Casualty Actuarial Society

Automated Vehicle Task Force:
Industry update

November 16, 2015

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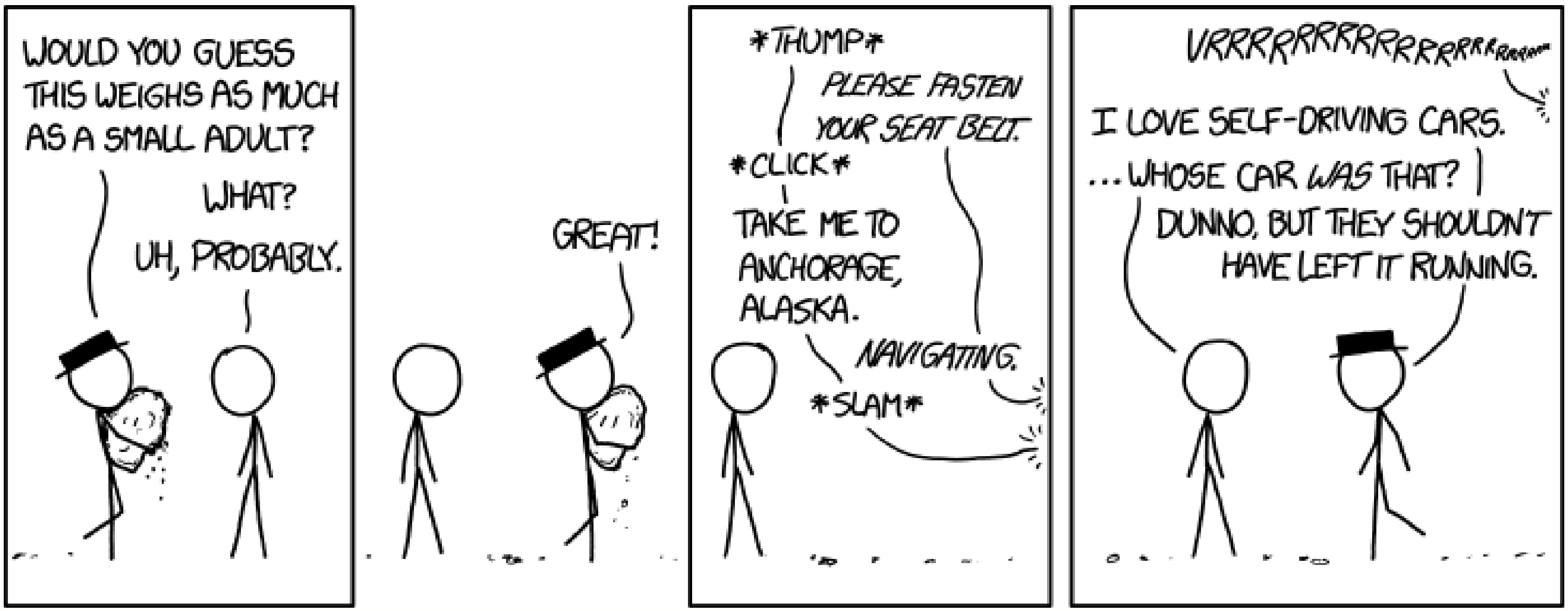

https://xkcd.com/1559/

CAS AVTF: Overview

Goal	The CAS AVTF is researching the technology's risks to provide policymakers with the information needed to ensure **the product is brought to market as safely and efficiently as possible.**

Focus		
Pre market	**Post market**	**Post claim**
identify & quantify risks	accurately price the technology	compensate claimants fairly & efficiently

Agenda

- **Automated Vehicles – Background**
- **Regulatory overview**
- **Insurance Industry Impact**
- **Automated Vehicle Risk Profile**
- **Vehicle Symbol Analysis**
- **Upcoming Projects**

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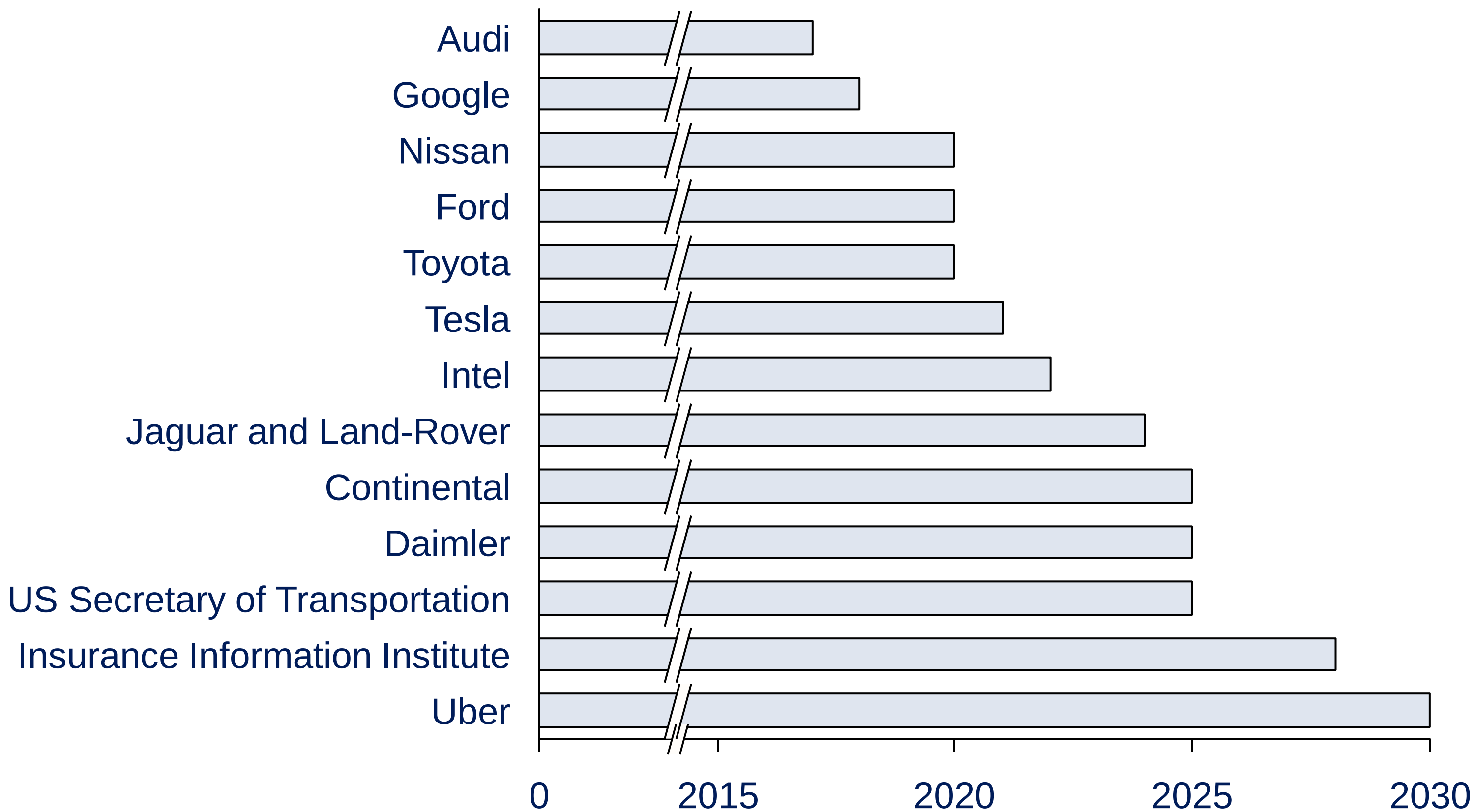
Current test vehicles are working towards level 3 and 4 automation

Level	*Brief Description*
Level 0	No automation
Level 1	Function specific automation
Level 2	Combined function automation
Level 3	Limited self-driving automation
Level 4	Full self driving automation

Most estimates have AVs entering the market within the next decade

Estimate when driverless cars come to market, years



http://www.driverless-future.com/?page_id=384

Three main technologies will work together for AVs

Comments

V2V/V2I

- Vehicle to Vehicle or Vehicle to Infrastructure using Dedicated Short Range Communications

LiDAR

- **Li**ght **D**etection **A**nd **R**anging
- combination of light and radar, and uses laser light to create 3D images
- Remote sensing technology to measure distances

Inertial Navigation Systems & GPS

- INS uses computers, accelerometers (motion), and gyroscopes (rotation)
- Calculates position, orientation, and velocity

Developments in AV technology have ramped up in recent years

2005 – 2010

- 05: Stanford wins DARPA Grand Challenge
- 07: CMU wins DARPA Urban Challenge
- 09: Google begins testing on public roads
- 09: EU launches Project SARTRE
- 10: Volvo City Safe standard

2011

- BMW begins testing self driving car on public roads
- NV passes autonomous car law

2012

- Nissan opens research facility in Silicon Valley
- Google & Continental receive autonomous car licenses
- FL & CA pass autonomous car laws

2013

- Oxford creates a $7,750 self-driving system
- Public road testing
  - Britain
  - Mercedes
  - CMU
- Audi receives AV car license
- NHTSA issues policy on AVs
- DC passes AV car law

2014

- MI passes AV law
- NHTSA passes V2V
- Google developing driverless car without steering wheel or brakes

2015 has already had many new investments in AVs(1/2)

Comments

Audi and Nvidia
January 2015
A

- Developing uses for Tegra X1 chips to compute and process the data from sensors and cameras

Nissan and NASA
January 2015

- Researching autonomous driving technology for both roads as well as space exploration missions

Uber and Carnegie Mellon
February 2015
B

- Strategic partnership including Uber Advanced Technologies Center, will focus on development of long term technologies

Apple
February 2015

- Apple reportedly working on its own AV
- Apple reportedly poaching Tesla and A123 engineers

A

Cameras and Deep Learning may be another technology

NVIDIA @ CES 2015

- https://www.youtube.com/watch?v=o29TBy2a0ek

B

Uber has continued expanding its advanced robotics team in 2015

Proof of risk

- Chris Valasek & Charlie Miller hack car
- Telematics in car used as gateway to controls
- Used access point in inessential tools (radio)
- Took control of steering, breaks, and engine

Uber hires hackers

- Uber Technologies Inc. has hired two top vehicle security researchers
- Joins dozens of advanced robotics researchers from Carnegie Mellon
- Work on increasing security for Ubers automated technologies

http://www.insurancejournal.com/news/national/2015/08/31/380086.htm

2015 has already had many new investments in AVs(2/2)

	Comments
Sony and ZMP February 2015	• ZMP, Japanese company makes 'robot cars' • Sony's image sensors and ZMP's robotics to make AV
Delphi April 2015	• 3,400 mile cross country trip with 99% of miles in autonomous mode
Mercedes April 2015 C	• Nevada licenses Mercedes' Freightliner truck with adaptive cruise control and steering assist • Hits the road in May 2015
Cruise Automation June 2015	• Developing aftermarket highway autopilot system (RP-1) • Uses millimeter-wave radar, stereo video cameras, GPS, and inertial sensors

C

The Mercedes truck allows drivers limited freedom while driving

What it can do

- ▶ Read lane markings
- ▶ Detect vehicles in front
- ▶ Steer through curves and turns
- ▶ Let drivers text, or talk on the phone, or watch YouTube
- ▶ Coordinate “platoons” of trucks for better fuel economy
- ▶ Start a countdown when the driver needs to take the wheel

Detachable tablet in the dash can be used by truckers while self-driving is engaged

COURTESY DAIMLER

What it can’t do

- ▶ Overtake slower cars
- ▶ Change lanes
- ▶ Exit highways
- ▶ Park
- ▶ Work on roads with insufficient markings
- ▶ Work in cities

http://www.bloomberg.com/news/articles/2015-05-14/daimler-s-freightliner-tests-self-driving-truck-in-nevada

Every year brings new research opportunities

University of Michigan D **Spring 2015**	• 32 acre testing facility for V2V, V2I, and AV • Support 2,800 connected vehicles in Ann Arbor in pilot and 9,000 within 3 years
Singapore **Spring 2015**	• 6km test route in real traffic • Approved vehicles get one year license for testing • Located in One North Business Park
Virginia Automated Corr. **2015**	• 32 acre testing facility for V2V, V2I, and AV • Support 2,800 connected vehicles in Ann Arbor in pilot and 9,000 within 3 years
A9 Autobahn: Bavaria **2016 or later**	• V2V and V2I for AV, similar to Michigan facility • A9 Connects Munich to Berlin
Volvo: Gothenburg **2017**	• 100 self driving cars on the road by 2017 • Array of sensors for AV on highways • No AV in inclement weather

D

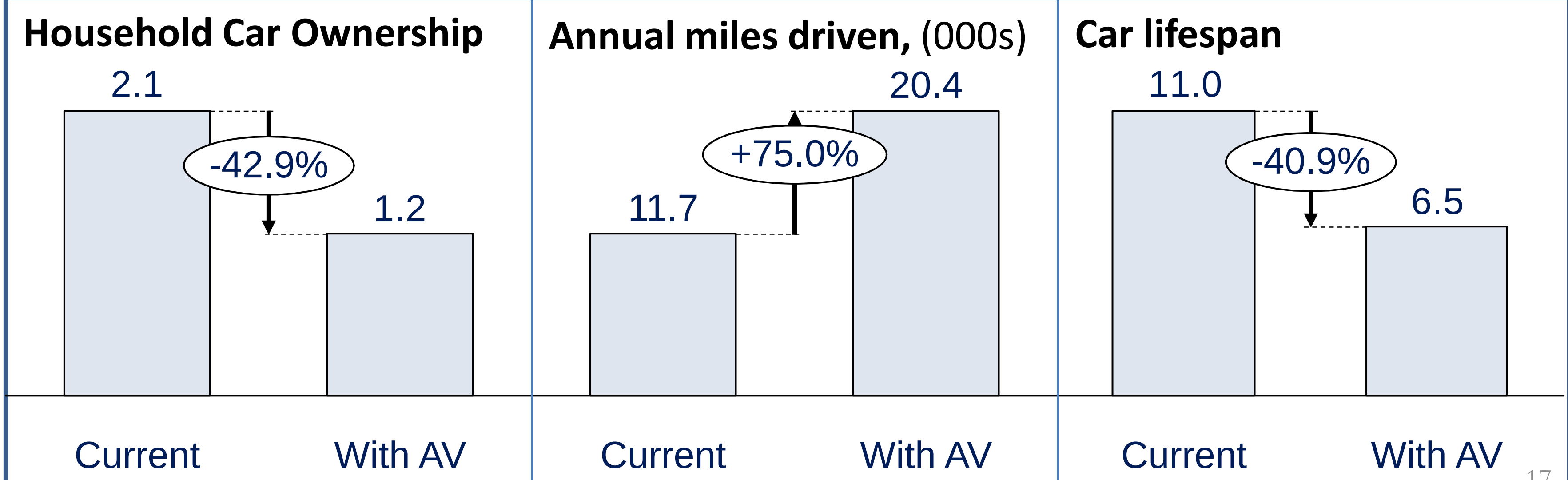
AV ownership may change household car ownership patterns

University of Michigan:
2009 National Household Travel Survey from U.S. DOT

- 84% of U.S. household trips today do not overlap with other trips
  - Only 16% of households require 2+ cars

Does not contemplate

- Additional miles from 'return to home' feature
- Additional miles if 'non-drivers' can operate vehicle for transportation
- Many commuters do not want to share vehicle



http://www.umich.edu/~umtriswt/PDF/UMTRI-2015-3_Abstract_English.pdf

London's AV testing regulations may increase investment

No special licenses or permits requires	No geographical limits	No additional insurance requirements

GOAL

- Light-touch non-regulatory approach
- provides clarity for industry to invest in further in research

London had 3 trials underway

UK Autodrive Programme: 3 years to pave way for introduction of AVs

Dept. of Transportation put ~$29M USD for trials

Explore both legal and technical changes required for Autonomous Vehicles

Milton Keyes and Coventry

- Lutz Pods that drive in pedestrian zones
- Max speed 15 mph
- Electronic AV

Greenwich

- GATEway shuttles
- Electronic AV
- Local tour with drop off points: input destination on CPU

Bristol

- Venturer consortium will investigate congestion and safety
- BAE Wildcat

Overall future development may create two models for AVs

All driving, limited location

- End to end service
- Fully automation
- Only operates in specified area
- “Taxi” service
- Google, Uber

Some driving, all locations

- Takes over some of the driving in specified areas
- E.g. Supercruise, parallel parking
- Driver owns and operates
- Mercedes, BMW, Volvo, Cadillac, Telsa

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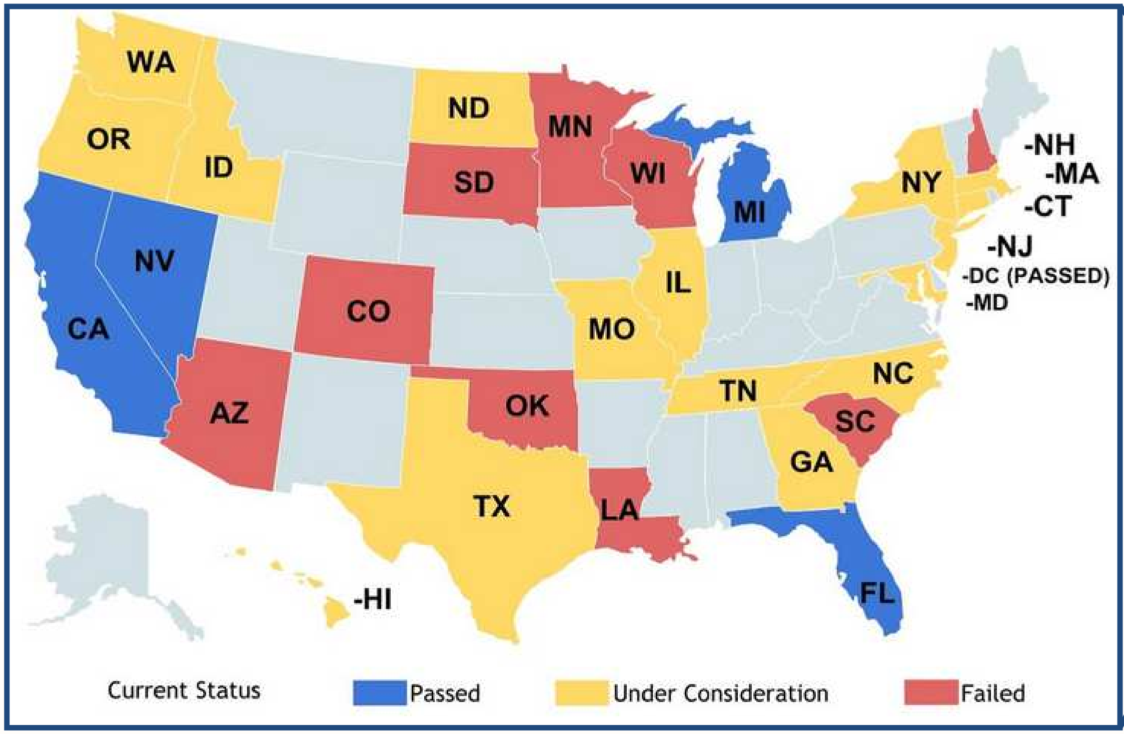
Current U.S. regulatory approach varies by state



Comments

- CA, DC, FL, MI, NV have state specific regulations on operation/testing of AVs
  - CA: Technology not approved for consumer use
  - CA: Driver must be employee or contractor for testing
- Government regulators may not fully understand technology and vision for future

http://cyberlaw.stanford.edu/wiki/index.php/Automated_Driving:_Legislative_and_Regulatory_Action

Regulations will also come from national and international markets

National

May 2013 - NHTSA

- Guidance to states on AV regulations
- NHTSA outlines plans for testing AV technology

May 2015

- NHTSA fast tracks V2I and V2V legislation

International (EU)

- Germany's Federal Government defines the long-term objectives for digitalization in Europe and beyond
  - Legal framework
  - Road Traffic Regulation
  - Liability
  - Product Safety
  - IT-Security and privacy

National and international regulations will shape the development of AV technology

http://www.twobirds.com/en/news/articles/2015/germany/september/germany-boosts-the-digital-agenda-for-autonomous-drive

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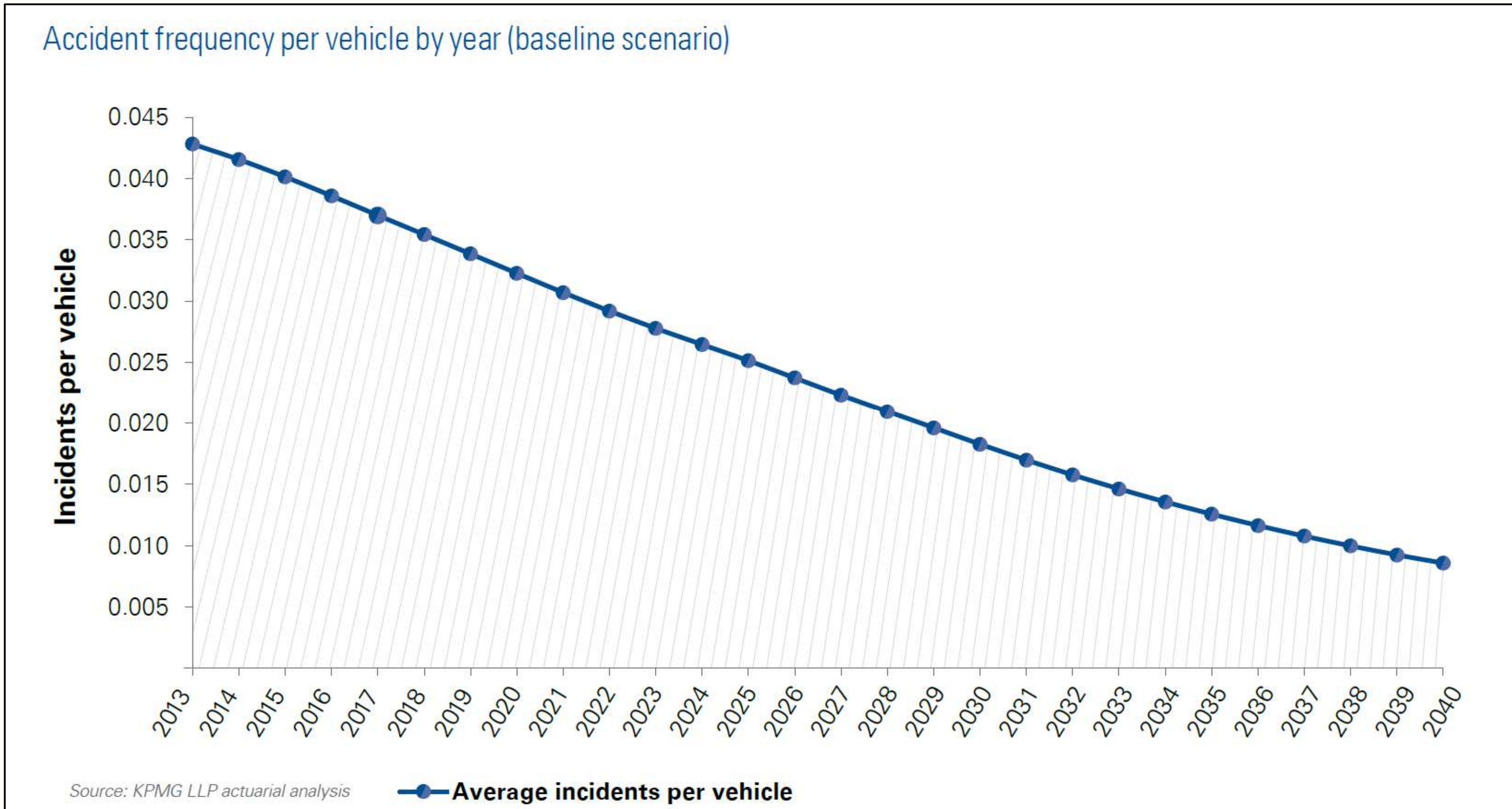
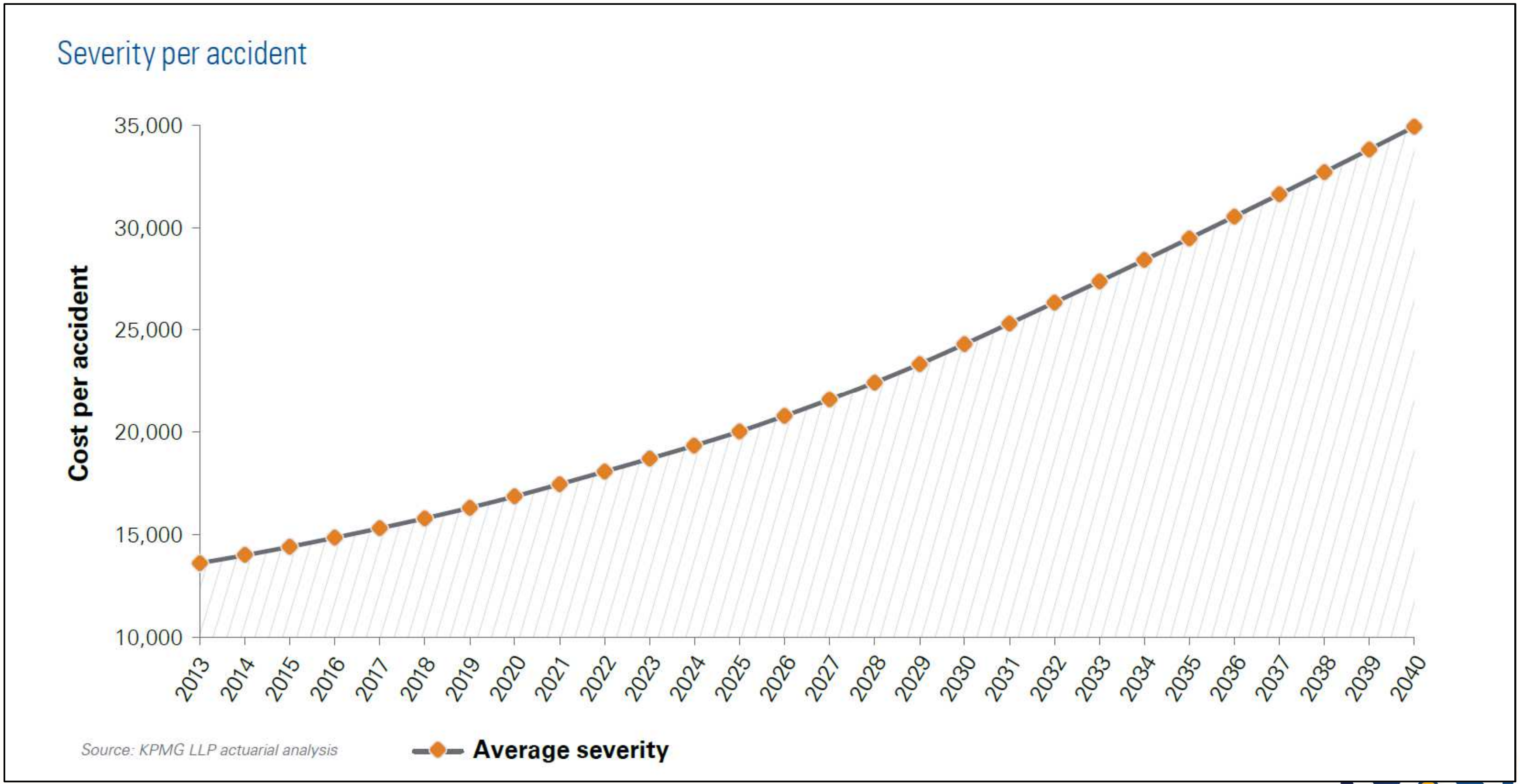
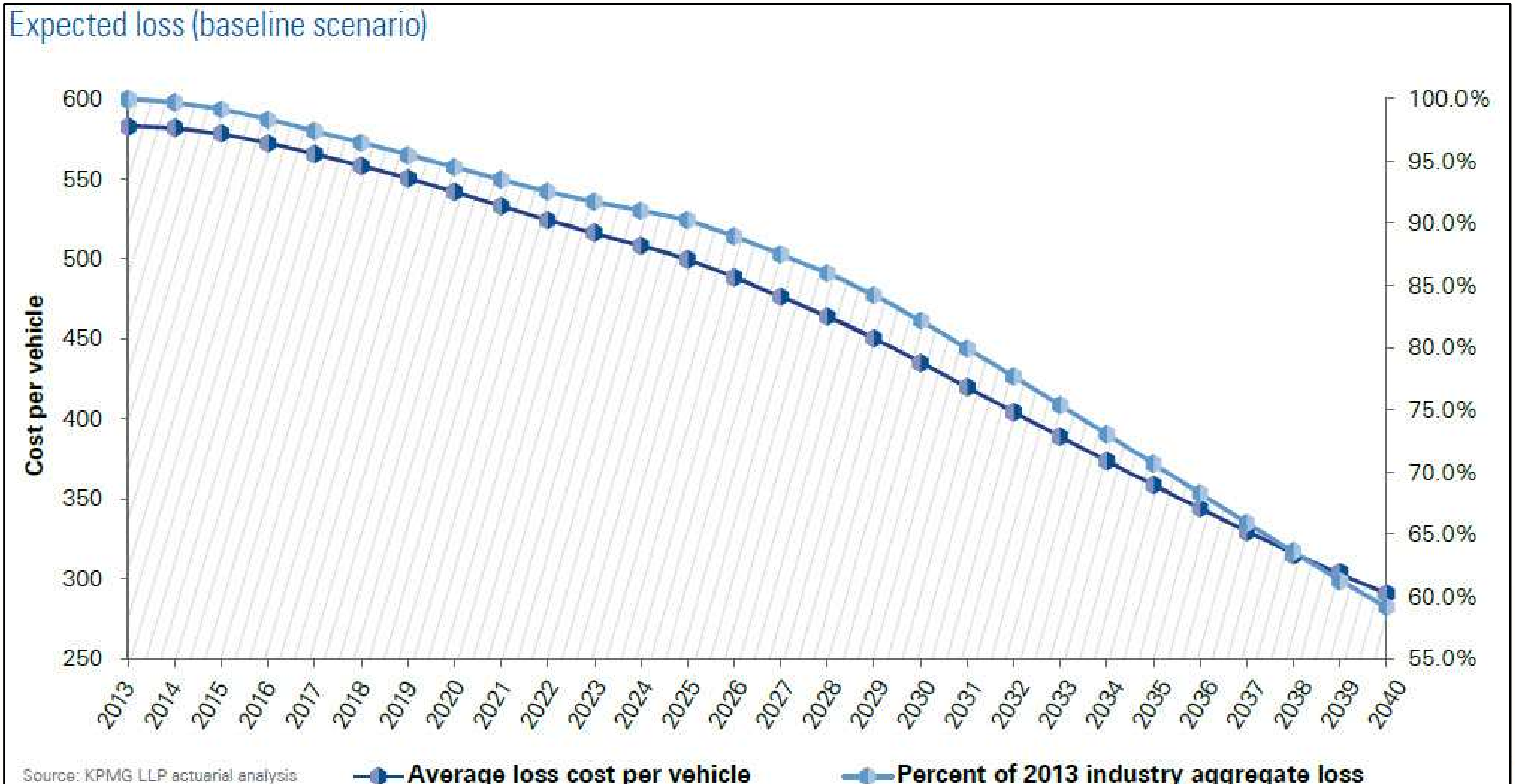
Loss frequency is expected to decrease



While severity increase, due to embedded technology

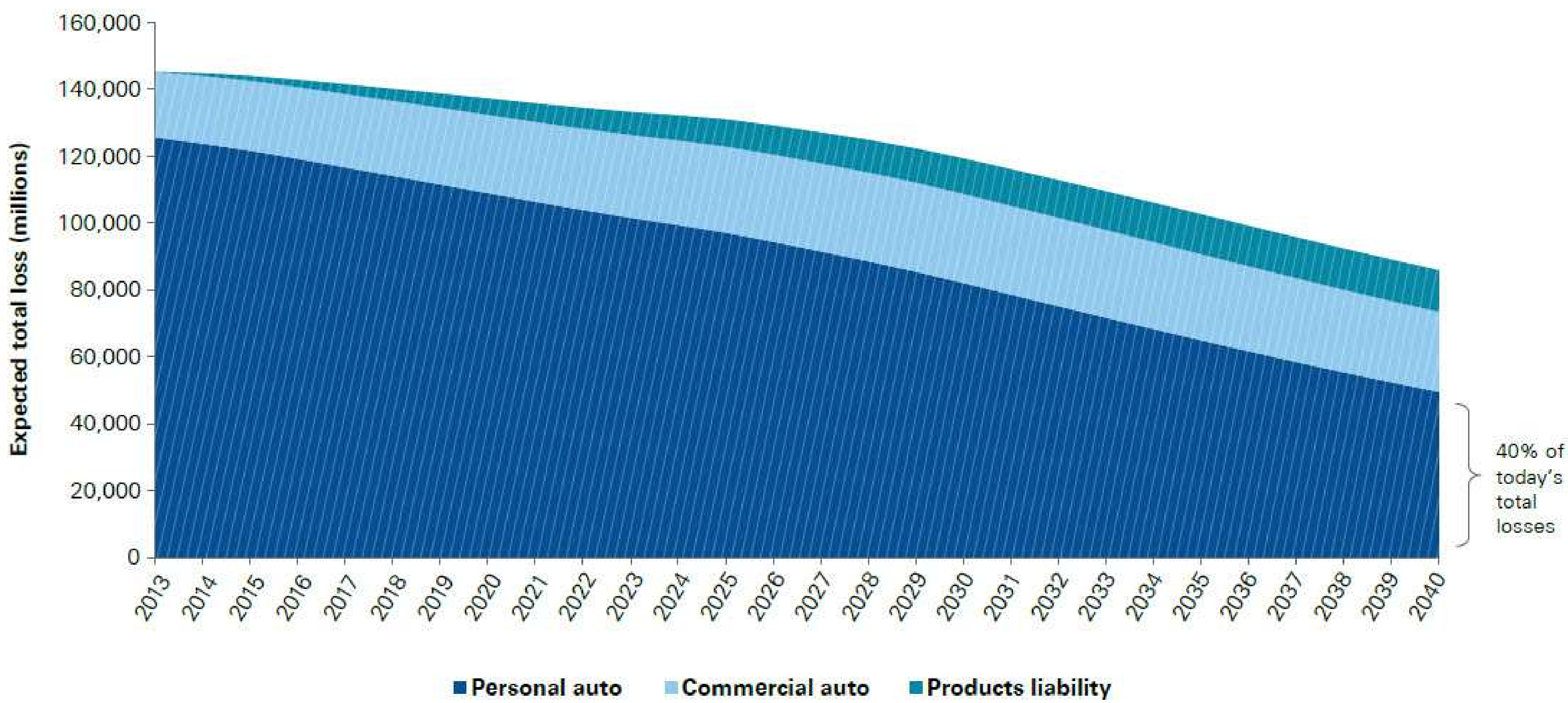


Overall losses are expected to decrease by 40%



The decrease in loss is projected to have a larger impact on personal auto

Expected loss allocated to products liability, personal auto, and commercial auto



Source: KPMG LLP actuarial analysis

Insurers have been taking actions to better prepare themselves for AVs

Pricing Adjustments	• Proprietary coverage level vehicle symbols
Patented Pricing Approaches	• State Farm: Trip-Based Insurance Pricing Plan (2015) • Travelers: "Risk-Zone" Pricing (2014) • Progressive: Vehicle sensor approach (2012)
Partnerships with manufacturers	• Ford, State Farm, & U of Michigan – Ford Hybrid automated research vehicle (Dec 2013) • Honda & major insurance company sign agreement to use self-driving automobile test track at former Concord Naval Weapons Station (March 2015)
Testifying at hearings	• CA DOI: State Farm & Nationwide & CAS AVTF[1] • NJ Senate: Munich Re America

(1) This is one of many industry groups performing research. Others include: CAS; HLDI-IIHS; RAND Corp; Brookings Institute

Illustrative example of road map for autonomous vehicles and insurance

1 Obstacles of AV development

- Redefine maps
- Regulation of Private Passenger Auto
- Liability Issues

2A Introduction of vehicle to market

- First Fully Autonomous Vehicle is within fleets of autonomous taxis and buses

2B Insurance

- Auto Insurance for the first fleets of autonomous taxis
- Autonomous Mode: All liability retained by manufactures and their insurance carriers
- Non Autonomous Mode: Current Commercial Auto Package

Introduction to market and insurance may be simultaneous

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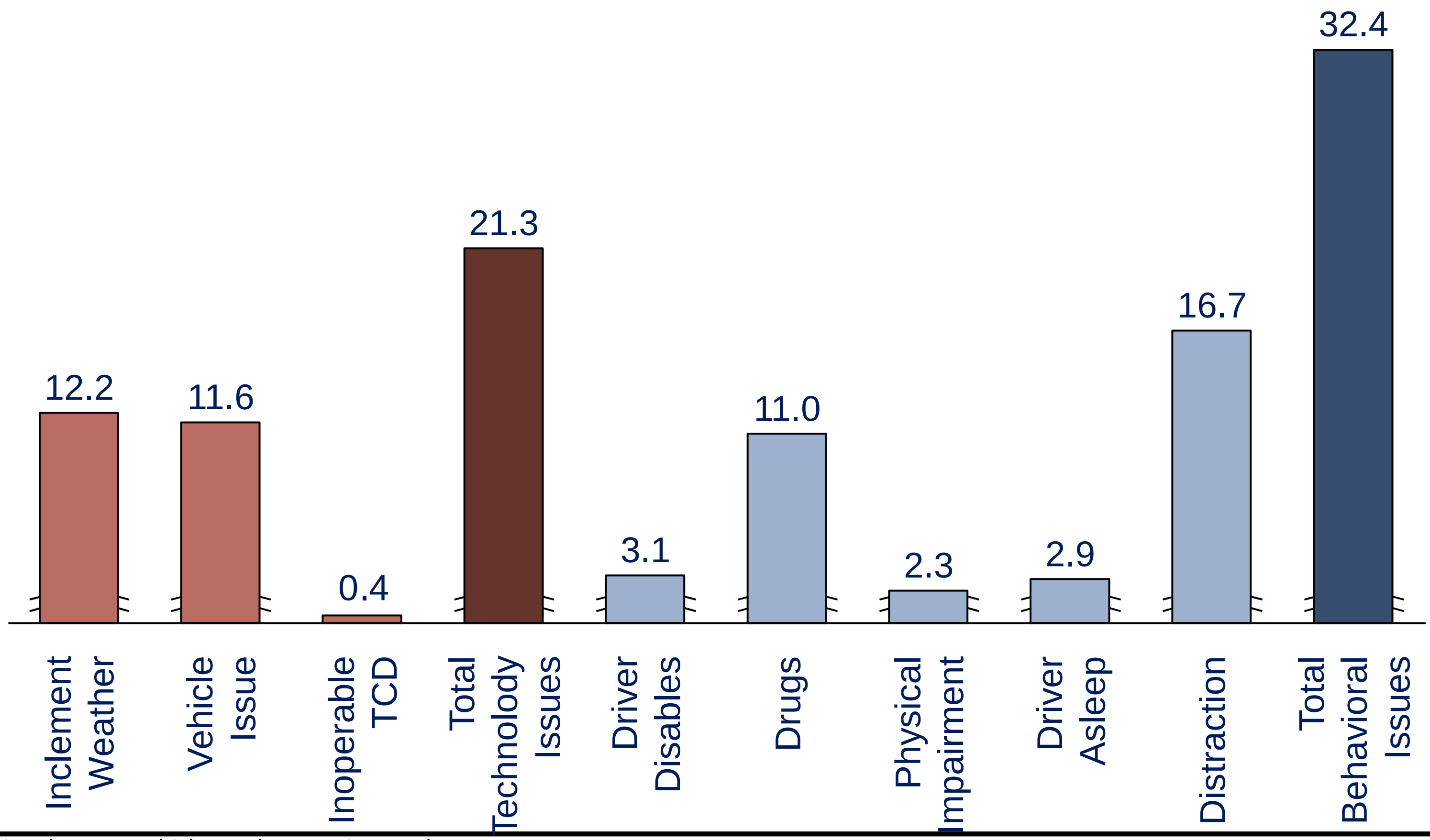
"93% of accidents are caused by human error…"

NMVCCS[1] shows that there are technological and behavioral factors that limit ability to reach the 93% theoretical limit

Limiting Factors to AVs ability to reduce loss, % pts



(1) National Motor Vehicle Crash Causation Study

NMVCCS –
Implications of the CAS Study

	Comments
New benchmark should be calculated	• Data is old and unrepresentative • Human driving risks <> automated vehicle risks
Appropriate test for each risk	• Computer simulations for technology's error rate • Simulations provide little insight into driver's actual use of technology
Policy changes can increase AV's safety	• 1% reduction in accidents is ~55k fewer accidents and $1.4 billion of economic value per year • Policy cost benefit analysis • E.g. driver training program, automated vehicle only lanes, allowing the AVs to speed

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Vehicle symbol analysis approach

	Comments
Vehicle experience groups	• Each group's experience is weighted and combined with similar vehicles
Complements to credibility	• Vehicle's body style factor • Prior year factor

Automated vehicle symbol: option 1	• Assume a brand new vehicle
	  • e.g. Mercedes introduces a new fully automated vehicle
	  • No initial prior year factor, growth trend impacts credibility

Automated vehicle symbol: option 2	• Assume update to a current vehicle • e.g. all new Honda Civics sold with AV equipment

Vehicle Symbol Calculation will got give enough credibility to new technology (1/2)

Automated vehicle symbol: option 1

- Assume a brand new vehicle
  - e.g. Mercedes introduces a new fully automated vehicle
  - No initial prior year factor, growth trend impacts credibility

Vehicle Symbol Discount						
Number of Exposures		Loss Attenuation				
	Year	0%	25%	50%	75%	100%
2,500	1	0.0%	0.5%	0.9%	1.3%	1.8%
5,000	2	0.0%	1.4%	2.6%	3.9%	5.1%
7,500	3	0.0%	2.8%	5.1%	7.4%	9.7%
10,000	4	0.0%	4.4%	8.0%	11.6%	15.2%

Vehicle symbol calculation will not recognize benefits fast enough

Vehicle Symbol Calculation will got give enough credibility to new technology (2/2)

Automated vehicle symbol: option 2

- Assume update to a current vehicle
  - e.g. all new Honda Civics sold with AV equipment

Vehicle Symbol Discount					
	Loss Attenuation				
Year	**0%**	**25%**	**50%**	**75%**	**100%**
1	0.0%	4.3%	7.4%	10.5%	13.6%
2	0.0%	7.1%	13.7%	20.0%	26.3%
3	0.0%	9.7%	18.2%	25.7%	35.4%
4	0.0%	11.1%	21.0%	31.0%	41.2%

Vehicle symbol calculation will not recognize benefits fast enough

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Upcoming project: Calculating the average accident rate for a driver

"One of the most important things we need to understand in order to judge our cars' safety performance is 'baseline' accident activity on typical suburban streets.

Quite simply, because many incidents never make it into official statistics, we need to find out how often we can expect to get hit by other drivers."

– Chris Urmson, Director of Google's Self-Driving Car Project

To calculate the average accident rate, NHTSA data is only a starting point

Issues with NHTSA data	• Only include police reported accidents • Cannot segment by driver type
Insurance Data	• Calculate frequencies for different driving segments • Can more accurately define "good driver" • GLM's lead to a more stable & accurate calculations
Comparable Driver	• Match location & type • Match driver characteristics

Studying the differences between Auto Liability vs. Products Liability will help choose the efficient insurance product

Goal: Quantify the change in costs from liability systems

Scenarios

1	Assumes no change in accidents
2	Assumes accident frequency is reduced by X%
3	Assume there is a liability cap of $Z
4	Assume some combination of scenario 2 and scenario 3

Initial indications show products liability would increase cost relative to private passenger auto

Metric	
ALAE Factor	↑
Permissible Loss Ratio	↑
Accident Classification	↑
Liability Limits	↑
Settlement Lag	↑
Unnecessary Coverages	↓

Questions and Discussion

Appendix

Notes

- Google Cash and Short term investments – 3/31/15: $65.44 Billion
- Apple has $194 bill in Cash & investments in Cash (4/28/15)

- Progressive market cap: $15.88 billion (4/4/15)
- Allstate market cap: $28.61 billion (4/4/15)
- Ace Mkt Cap: $35.08 billion (4/4/15)
- QBE Mkt cap: $18.71 billion (4/4/15)

- Ford Mkt Cap: $62.7billion
- GM mkt Cap: $57.18bil
- Tesla Mkt cap: $18.71 bil
- Nissan $43.6 bill
- Volvo $28.94bil

Google could buy Progressive, Volvo, and tesla and still have $1.9 billion of cash left.
Google could buy Progressive, Allstate, and tesla and have $2.24 billion left over
Google could buy Ace and volvo and have $1.42 billion left over.
Google could buy Ace and Tesla and have $11.65 billion let over.

Apple could buy progressive, tesla, volvo, GM, and ford and still have $10.59 billion
Apple could buy progressive, ace, GM, Tesla, and volvo and still have $38.21 billion