

Planning for Non-Traditional Vehicles

NDDOT - Planning and Asset
Management

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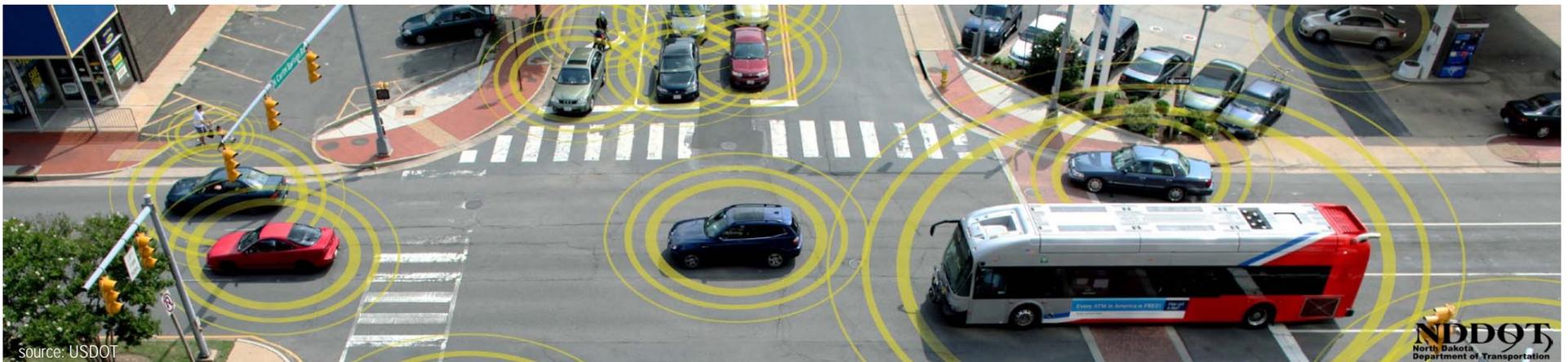
Key Terms

- CAV – Connected Autonomous Vehicle
 - V2V – Vehicle to Vehicle
 - V2I – Vehicle to Infrastructure
- HAV – Highly Automated Vehicle
- ADS – Automated Driving System
- AI – Artificial Intelligence
- EV – Electric Vehicle
- ICE – Internal Combustion Engine
- TAAS – Transportation as a Service
(some refer to Mobility as a Service)



USDOT Definition

- At least some aspect of a safety-critical control function (e.g., steering, throttle, or braking) occurs without direct driver input.
- May be autonomous (i.e., use only vehicle sensors) or may be connected (i.e., use communications systems such as connected vehicle technology, in which cars and roadside infrastructure communicate wirelessly).
- Connectivity is an important input to realizing the full potential benefits and broad-scale implementation of automated vehicles.



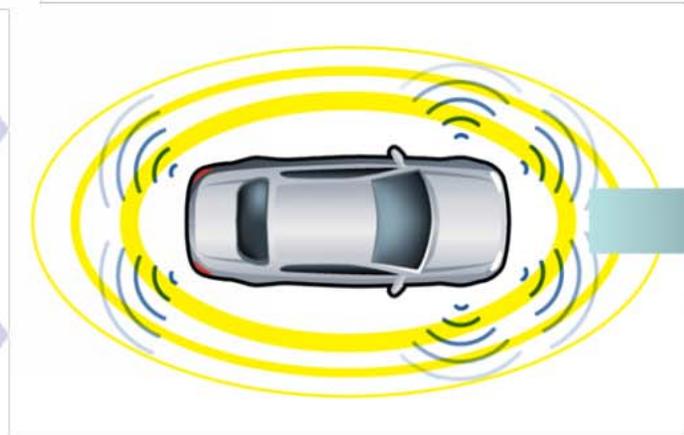
Connected

Connected Vehicle

Communicates with nearby vehicles and infrastructure; Not automated



Connected Automated Vehicle
Leverages autonomous automated and connected vehicles



Autonomous Vehicle

Operates in isolation from other vehicles using internal sensors



For on-road vehicles



Human driver

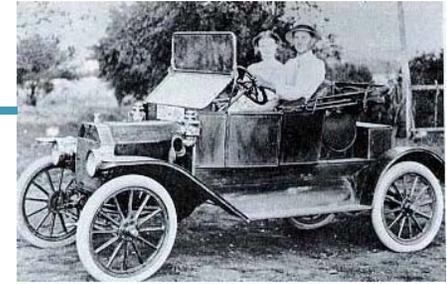


Automated system

Levels of Autonomy

		Steering and acceleration/ deceleration	Monitoring of driving environment	Fallback when automation fails	Automated system is in control
Human driver monitors the road	0 NO AUTOMATION				N/A
	1 DRIVER ASSISTANCE				SOME DRIVING MODES
	2 PARTIAL AUTOMATION				SOME DRIVING MODES
Automated driving system monitors the road	3 CONDITIONAL AUTOMATION				SOME DRIVING MODES
	4 HIGH AUTOMATION				SOME DRIVING MODES
	5 FULL AUTOMATION				

Model T



GM "Super Cruise"
2017 Cadillac CT6



Tesla Model S



Waymo (Google)



source: HDR

Benefits



Safety



Reduced Driver Costs



Productive Commutes



Wider-Reaching Mobility

source: HDR



Efficient Infrastructure

NHTSA



- Voluntary Policy Guidance for HAV Manufacturers
 - Safety
 - Vehicle Testing
 - Operational Design
 - Software Design/Upgrades
 - Crash Related Data
 - Consumer Education and Training
 - How equipment adapts to varying jurisdictional traffic laws or legal requirements
 - Cyber Security

115TH CONGRESS 1ST SESSION

House of
Representatives HR3388
SELF DRIVE ACT

Senate SB1885 – AV
START ACT

- Provides overarching guidance for HAV testing and operations
 - Gives States Authority to license, register, and insure, and perform vehicle inspections as needed
 - Does give general guidance on data ownership privacy and use however enforceability is unclear
- US House Bill 3388 SELF DRIVE ACT
- US Senate Bill 1885 AV START ACT
 - Conference committee will reconcile differences of the House and Senate legislation and combine into one bill

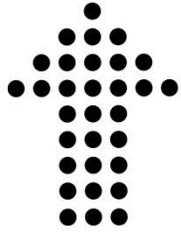
ND HB 1202

- Working with industry partners to review current laws and recommend potential changes associated with HAVs in the following areas
 - Licensing, Registration, and Insurance
 - Data ownership, privacy, and usage
 - Vehicle Inspections
 - Currently don't have a robust inspections program (only if a vehicle has been damage)
 - Non-Operator Issues
 - Examples - Minimum age to ride, Alcohol or Drug Related Offense
 - Want to be consistent with other states
 - Business Regulation
 - Examples - Truck platooning, Ride sharing (Uber/Lyft)
 - Want to be consistent with other states

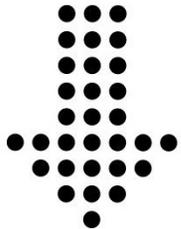
EV vs ICE

PROJECTED 2020-2025

performance



\$33,500
\$2,000
\$1,000 } **average ICE**



purchase price

fuel costs 90%

maintenance costs 90%



Ford to invest \$4.5bn in electric cars

11 December 2015 | Business

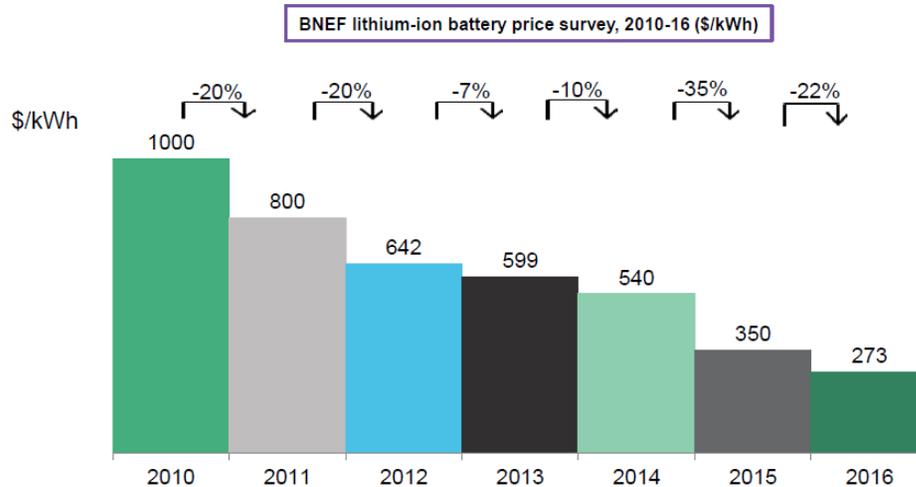
f t v e Share



Ford says it will invest \$4.5bn (£3bn) to expand its fleet of plug-in and hybrid electric vehicles, and will start selling 13 new electric models by 2020.

Key Technology Costs

- Battery cost currently is 1/3 to 1/4 the total cost of an electric vehicle



Notes: This includes cells plus pack prices. For years where there were two surveys, the data in this chart is an average for the year.

Source: Bloomberg New Energy Finance

LIDAR Costs Decreasing

2012 - \$70,000



2014 - \$1,000



Next Generation - \$90

source: Seba 2016

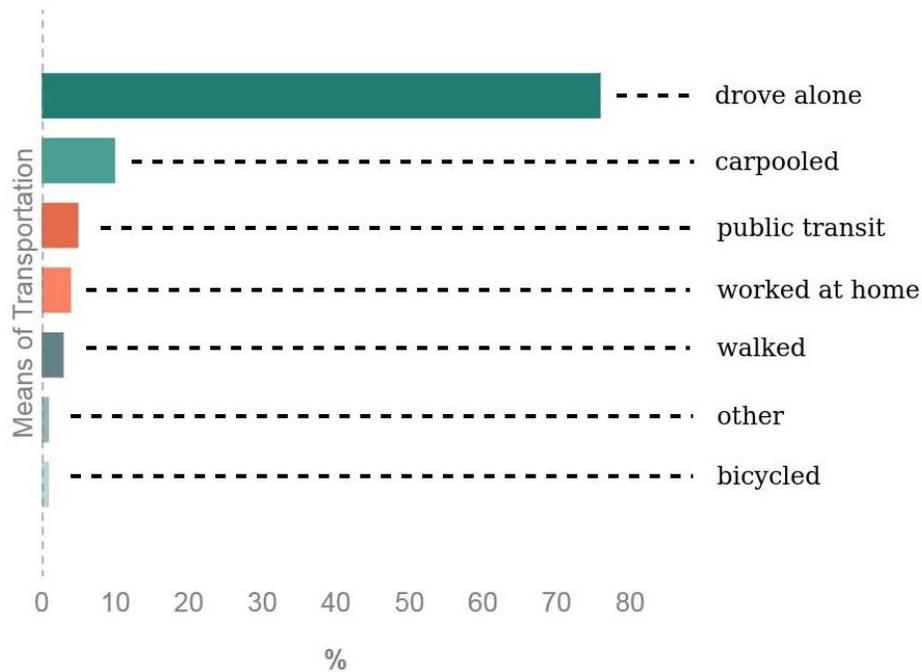
Into The Unknown

- What We Know: Things are Changing
- What We Don't Know: How and When They Will Change?



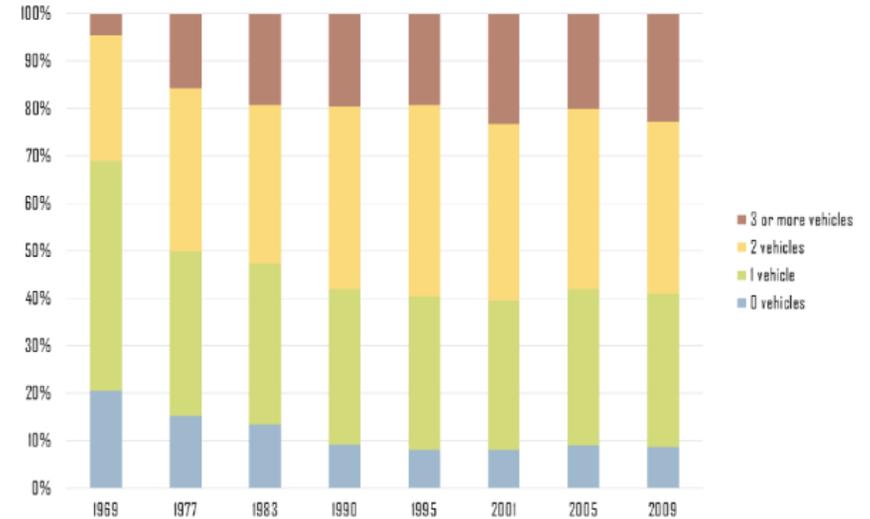
Current Model

TRANSPORTATION TO WORK



Source: US Census Bureau 2015 ACS, S0801

AUTOMOBILE OWNERSHIP



Source: U.S. Department of Commerce, U.S. Census Bureau, American Community Survey.

Percentage of Households by Number of Vehicles, 1977-2009

Current Model

AUTOMOBILE UTILIZATION CURRENT MODEL

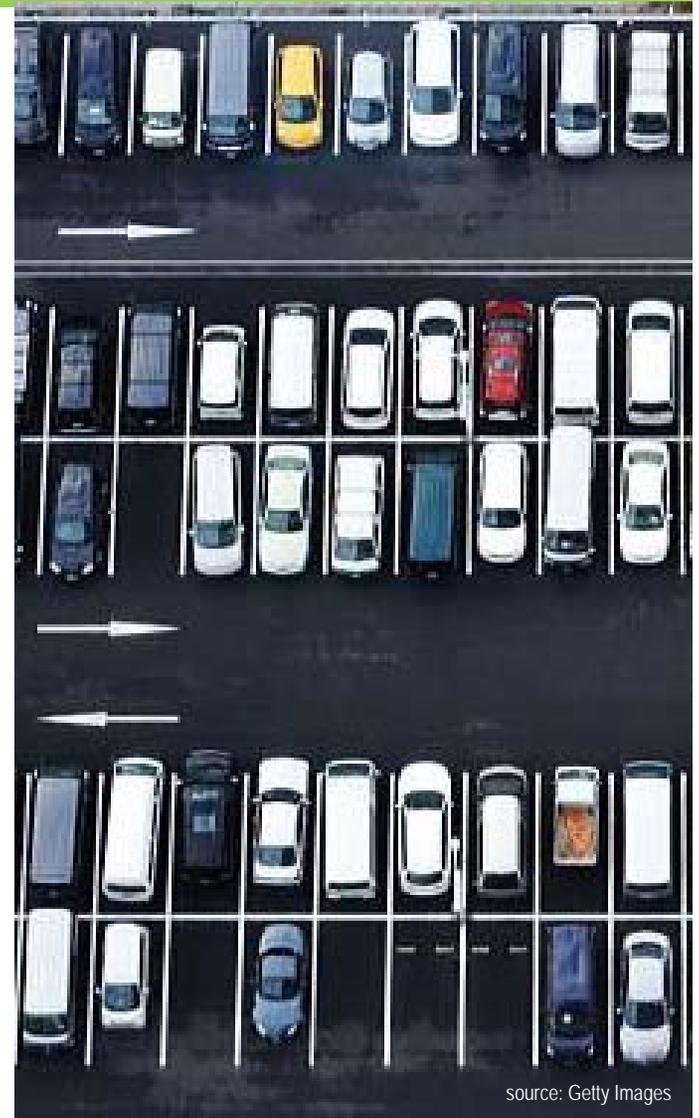
Parked



In Use

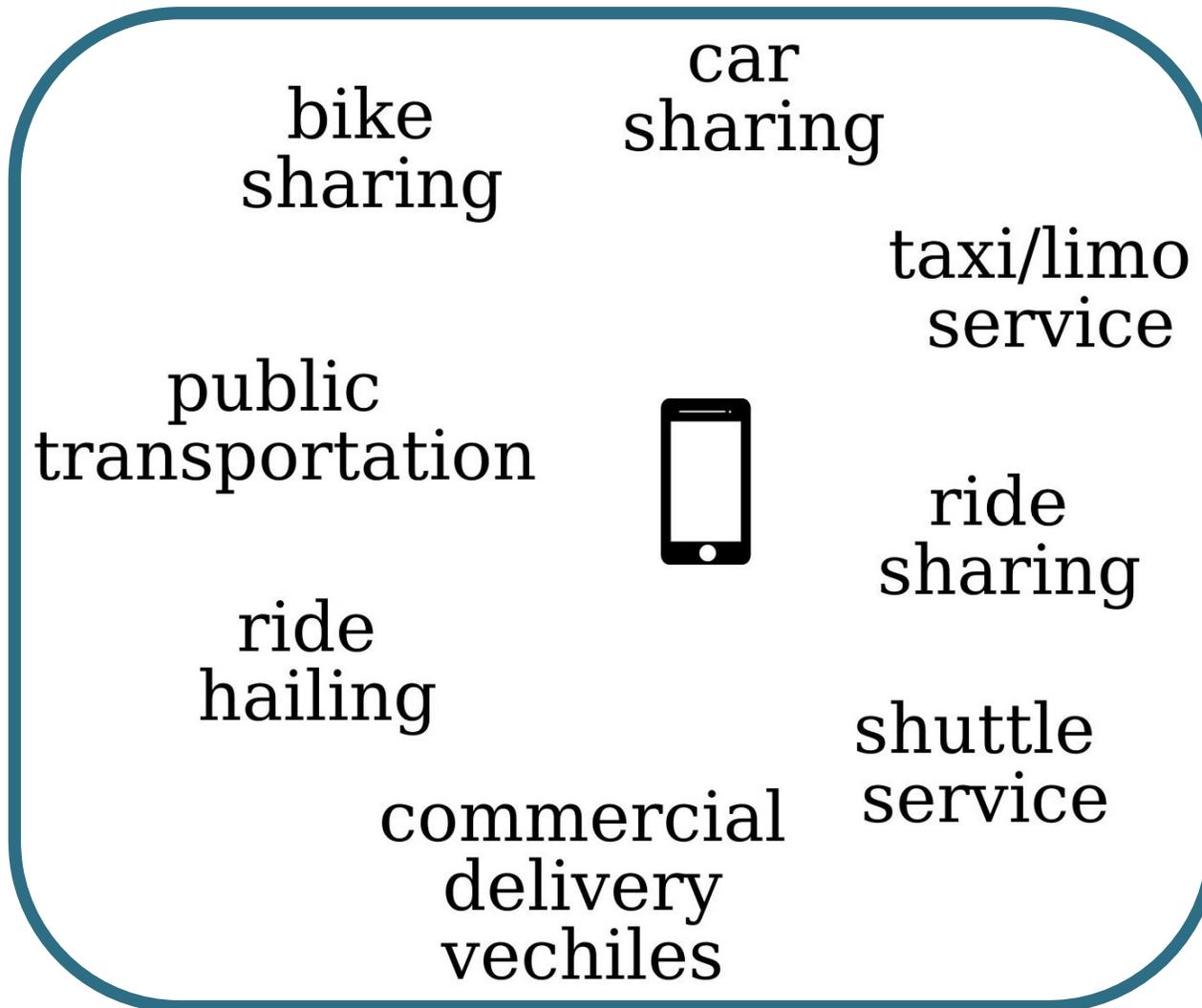


Source: Seba, March 2016



source: Getty Images

TAAS



Current vs. TAAS

CURRENT MODEL



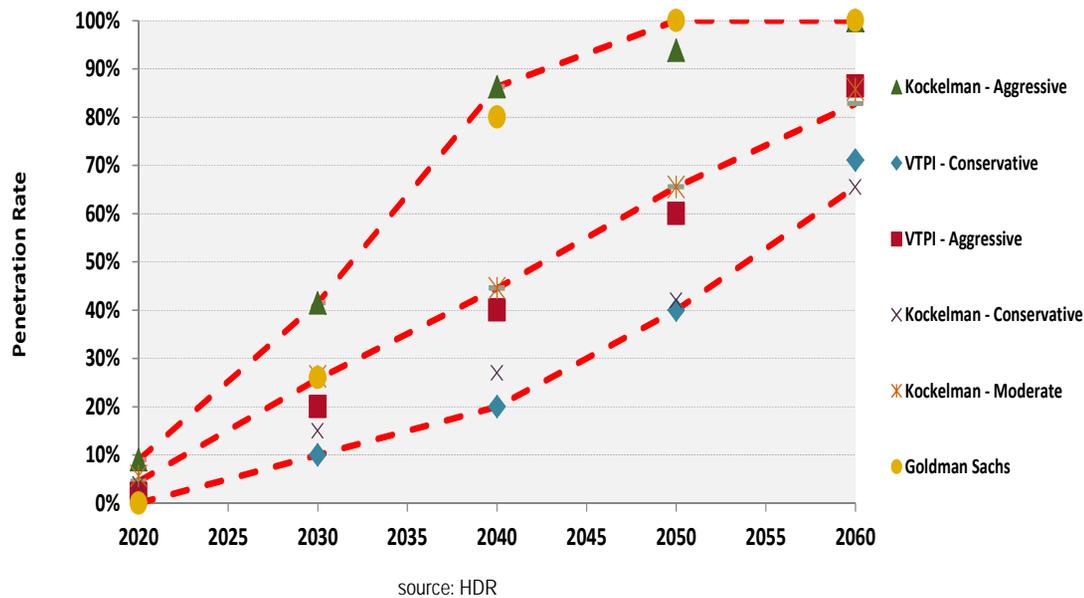
TAAS MODEL



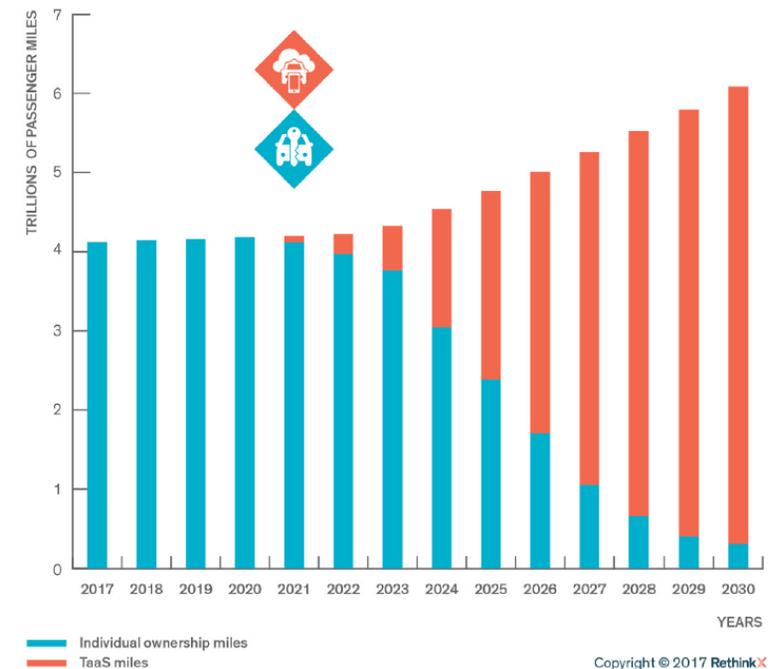
Source: McKinsey & Company, January 2016

When

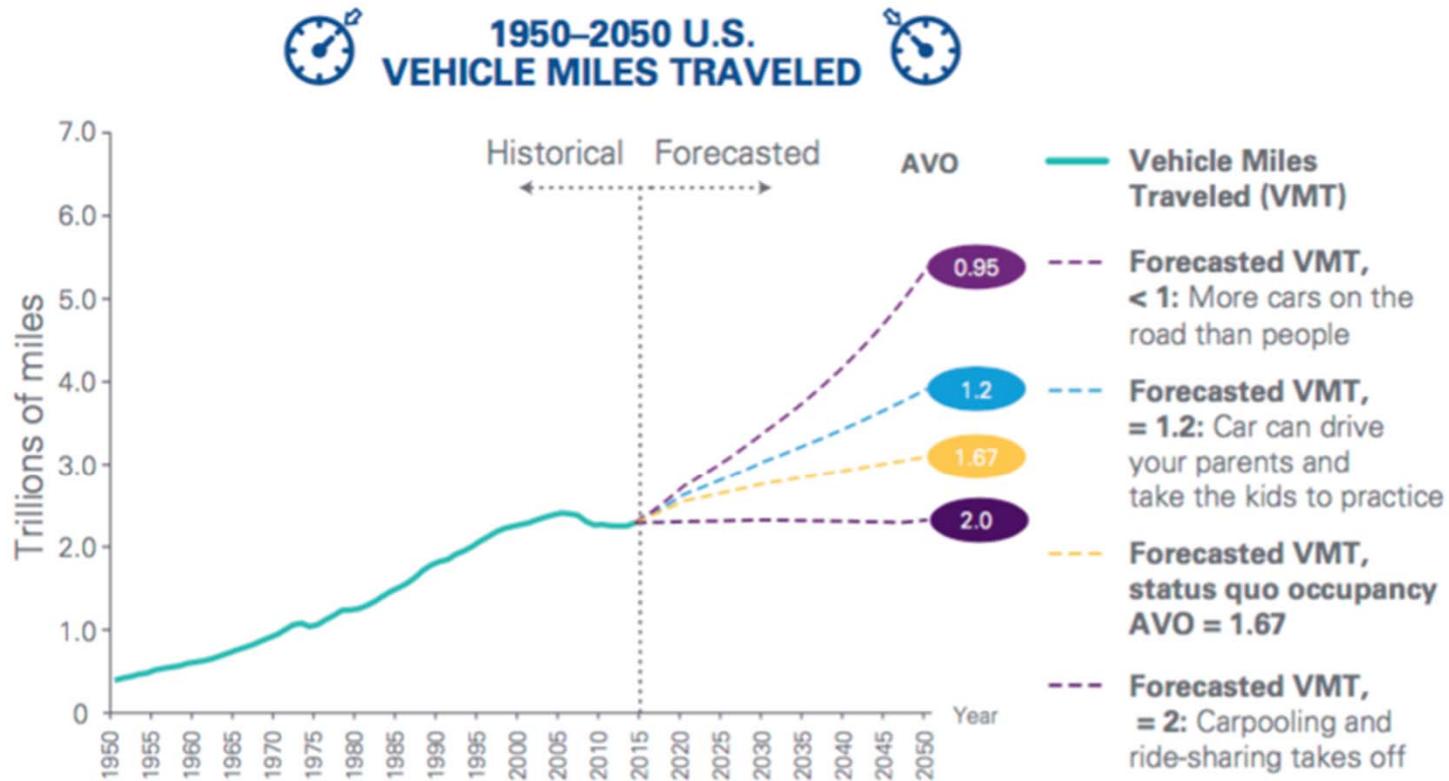
- Reviewed: McKinsey & Company; Bloomberg; KPMG; Goldman Sachs; Victoria Transport Policy Institute; and Rethink X
- Generally projections range for majority market penetration from 2030 to 2070



» Speed of TaaS adoption



Planning



Note: (a) Discounted 25% from U.S. BTS total VMT for 1995, 2001, 2009, 2014 (assumed to be commercial miles), (b) Multiplied by NHTS occupancy rates applied 2009 rate to 2014 numbers).

Source: U.S. BTS data, NHTS data, U.S. Census data, KPMG Analysis

Design

Current

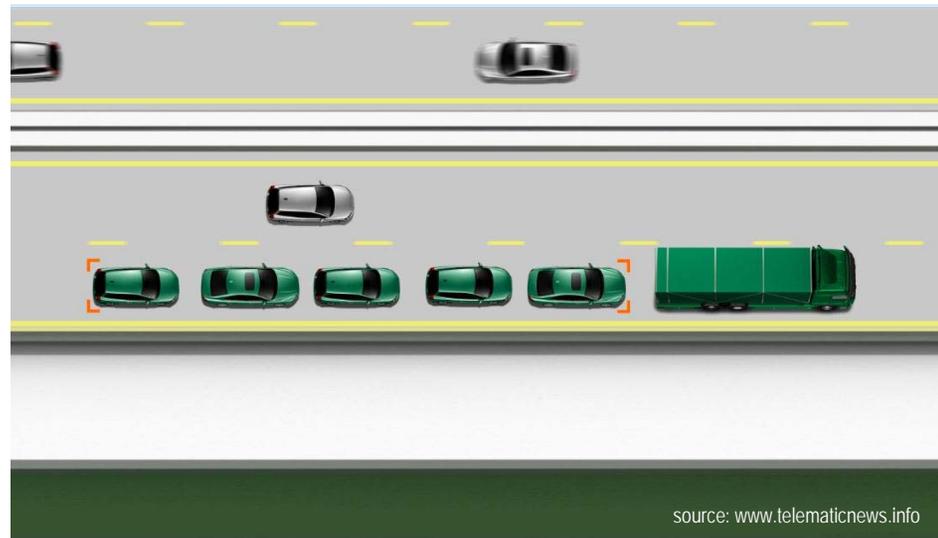


Autonomous



Operations

- Allow platooning (vehicles traveling closer together)
- Increased intersection efficiency with connected vehicles and infrastructure
 - Will traffic signals be necessary at some point if all vehicles are connected?



Maintenance



Other Considerations

Connected Truck Platooning



Autonomous Freight Shuttle

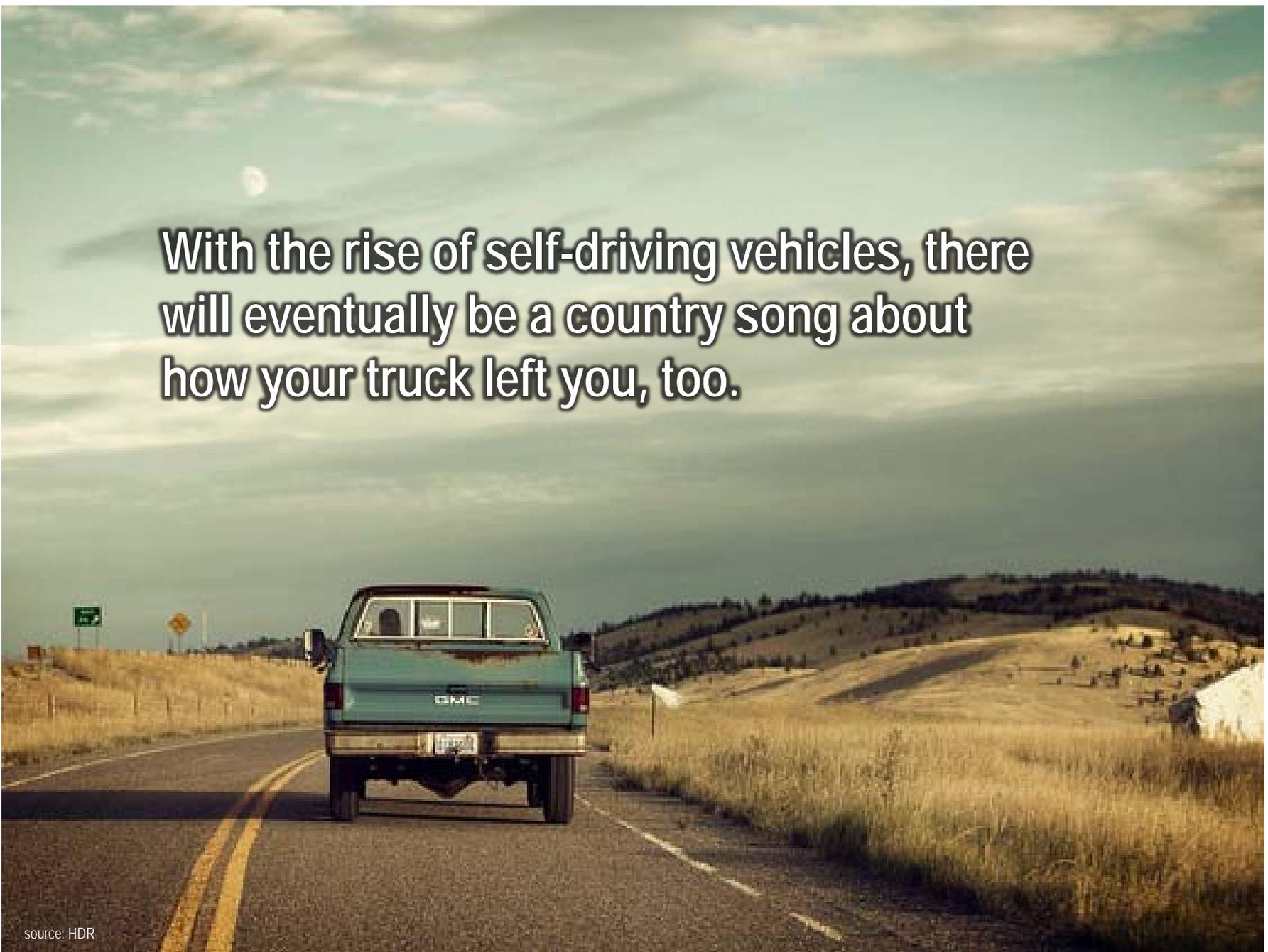


Autonomous Transit



Drone Product Delivery





With the rise of self-driving vehicles, there will eventually be a country song about how your truck left you, too.

source: HDR