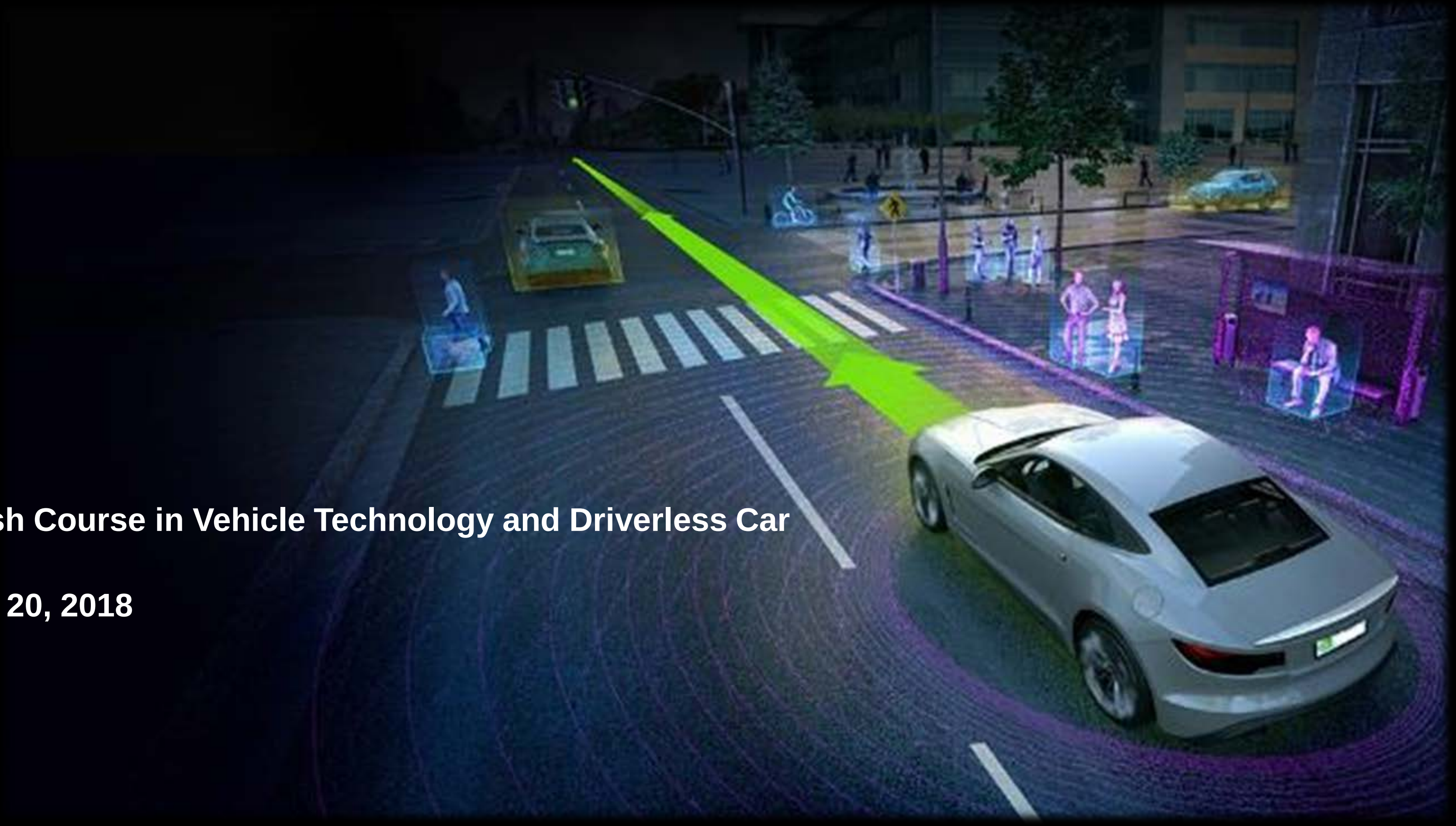
KPMG

From First Gear to Full Torque: Auto Insurance in the Era of Autonomous Vehicles



Crash Course in Vehicle Technology and Driverless Car

July 20, 2018

Presentation Overview

1 **First Gear: Early Adoption**	**Self driving features in today's vehicles and planned production**
2 **Acceleration: Estimated Impact**	**Long term scenario testing indicates loss costs may plummet**
3 **Market Implications: Preparing for the Future**	**Potential impact on insurers' books of business and the consumer marketplace for insurance**

First Gear: Early Adoption

Self driving features in today’s vehicles and planned production

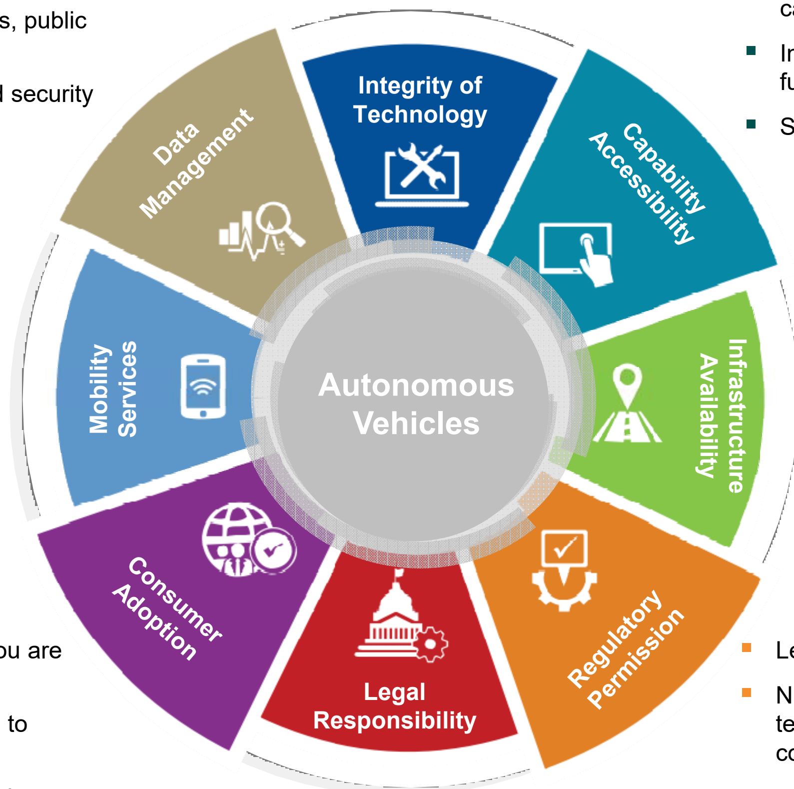
Key Elements for Transformation

A variety of forces will be responsible for the foundational transformation across the driving ecosystem

- Technologies already exists
- Convergence and enhancement lead next wave

- ‘Black box’ driving data highly valuable
- Who owns the data – incentives, public good, etc…
- Integrity, storage, analytics and security critical

- Robust pipeline of new vehicles / capabilities
- Incremental advancements + leap frog full-autonomy plays
- Scale of operations drop costs over time



- Car-sharing is a standard option for urban drivers
- Potential end of two car household

- Technology works in existing infrastructure
- Potential for ‘smart’ infrastructure (V2I) to complement vehicle-to-vehicle (V2V) communications

- More you know, the more likely you are to adopt
- Flexible value proposition tailored to individuals
- Focus on consumer education and awareness

- Leader states setting first round of rules
- NHTSA key factor in mandating technology – position papers and comment letters

- Driving risk will follow vehicle operator – driver to technology
- Hybrid environment of combined vehicle decisions will take time to sort

Phases of Transformation

No one has a crystal ball to predict the future pace of change. As we synthesized our initial analyses, we envision there to be four potential incremental changes to the transformation over the next 25 years, with the foundation laid for a "new normal" within a decade

"Training Wheels"

Now - 2017

- **Introduction to autonomous vehicles as manufacturers roll out some of the underlying technology**
- **High-tech companies express interest in fast-tracking production of fully autonomous vehicles**
- **SAE Phase 1**

"First Gear"

2017 - 2020

- **In 2017, partial driver substitution technology is introduced. A broader set of consumers experience this technology, witnessing firsthand its safety and soundness**
- **This helps shift market perceptions. Potential mandate from NHTSA for V2V communications**
- **SAE Phase 2**

"Acceleration"

2020 - 2025

- **Five years from now, fully autonomous all-speed vehicles become more common**
- **V2V capabilities are likely to be embedded in all new vehicles and the increase in scale drives down costs, making the technology accessible to a larger segment of consumers**
- **SAE Phase 4**

"Full Speed"

2025 - 2050

- **In 2025, a broad-based transformation begins. All new vehicles have autonomous capabilities and existing vehicles are potentially retrofitted**
- **Over the next 25 years, integrated driving emerges, a web of information is flowing between vehicles and infrastructure tightens. A "new normal" is realized by 2050**
- **SAE Phase 5**

Model phases in adoption of automation over the next 15 years

	2017	2018	2019	2020	2021	2022	2023	2024 - 2033

Vehicle Make / Model Sales by Specific ADAS Adoption

Phase 1 – Driver Assistance

- Rear Camera (RC)
- Rear Parking Sensors (RPS)
- Lane Detection Warning (LDW)
- Blind Spot Detection (BSD)
- Cross Traffic Alert (CTA)
- Forward Collision Warning (FCW)
- Lane Keep Assist (LKA)
- Automatic Emergency Braking (AEB)
- Adaptive Cruise Control (ACC)

Autonomy Description:

- Equivalent to SAE Level 1 Autonomy
- Vehicle is controlled by Driver but features assist driver performance

Passive System (Rear Camera through Forward Collision Warning)

Active System (Lane Keep Assist, Automatic Emergency Braking, Adaptive Cruise Control)

Total Vehicle Sales broken down by Phased Adoption

Phase 2 – Partial Automation
(Tesla Autopilot, Mercedes Drive Pilot, Cadillac Super Cruise, Etc…)

- Similar to SAE Level 2 Autonomy
- Vehicle has limited automated functions; Driver must be engaged

Phase 3 – High Automation

- Combination of SAE Level 3 and 4
- Vehicle has full automated functions; Driver may override

Phase 4 – Full Automation

- Equivalent to SAE Level 5
- Vehicle has full automated functions in all situations

Source(s): NHTSA, SAE

Company announcements to date indicate that autonomous vehicles being developed aggressively with plans to launch post-2020

AV Launch Timeline

2015-16

- **2015:** Tesla Auto Pilot available
- **2016:** NuTonomy begins pilot of self-driving vehicle in Singapore
- **2016:** Uber begins pilot of self-driving vehicle in Pittsburgh

2017-19

- **2017:** A8 with AI traffic jam pilot (SAE level 3) to handle traffic upto 37.3mph
- **2017:** Self-driving features to be made available in new E-Class
- **2017:** Launch 2018 Cadillac CT6 with Super Cruise
- **2018:** Launch of fully AV in the Phoenix area in partnership with FCA
- **2019:** Plan to launch car with full self-driving capabilities

2020

- **2020:** Next gen of Leaf to have autonomous features
- **2020:** Lexus to self-drive on highways, RoboTaxi for Olympics
- **2020:** Expected launch year of Google's self-driving car
- **2020:** Expected launch of level 4 Audi's self-driving car
- **2020:** Launch of fully AV fleet commercially to compete with Uber and Lyft

2021-30

- **2019-21:** Partnered with Uber to provide 24,000 XC90 SUV with AV technology
- **2021:** Plans to mass produce AVs and partner with ride sharing companies
- **2021:** Plans to introduce self driving car in its i Next series
- **2021:** Expects to launch full AV for commercial ride sharing
- **2021:** Plans to launch fully AVs (the Sedric) electric cars, vans, and trucks
- **2021:** Partnered with Bosch to develop fully AV and launch a driverless taxi service
- **2024:** Announced in 2014 that JLR was 10 yrs from a fully AV
- **2030:** Investing $1.7b to launch AV on highways (2020) and in city streets (2030)

Key:
- Semi-autonomous models
- Fully autonomous models

Source(s): CB Insights, The WSJ, Autonews.com, Topgear.com, Driverlessfuture.com, Business Insider, Wired, The Guardian, Slashgear, Drive, Huffington Post, Motoring.com, The Verge, IEEE, CNBC

Traditional OEMs and mobility providers are rushing in with investment to accelerate AV development

New Entrants: Tech Companies

- **Waymo:** Owned by Alphabet, it **launched public trials for fully autonomous ride-hailing service** in Phoenix using Pacifica mini-vans sourced from its partner Fiat Chrysler
- **Baidu:** Developing an **open-source autonomous driving platform** (Apollo) involving over 50 partners across hardware, software and cloud data services (key companies include Ford, Daimler, NVidia, Intel, Velodyne)
- **Apple:** Apple began its self-driving car project (Project Titan) in 2014 and recently announced its **revised strategy to focus on autonomous software** to be developed for carmakers. It plans to test autonomous shuttles in Palo Alto by sourcing vehicles elsewhere

New Entrants: Ridehailing Companies

- **DiDi:** **Partnered with UiSee** Technology, a driverless car start-up based in Beijing, in Oct 2016 to explore their road-scanning technology for self-driving cars
- **Uber:** **Partnered with Volvo** in Nov 2017 for 24,000 cars to turn them into self-driving cars using their proprietary technology; **launched public trials** of fully AV in Dec 2016

  Acquired Otto, a self driving truck start-up, in Aug 2016 to strengthen their self-driving technology
- **Lyft:** Launched a **new self driving division in Jul 2017** to develop its own autonomous technology; Partnered with Drive.ai to provide self-driving rides in San Francisco

Traditional OEMs

- **Volkswagen:** Invested $180M to form a **JV with Mobvoi**; Announced **partnership with Mobileye** to leverage its real-time mapping service into its vehicles by 2018
- **Renault Nissan:** **Partnered with Transdev** to develop AV for public transportation in France and announced **roll out 40 AVs by 2022**
- **FCA:** Partnered with **BMW and Intel in Aug 2017** to develop AVs
- **Ford:** **Committed $1B** over the next 5 years in a JV with Argo AI to develop AI for AVs and aim to launch fully AV by 2021
- **GM:** **Acquired Cruise Automation for $1B** to obtain software talent and accelerate AV technology development
- **Daimler:** Holds over **900 patents related to autonomy** and have partnered with Bosch to bring level 4 AVs within five years
- **Hyundai:** Plans to commercialize self-driving cars by 2020 and invest **~$1.7B**to develop autonomous driving technologies in the next 5 years
- **Honda:** Announced partnership with **Google's Waymo in Dec 2016** to develop self driving technologies and plans to launch **level 4 AV by 2020 and level 5 AV by 2025**

Note(s): Miles driven with Tesla's semi-autonomous feature

Source(s): Company websites, Telematics Wire, Forbes, TechCrunch, Financial Times, China Money Network, Business Insider September 2017, Futurism Website 2017, Fortune 2017

Current Impact - ADAS efficacy from various sources

				Testing Method Assessment				Test Parameter Assessment		
ADAS Technology	**Collision Type**	**Source**	**Reduction Estimate**	**Estimate Method**	**Weather**	**Geography**	**Speed**	**Sample Size**	**OEM Diversity**	**Publication Date**
Rear Camera	Rear	IIHS	*17%*	✓	✓	✓	✓		✓	
	Rear	AAA	*30%*	✓			✓		✗	✗
Lane Detection Warning System	All	IIHS	*11%*	✓	✓	✓	✓		✓	
	All	NCBI	*23%*	✓			✓	✓		
	All	EUROPA	*33%*	✓				✗		
	All	AAA	*3%*	✓						✗
Blind Spot Detection	Side	IIHS	*14%*	✓	✓	✓	✓			
	Side	EUROPA	*33%*	✓						
Cross Traffic Alert	Side	IIHS	*13%*	✓			✓		✗	✓
	Side	Consumer Reports	*31%*	✗						
	Side	SAE	*39%*	✓	✗	✗				✗
	Side	IIHS	*2%*	✗			✗		✗	✗

Legend — ***Estimate Method***: ✓ Collision Data ✓ Simulation ✗ Survey / Other — ***Other***: ✓ Inclusive / Favorable ✗ Limited / Unfavorable

Note(s): Missing assessment indicates no information was provided. Assumes collision data assessment of random sample incorporates weather, geography and OEMs

Current Impact - ADAS efficacy from various sources

				Testing Method Assessment				Test Parameter Assessment		
ADAS Technology	**Collision Type**	**Source**	**Reduction Estimate**	**Estimate Method**	**Weather**	**Geography**	**Speed**	**Sample Size**	**OEM Diversity**	**Publication Date**
Forward Collision Warning	Rear	IIHS	*27%*	✓	✓	✓	✗		✓	✓
	Rear	DOT	*27%*	✓	✓	✓	✓			✓
	Rear	IIHS	*23%*	✓		✓			✓	
	All	NCBI	*67%*	✗			✗	✓		
	Rear	AAA	*10%*	✓				✗		✗
Automatic Emergency Braking	Rear	IIHS	*50%*	✓	✓	✓	✗		✓	✓
	Rear	DOT	*43%*	✓	✓	✓	✓			✓
	Rear	IIHS	*40%*	✓		✓			✓	
	All	IIHS	*17%*	✓	✓	✓	✗			
	Rear	EU NCAP	*38%*	✓	✓	✓	✗			✗
Adaptive Cruise Control	Rear	Academic	*10%*	✓						✗
	Rear	AAA	*17%*	✗					✗	✗

Legend — ***Estimate Method***: ✓ Collision Data; ✓ Simulation; ✗ Survey / Other — ***Other***: ✓ Inclusive / Favorable; ✗ Limited / Unfavorable

Note(s): Missing assessment indicates no information was provided. Assumes collision data assessment of random sample incorporates weather, geography and OEMs, select sources / studies shown for AEB

Federal as well as State governments in the US have taken measures to enact legislations in favor of autonomous vehicles

Autonomous Vehicles Legislations – Federal and State

At the national level, the SELF DRIVE Act, if passed, would authorize the deployment and regulation of autonomous vehicles on the road over the next few years years …

Federal Legislations and Policy

Federal legislation	Provision
SELF DRIVE Act (Yet to be passed by Senate)	– Allows each autonomous car maker to put up to 25,000 autonomous vehicles on the road in the first year. Over the three years, the cap would rise to 100,000 vehicles annually – Also exempts automakers from having to meet some existing safety standards if they can prove a new design is safe
Federal Automated Vehicles Policy	– Reduces a 15-point safety assessment before putting test vehicles on the road to a 12-point voluntary assessment, asking automakers to consider things like cybersecurity, crash protection, how the vehicle interacts with occupants and the backup plans if the vehicle encounters a problem

… while 21 states, such as the following, have also passed legislations over the last few years to encourage the development, testing and deployment of fully-autonomous vehicles

State Legislations

State	Provision
California	– Allows testing and deployment of autonomous vehicle on state roads without a human operator
Nevada	– Allows for testing and operation of fully-autonomous vehicles; also authorizes commercial use of fully autonomous vehicles
Washington	– Executive order signed by the Governor in June 2017, establishing an autonomous vehicle work group and directing state agencies to support the safe testing and operation of autonomous vehicles on Washington's public roads
Florida	– Allows operation of autonomous vehicles on public roads and eliminates requirements related to the testing of autonomous vehicles and the presence of a driver in the vehicle
Michigan	– Allows fully autonomous vehicles, including those without drivers and steering wheels, to begin using public roadways
Arizona	– Executive order signed by the Governor in August 2015, permitting several agencies to take adequate steps to aid testing and operation of automated vehicles on public roads in the state
Massachusetts	– Executive order signed by the Governor in October 2016 to promote the testing and deployment of autonomous vehicles, by creating a working group on autonomous vehicles

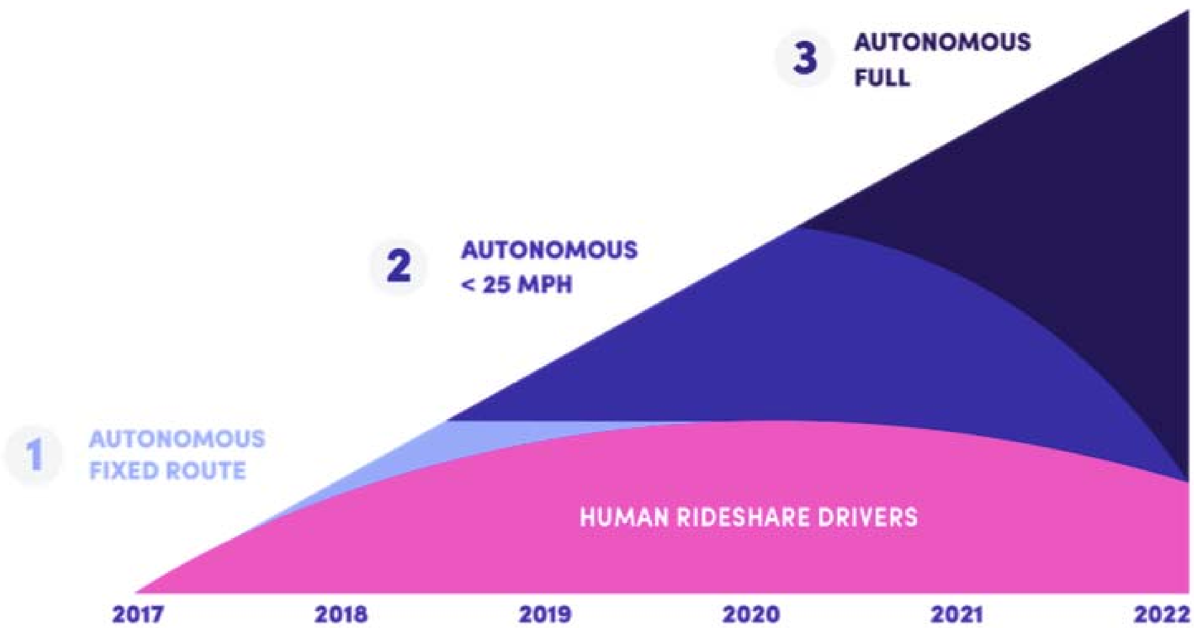
Note(s): SELF DRIVE Act - Safety Ensuring Lives Future Deployment and Research in Vehicle Evolution Act
Source(s): Reuters, NCSL Website, The Verge, The Columbian Website, Computerworld Website, US DoT , NHTSA

Lyft's Point of View on Autonomous Technology Roll Out

Lyft says robots will drive most of its cars in five years

Expect to see semi-autonomous vehicles driving on fixed routes by 2017 in a subscription model.

BY JOHANA BHUIYAN · @JMBOOYAH · SEP 18, 2016, 9:15A



- **Announced shortly after GM's investment in 2016**
- **Autonomous Lyft fleets now available:**
  - **San Francisco – Sep 2017**
  - **Boston – Dec 2017**
  - **Las Vegas – March 2018**

Others:

- **Uber**
  - **Still investigating Tempe fatality but had been operating in Pittsburg, San Francisco, Toronto, and Tempe since as early as 2015**
- **Waymo**
  - **Phoenix – April 2017**

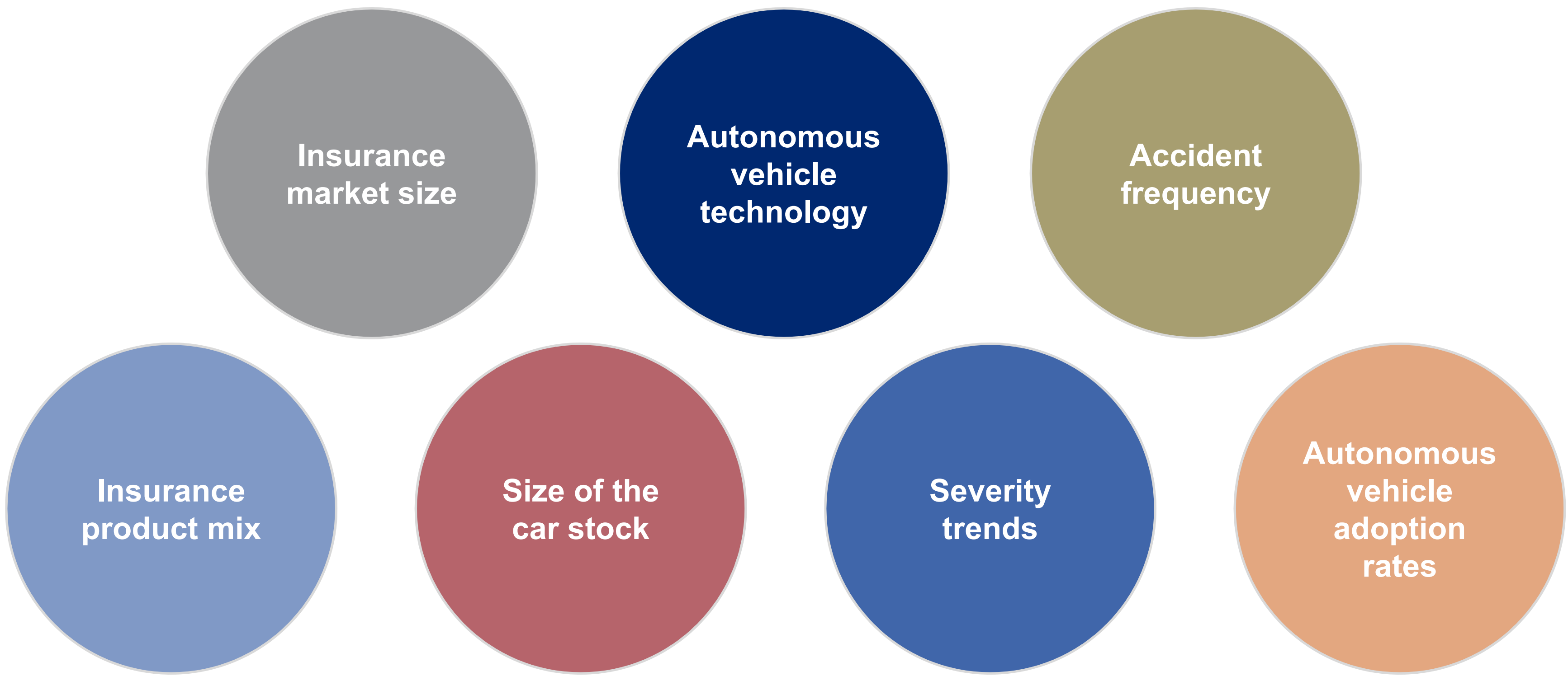
Acceleration: Estimated Impact

Long term scenario testing indicates loss costs may plummet

Actuarial Analysis

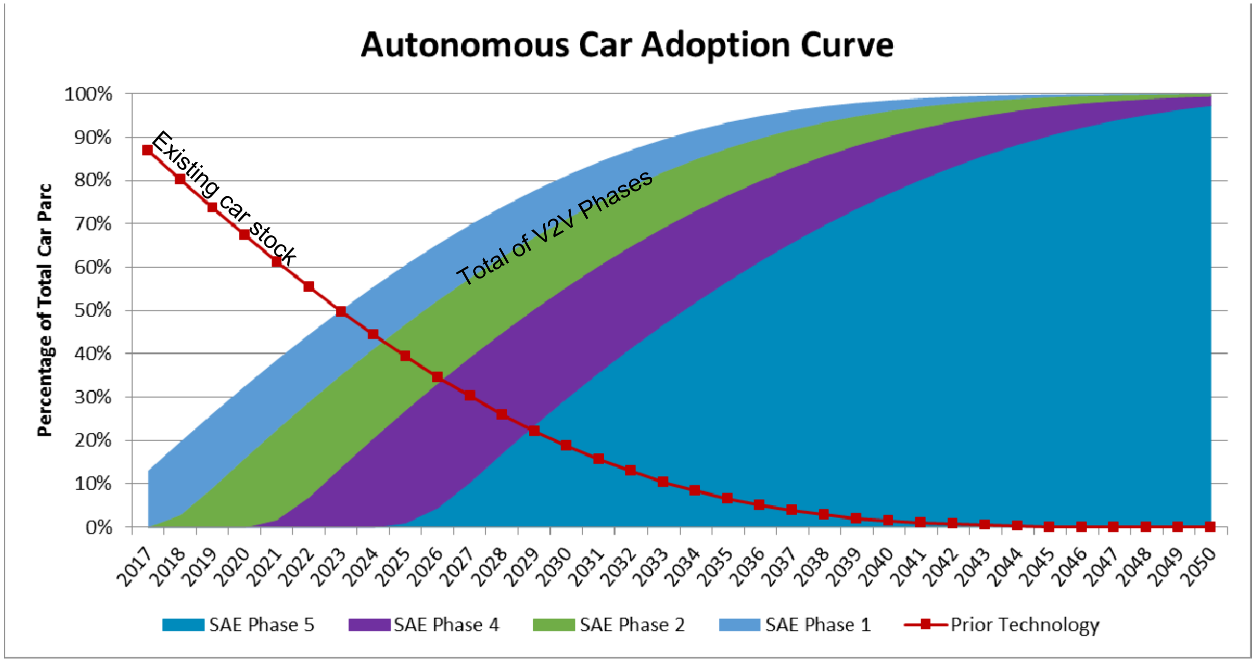
Working closely with our automotive team and leveraging their extensive research, KPMG's Actuarial Team developed models to translate the technology and market changes in order to demonstrate the potential impact on auto insurer performance

Actuarial Analysis



Adoption Assumptions

KPMG developed a model to test the potential effects of Autonomous vehicles on the auto insurance marketplace. The first assumption of the model mapped the cumulative effect of the four phases of advancing technology (per the baseline scenario) on the stock of total cars. By 2028, cars with some degree of automated controls could account for over half of those in use and nearly all vehicles by 2050.



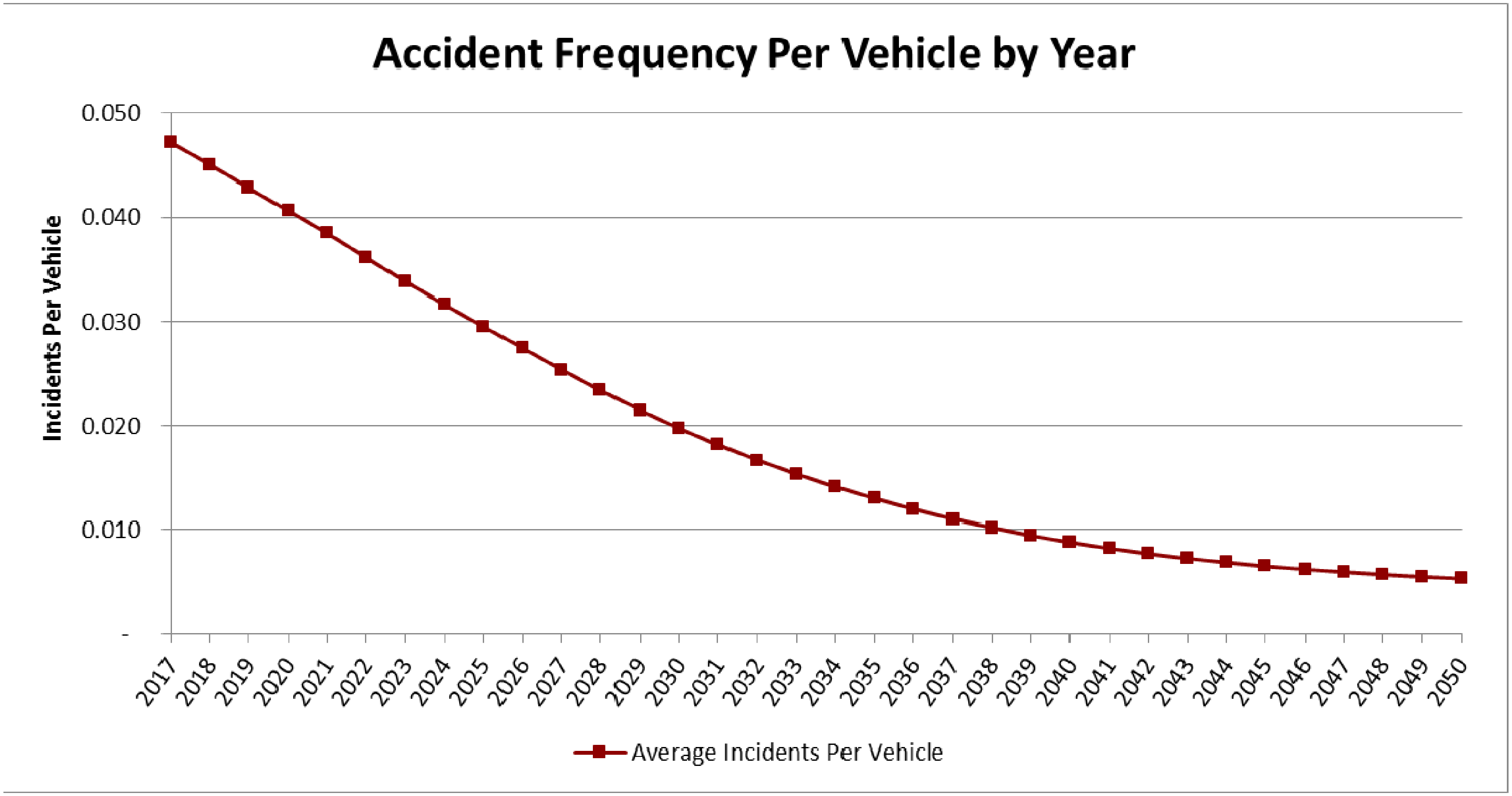
Commentary

- The baseline scenario uses reasonable assumptions based on reviews of industry literature around introduction timelines and capabilities of new phases, and turnover of the car park.
- Note the change in car stock takes place as vehicles are retired and replaced
  - It could accelerate if there is a:
    - Surge in demand for the new capability
    - Government mandate
    - Widespread retro-fitting

Source: KPMG LLP actuarial analysis

Accident Frequency

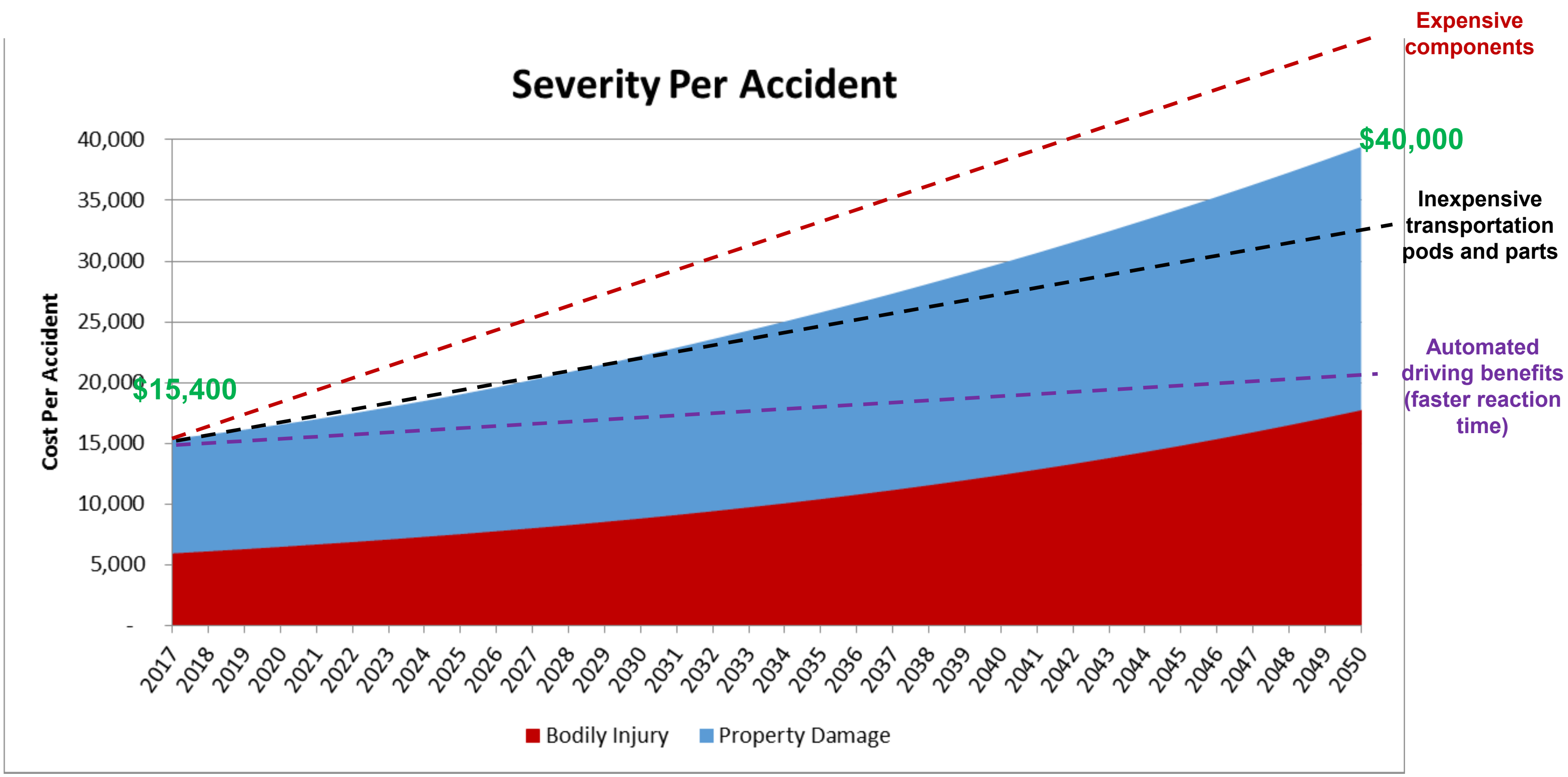
Given the new safety technology in autonomous vehicles, the KPMG Actuarial Team predicts a potential 90% reduction in accident frequency by 2050, which is the largest driver of loss reduction



Source: KPMG LLP actuarial analysis

Loss Severity

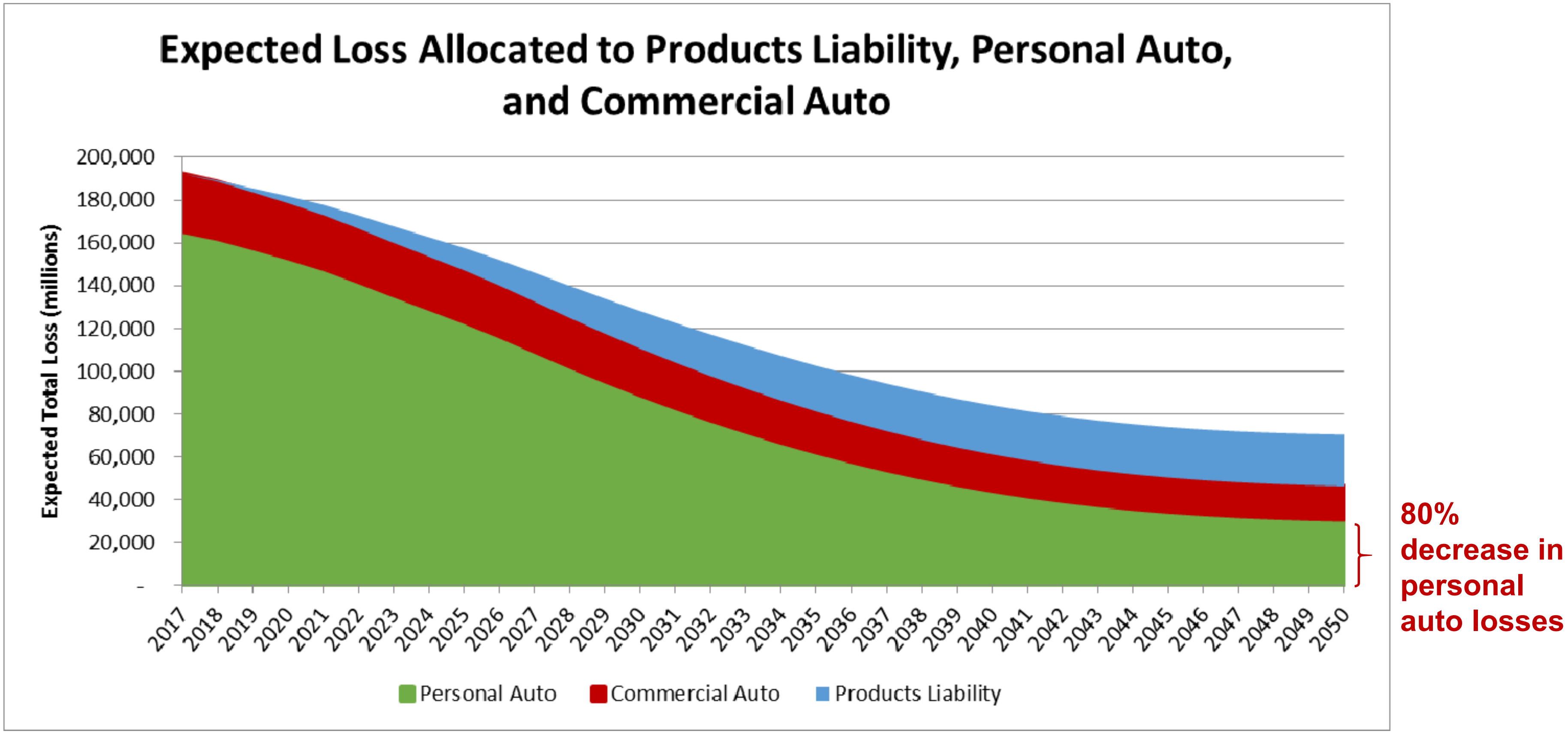
The KPMG Actuarial Team modeled severity broadly in line with inflationary trends. There are, however, a variety of different potential scenarios that could have a significant impact on severity over time



Source: KPMG LLP actuarial analysis

Industry Loss Costs

Safer vehicles could result in total auto insurance industry losses decreasing by 60% by 2050 with commercial and product liability accounting for a larger portion of the loss pie



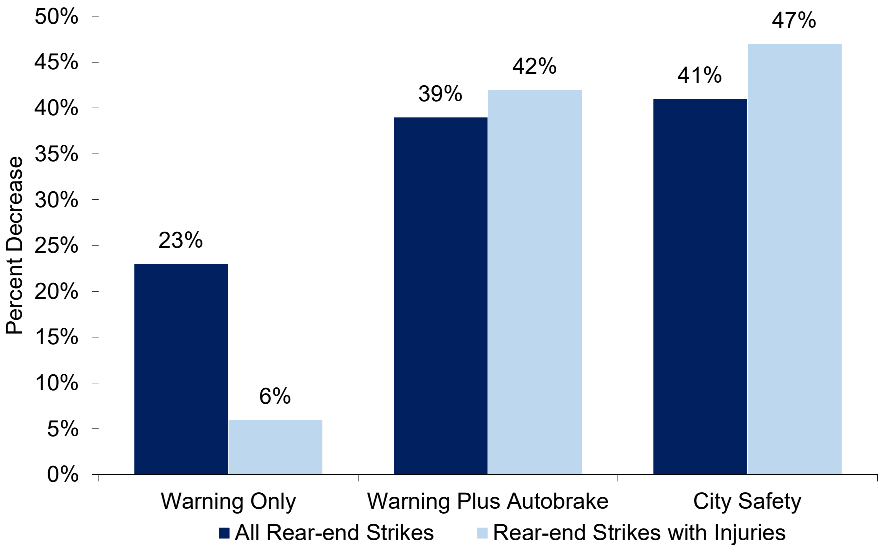
Source: KPMG LLP actuarial analysis

Automated Vehicle Technology is Making Driving Safer…Today

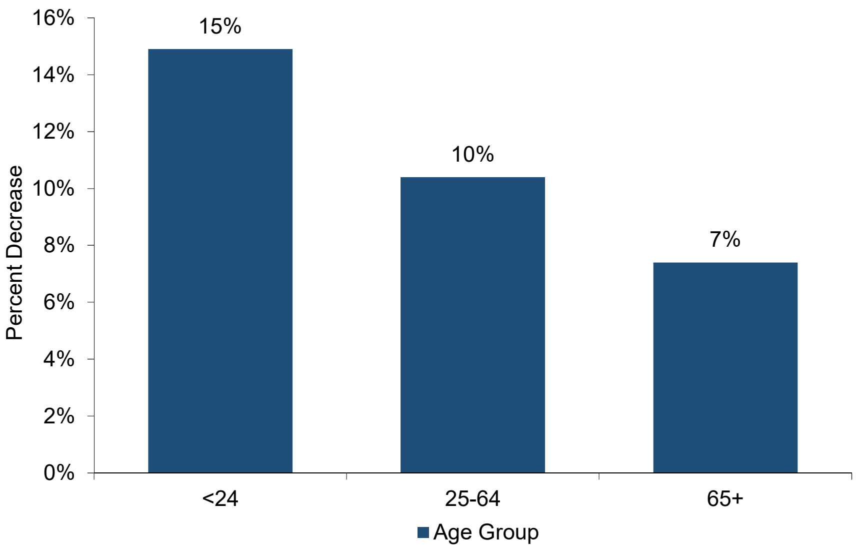
Crash avoidance features which underpin autonomous vehicle safety technology are already improving the safety profile of vehicles…

Impact on Driving Safety of Vehicles With Crash Prevention Technology vs. Vehicles Without It

Vehicles With Front Crash Prevention Technology[1,2]



Prop. Damage Liability Claim Frequency by Driver Age[3]



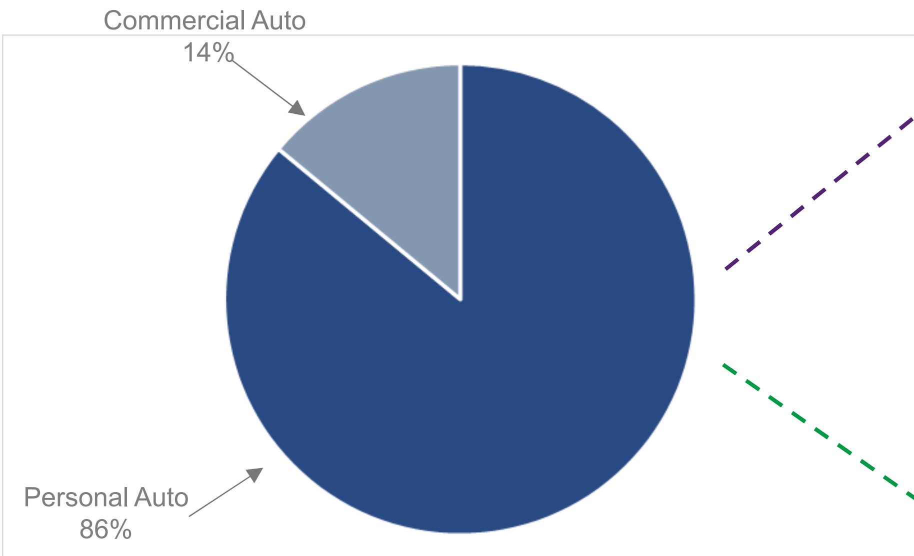
…furthermore, according to recent findings[1], more than 700,000 police-reported rear-end crashes in 2013 could have been avoided if the vehicles involved were equipped with autobrake technology

Note: (1) Study analyzes police-reported rear-end crashes in 27 states during 2010-2014 involving Acura, Honda, Mercedes-Benz, Subaru and Volvo vehicles with forward collision warning ("warning") and autonomous emergency breaking ("autobrake") vs. the same models without the optional technology; (2) 'City Safety' represents Volvo's low-speed autobrake system. The test was conducted by comparing two Volvo models with City Safety vs. other vehicles without front crash prevention technology; and (3) Study examines Honda's camera-based and radar-based forward collision and lane departure warning systems for vehicles equipped with these features vs. vehicles without them, bucketed by driver age group. Source: IIHS's research papers 'Effectiveness of Forward Collision Warning Systems with and without Autonomous Emergency Braking in Reducing Police-Reported Crash Rates' and 'Effectiveness of Volvo's City Safety Low-Speed Autonomous Emergency Braking System in Reducing Police-Reported Crash Rates' and IIHS's 'Status Report, Vol. 51, No.1, January 2016'

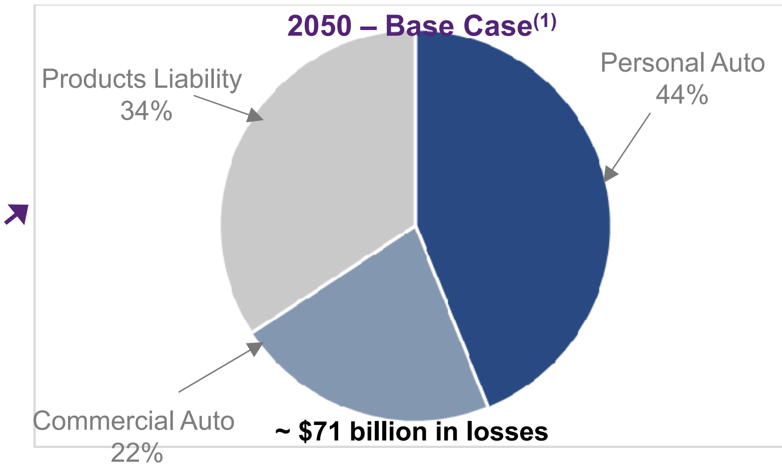
Potential Business Mix Composition

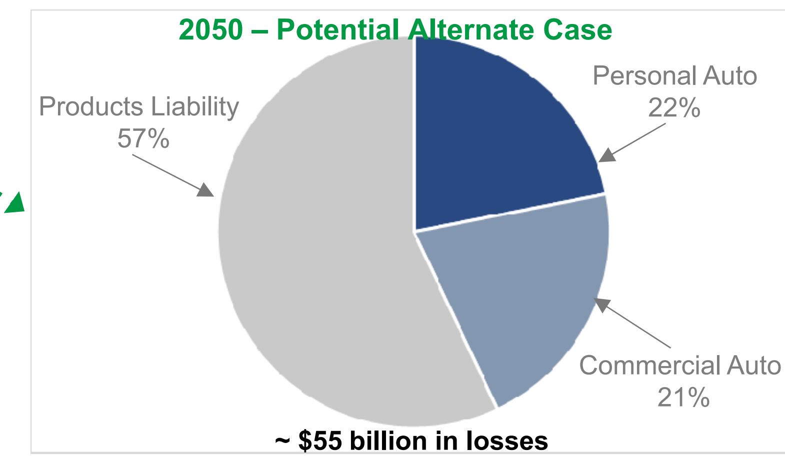
While personal and commercial auto insurance represents the whole loss pie in 2017, products liability insurance will play a greater role in the future as the vehicles themselves make more driving decisions

2017[1]



~ $192 billion in losses



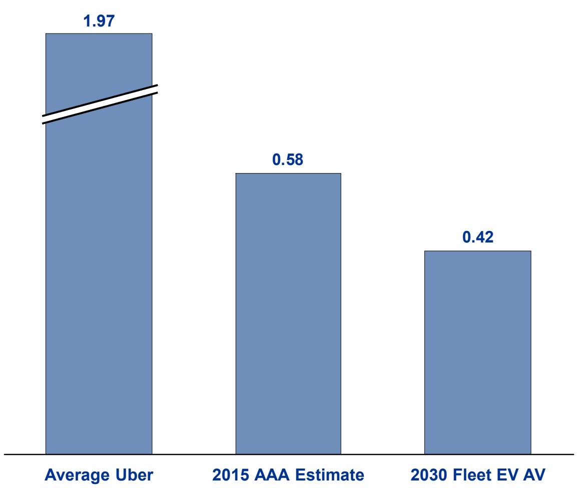


Note: (1) Based on KPMG LLP actuarial analysis

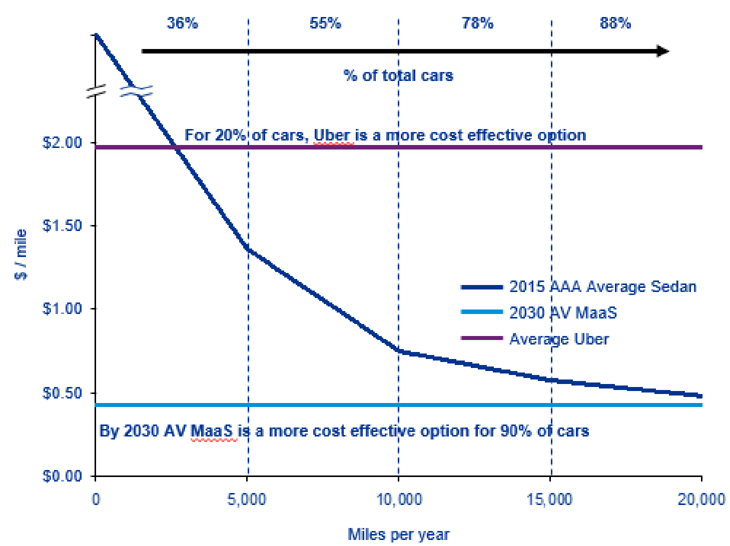
Potential Business Mix Composition

By removing the driver from Mobility Services, EV AV MaaS will become the lowest-cost mode of private transportation

Transportation Cost in $ per mile



By 2030 AV MaaS will be cheaper per mile than most personal vehicles[a]



Note(s): Average Uber cost per mile for 5 mile / 20 min. trip in top 10 largest US cities; 2015 AAA estimate assumes 15K miles/year, 2030 Fleet EV AV assumes 110K miles/year

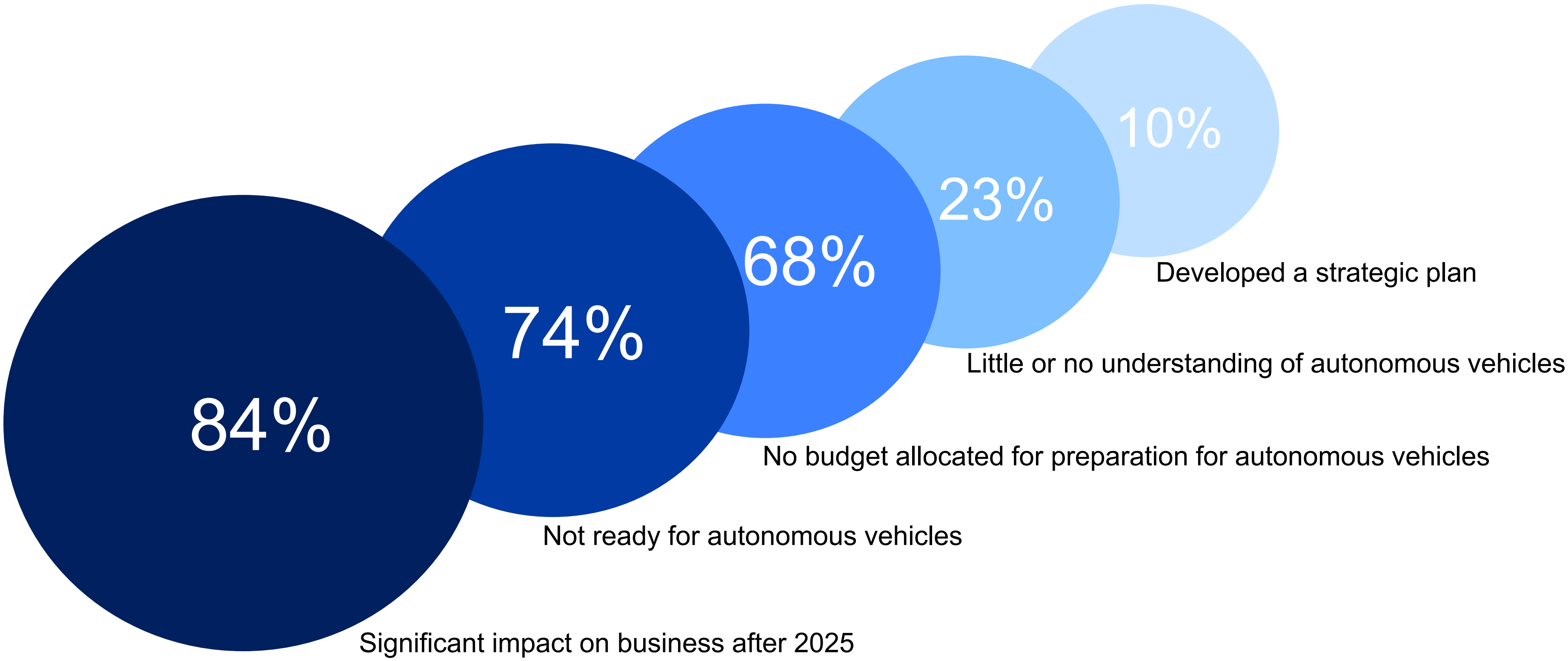
Source(s): AAA, NHTSA, Business Insider, Uber, KPMG Analysis

Market Implications: Preparing for the Future

Potential impact on insurers' books of business and the consumer marketplace for insurance

Insurance Industry View on Timeline

Currently, there is significant skepticism among insurance leaders about the potential for autonomous vehicles to transform the industry - few insurers have taken action, most likely because many believe the change will happen far into the future, if at all

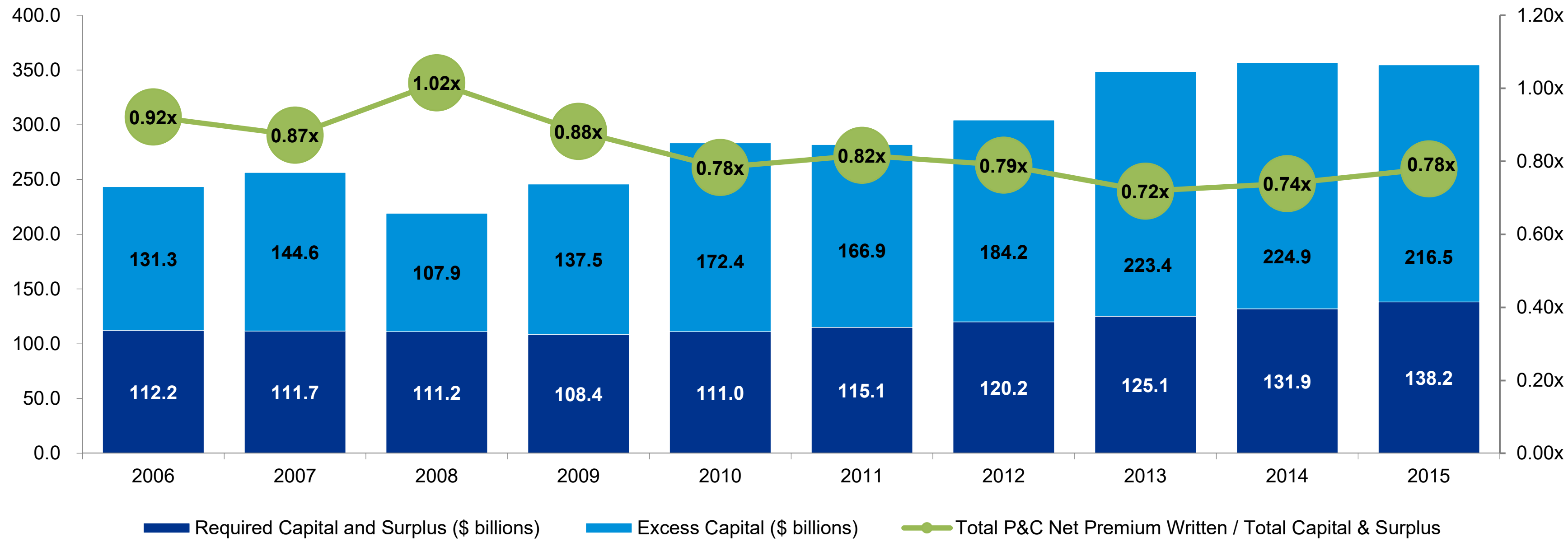


Source: KPMG LLP's 2015 Automobile Insurance in the Era of Autonomous Vehicles Survey Results

Insurer Excess Capital

The good news is that personal auto insurers have lots of capital, giving them significant financial flexibility. The bad news is that this large capital cushion may also give many a false sense of security

Capital Position of Top 15 Personal Auto Insurers' Overall P&C Businesses[1]



Note: (1) 2015 statutory P&C insurance data aggregated for the top 15 writers of private passenger auto direct premium written, based on SNL groups / unaffiliated companies. Required capital was calculated by dividing total P&C NPW by two given an assumed NPW / capital & surplus ratio of 2:1. Excess capital is then calculated by subtracting required capital and surplus from total capital & surplus of the top 15 personal auto insurers on an aggregate basis. Source: SNL Financial

Insurer Impact

Autonomous vehicle technology will result in a dramatically safer driver experience, thereby significantly impacting the insurance marketplace by reducing traffic fatalities and other losses

Insurance

Auto insurance
Claim frequency will fall, ultimately leading to lower premiums

Life and annuities
Mortality tables will be impacted – road traffic accidents leading cause of death for ages 15 to 34

Workers' compensation
6% of claims costs arise from auto accidents

Source: KPMG LLP actuarial analysis and US Centers for Disease Control and Prevention (2010)

The Consumer, the Autonomous Vehicle and Insurance

From safety to saving money on insurance dollars spent, autonomous vehicles have the potential to positively impact consumers in a variety of different ways, although associated risks of this new technology also must be considered

Considerations

General

- Cost of vehicle
- Cyber threats
- Privacy issues
- Ownership of data
- Access to mobility (urban areas most likely to benefit)

Insurance Related

- Lower premiums most likely to benefit those utilizing autonomous vehicles more
- Pricing transparency if included in sticker price
- Insurance industry disruptions – job impact

Potential Benefits

General

- Safer vehicles = less auto related deaths and injuries
- Autonomous mobility-on-demand and cost effective, tailored means of transportation
- Greater access to mobility for urban youth, the disabled, the elderly and other segments of the population

Insurance Related

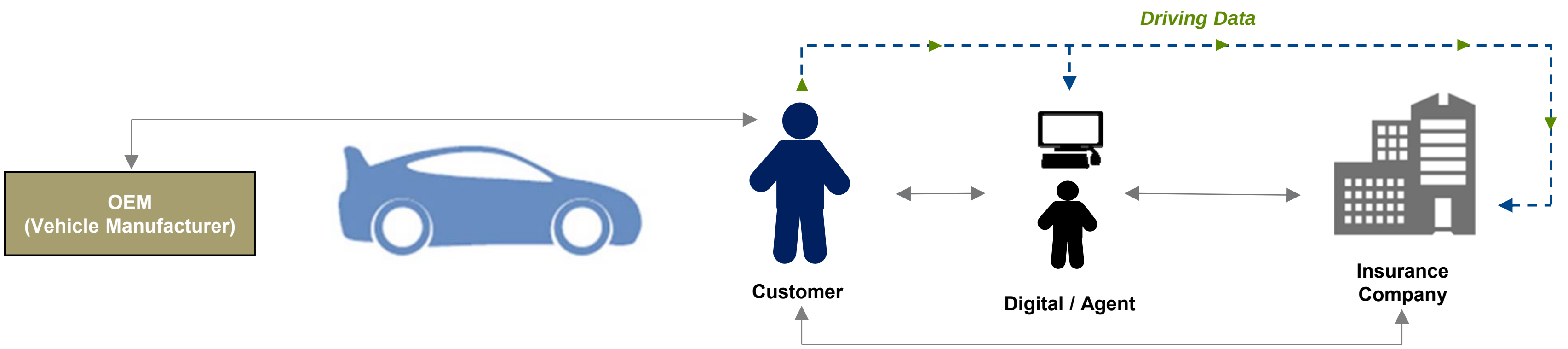
- Lower losses lead to lower premiums
- The “new” two car family – now one car family supplemented by mobility-on-demand – lower overall insurance (and vehicle) spend

The OEM Advantage – Data and the Customer Relationship

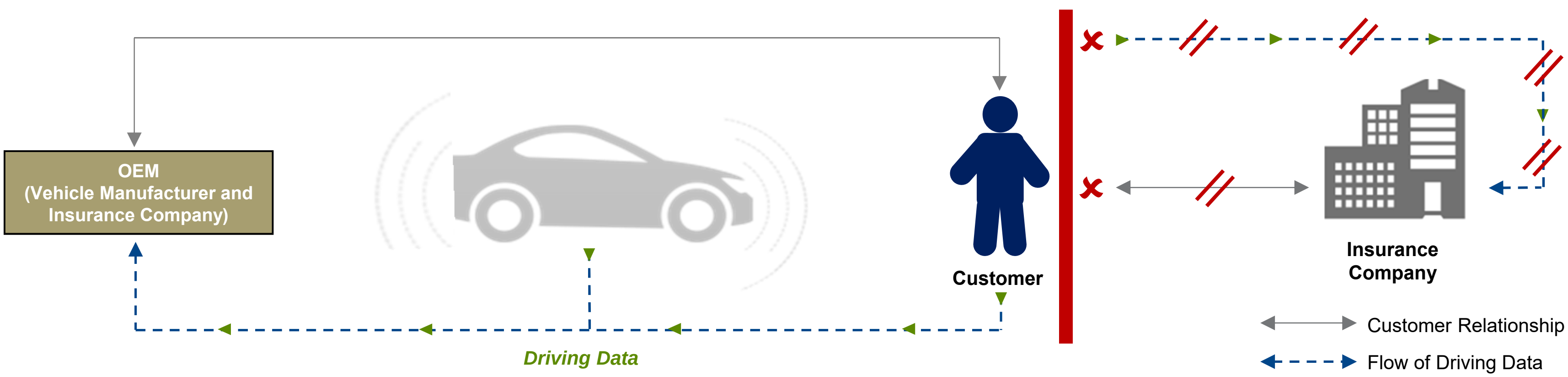
Ultimately, the original equipment manufacturers ("OEMs") have the ability to not only control the data, but also the customer relationship, thereby dramatically altering the traditional auto insurance model

Illustrative Process of Buying Automotive Insurance

Today



The Future



Potential Business Models

The (re)entrance of OEMs into insurance could take a variety of forms

Illustrative Future State Business Models

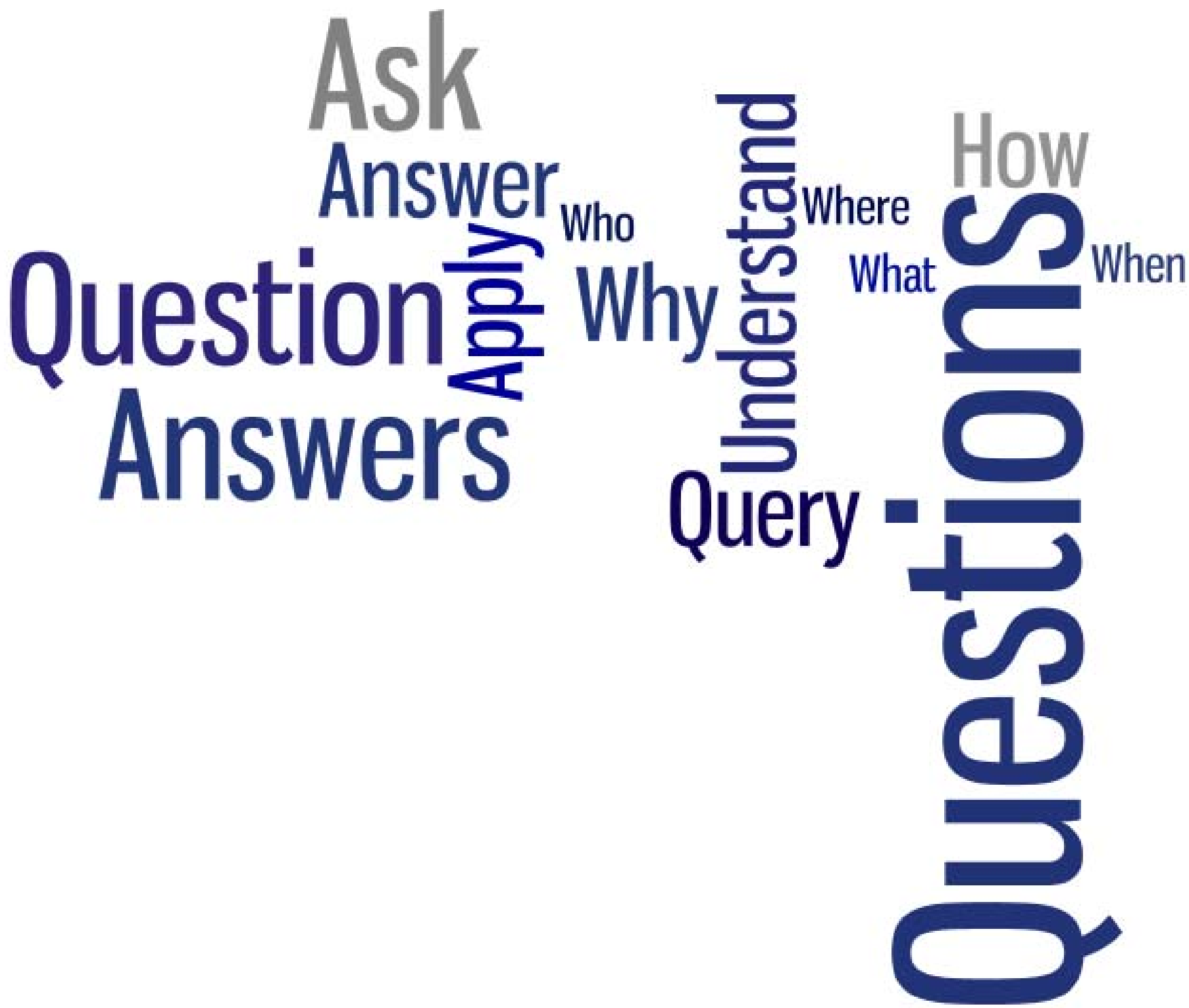
	Entity	Scenario A	Scenario B	Scenario C	Scenario D
OEMs		▪ Provide driving and vehicle data to insurers	▪ Become distributor of insurance for a selected set of carriers	▪ Act as an insurance company with many functions outsourced	▪ Become a fully integrated insurance company
OEMs	**Strategic Angle**	▪ Telemetry data	▪ Brand, customer connectivity	▪ Product advantage	▪ Product advantage
OEMs	**Revenue Model**	▪ Fees	▪ Commissions	▪ Underwriting profit and investment income (annuity) ▪ Vehicle and parts sales	▪ Underwriting profit and investment income (annuity) ▪ Vehicle and parts sales
Insurer		▪ License data from OEMs to underwrite policies	▪ Form alliances with OEMs	▪ Serve as third-party administrators - for example, current insurers could process the claims of the OEMs	▪ Transform business model to compete with new entrants ▪ Expand into new products and services

KPMG

Preparing for the Future - Auto Insurance Considerations

1. Acknowledge that the Autonomous Vehicle Transformation is Real
2. Understand Exposure
3. Evaluate Business Strategy / Consider Diversification Options
4. Identify and Monitor Leading Indicators
5. Prepare Operations
6. Understand Cost Structures
7. Align with Other Insurers and Form Partnerships

Questions


Ask
Answer
Who
Understand
Where
How
Question
Apply
Why
What
When
Answers
Query
Questions

KPMG Contact

Name	**Nate Loughin**
Title	*Manger, Actuarial and Insurance Risk*
Office	+ 1 610 230 2068
Email	nloughin@kpmg.com

Some or all of the services described herein may not be permissible for KPMG audit clients and their affiliates.

kpmg.com/socialmedia