
- *Stakeholder Inventory and Outreach*
- *Connected Vehicle Application Roadmap*
- *Selected Application Demonstrations*
- *Final Recommendations*
- *Final Report*

Thank You for Your Attention

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