

THE CONNECTED/ AUTOMATED VEHICLE WAVE:

*What does it mean for the
infrastructure industry?*

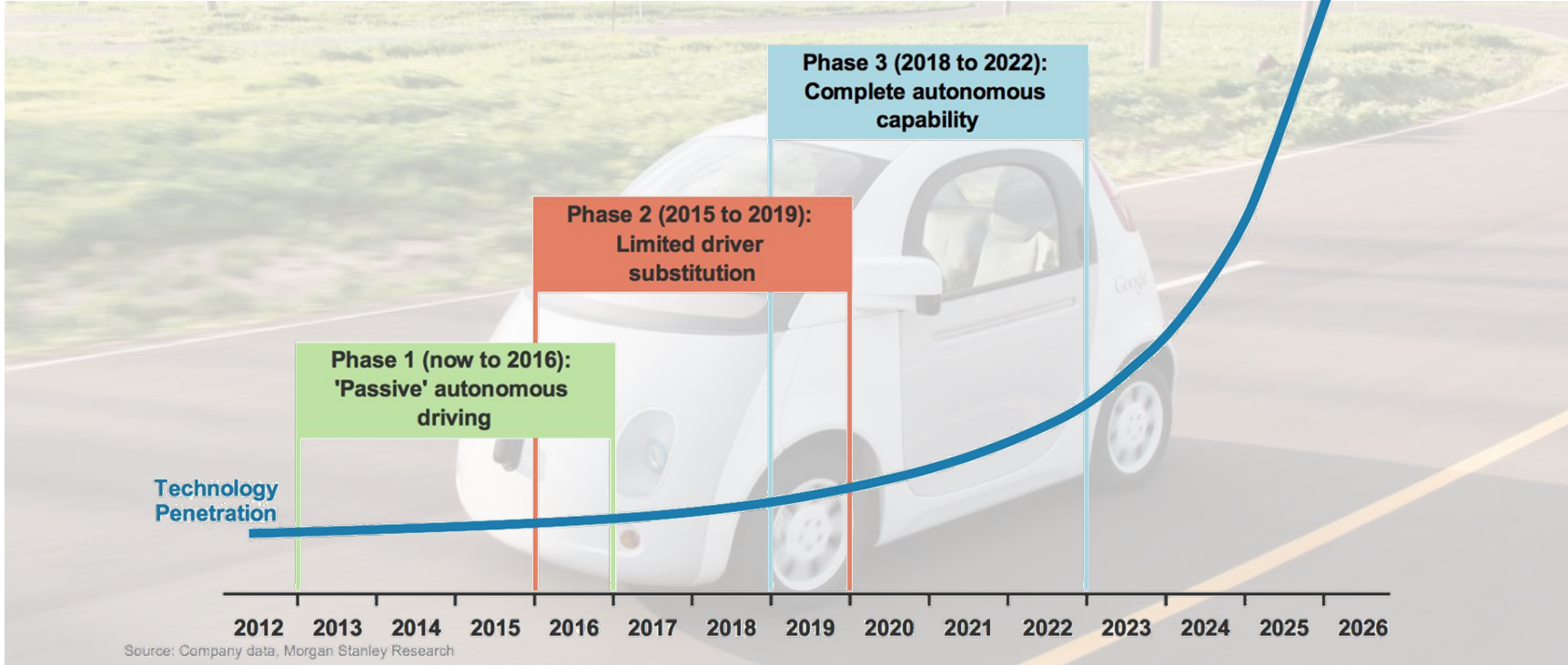
Illinois Transportation and Highway Engineering Conference
February, 2016

THE RACE TO DRIVERLESS





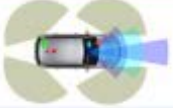
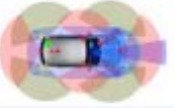
Source: Google

THE RACE TO DRIVERLESS



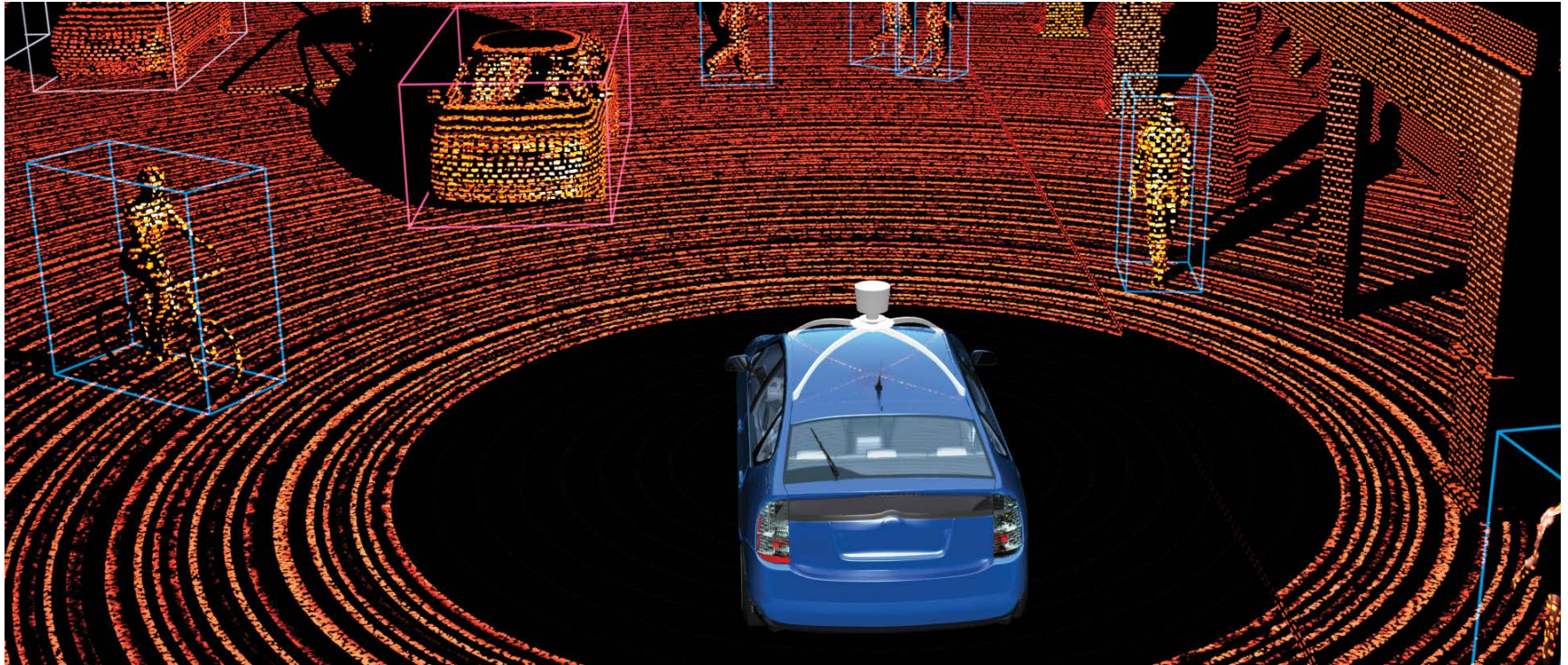
Source: Morgan Stanley

NHTSA AV LEVELS

	Level 0	Level 1	Level 2	Level 3	Level 4
	Driver only	Assisted	Partial	Conditional	Full
Feature		Active high beam	Traffic jam assist	Collision avoidance	Valet self-parking
		Collision imminent braking	Adaptive cruise & lane keeping	Automated highway	Highway point-to-point
		Cruise control	Self-parking (with driver)	Automated urban	Urban point-to-point
Technology					
		Radar	Radar	LIDAR & 360° radar	LIDAR & 360° radar
		Forward sensors	Forward sensors	High accuracy GPS	High accuracy GPS
			Multi-domain controller	Multi-domain controller	Multi-domain controller
		Driver state sensor	Forward, HD & IR cameras	Forward, HD & IR cameras	
		V2X	V2X	V2X	
			Internal moment unit	Internal moment unit	
	Today		2020		2025+

DELPHI

IS THIS A CONNECTED CAR?



Source: Google

AV ~~≠~~ CV + 1

WHAT IS CONNECTED?

- Cooperative communications systems
- Linking vehicles together, to the roadside, and to the “cloud”
- Interoperable systems that work across all equipment and manufacturers

WHY DOES AV SEEM TO BE GAINING GROUND ON CV?



- Autonomous Vehicles
 - Market driven
 - Day-one benefit
 - No inter-operability required
- Connected Vehicles
 - Regulation required
 - Must be national, inter-operable system
 - Day-one benefits more difficult to capture

CV AND AV ON A COLLISION COURSE

→ “Connected Vehicles give you further lines of safety that you couldn’t get from an independent, autonomous vehicle”

Mark Rosekind,
NHTSA Administrator
February, 2016

Autonomous Automated Vehicle

- Operates in isolation from other vehicles using internal sensors



Connected Vehicle

- Communicates with nearby vehicles and infrastructure
- Not automated (level 0)



Connected Automated Vehicle

- Leverages autonomous automated and connected vehicles



WHAT IS THE ROLE OF CV IN THE AV SPACE?

- AV “sees” with sensors and must interpret environment
- Sensors detect green indication, computer knows green means GO
- No context beyond what human driver can see



WHAT IS THE ROLE OF CV IN THE AV SPACE?



- In a CV environment, the other vehicles and the traffic signal are “talking” to the AV:
- Phase state
 - Time to phase change
 - Real-time optimal progression speed
 - Real-time route guidance based on signal delay
 - Identification of hazards out of the view of sensor systems

“The technology may be ready
before society is.”

Bill Ford, Jr., Chairman, Ford Motor Company
December, 2015

The technology itself is not able to answer the societal impact questions

Increased VMT?

Insurance Industry
Disruption?

Increased Urban
Sprawl?

Legal Liability?

Revenue Impacts?

Acceptance of
“Computer Driver”?

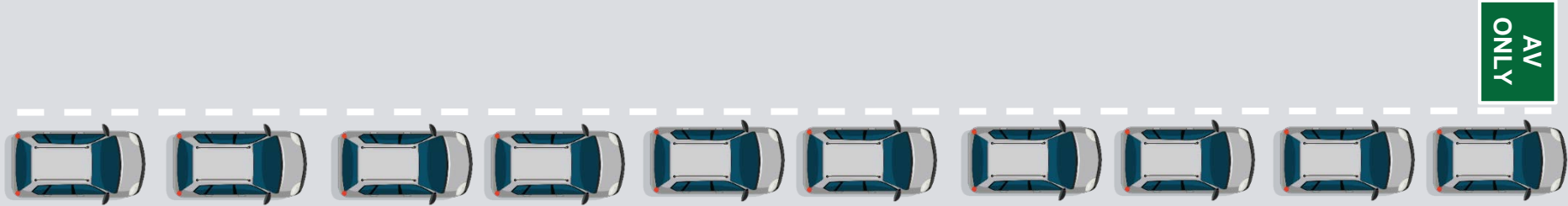
Auto Industry
Disruption?

POTENTIAL TO CHANGE THE CAR OWNERSHIP PARADIGM



C/AV will impact
everyone in this room

CHANGES IN ROADWAY CAPACITY



Under low-volume conditions, vehicles travel at high speeds with sufficient spacing

As volume increases, speed decreases as vehicle headways decrease

If AVs could operate at high speed with low headways, huge potential capacity increases

IS THIS OUR FUTURE?



CHANGES IN ROADWAY GEOMETRY

What if a two-lane highway today...

CHANGES IN ROADWAY GEOMETRY

What if a two-lane highway today...

...could become a three-lane highway tomorrow?

CHANGES IN VEHICLE-MILES TRAVELED (VMT)



When driving time is “regained”, how far might you ride in your car to work?

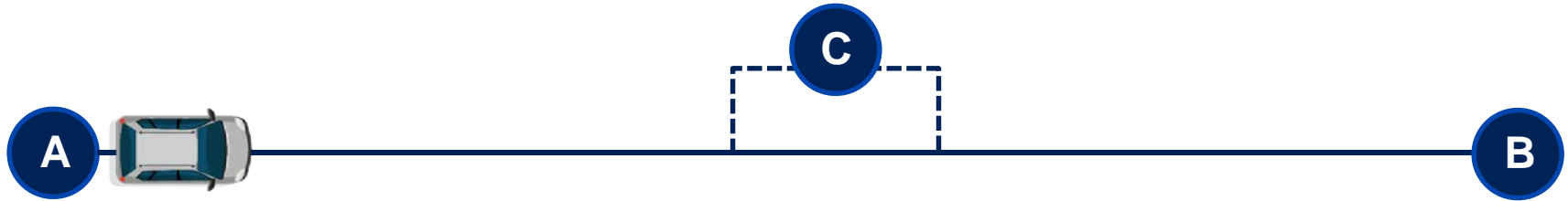
CHANGES IN CAR OWNERSHIP MODEL



What if this...

...increasingly
became this

CHANGES IN TRIP BEHAVIOR/RIDE SHARING



What if during the automated taxi trip from A to B...

...the system could identify a compatible ride share in real-time...

...reducing the trip cost and number of trips on our roads

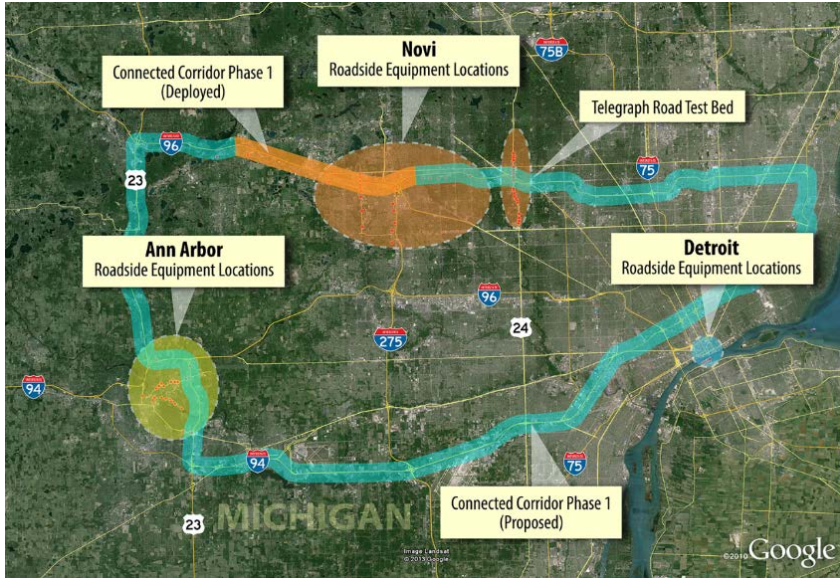
CHANGES TO REVENUE

What happens to revenue from speeding and parking tickets?



WHAT SHOULD YOU BE
DOING TO PREPARE
FOR THIS FUTURE?

RACE TO EMBRACE



- Four major Federal pilot programs underway:
 - Ann Arbor Connected Vehicle Test Environment (AACVTE)
 - Tampa (THEA) Pilot
 - Wyoming/ICF Pilot
 - New York City Pilot
- State/locally led initiatives in Michigan, Virginia, Arizona, Minnesota, Florida, California, New York, Utah and many others.

WHY START EARLY?

- Further economic competitiveness
- Identify pathways to early user benefits
- Gain deployment experience before mandate



MDOT LOOKING TO MOBILE FOR NEAR-TERM BENEFITS



Data Entry Portal for Construction Personnel

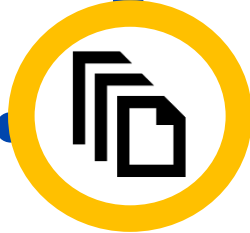


Data Elements Including:

- Speed Limit
- Lane and Ramp Closures
- Workers Present
- Truck Restrictions



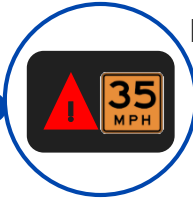
Data Collection and Processing



Message Development



DSRC



DVI



Internet



Mobile Device



Cellular

PREPARE YOUR DIGITAL INFRASTRUCTURE

- Assess whether your systems today are scalable/compatible with a connected vehicle environment
 - Data management
 - Communications network capacity
 - Data sharing agreements
 - IT/network security

KEY INFRASTRUCTURE SYSTEM ELEMENTS

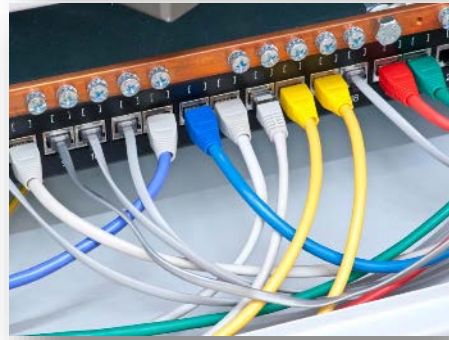
5.9 GHz DSRC
Roadside Units



Signal
Controller/
Cabinet
Upgrades



Backhaul
Communications
and Data
Management



Infrastructure-
Based
Messaging

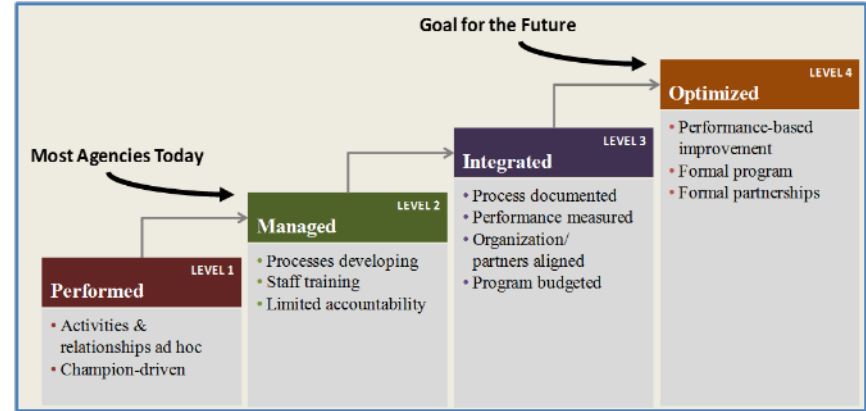


YOU DO NOT HAVE TO PILOT TO PREPARE

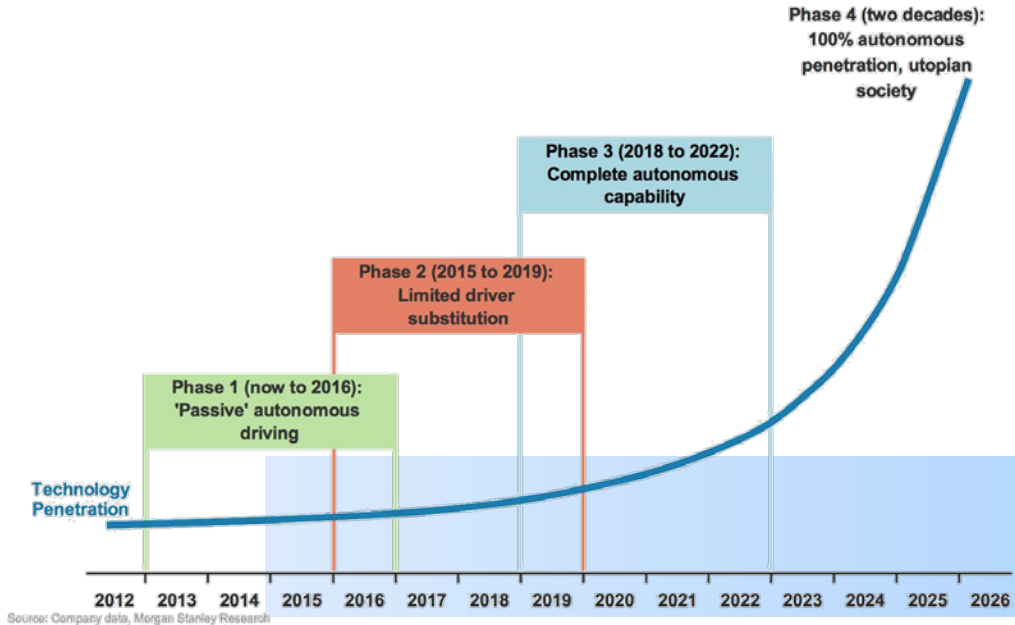
- Follow industry activity/research
- Anticipate greater communications needs and plan it into projects where sensible
- Conduct readiness self-assessment using a Capability Maturity Model

Capability Level Self Evaluation Structure				
DIMENSIONS	LEVEL 1 PERFORMED	LEVEL 2 MANAGED	LEVEL 3 INTEGRATED	LEVEL 4 OPTIMIZING
Business Processes		X		
Systems & Technology			X	
Performance Measurement	X			
Culture			X	
Organization/staffing		X		
Collaboration			X	

Lowest level is constraint



CONSIDER C/AV IMPACT ON LONG-RANGE PLANNING



2016

Source: Morgan Stanley

2036

- Changes to network capacity?
- Changes in VMT?
- Changes in car ownership?
- Changes in trip sharing?
- Changes in transit efficacy?

WHERE ARE THE ANSWERS?



OR

Scenario Planning

- Roadway capacity
- Travel behavior
- Vehicle occupancy
- Timeframe of introduction
- Rate of fleet penetration

I-94 CORRIDOR STUDY – TWIN CITIES



- MnDOT is asking “how will changes with C/AV impact our long-term plans for the corridor?”
- Scenario planning and modeling framework under development

This era will represent the biggest change in transportation since the advent of the automobile itself.

Embrace

Plan

Prepare



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