PTOLEMUS Consulting Group

The impact of autonomous vehicles on risks

Presentation to the Casualty Actuarial Society

RPM Seminar - Chicago - March 20th, 2018

PTOLEMUS intellectual property

The consulting & research firm for the connected world

Consulting services

- **Strategy definition**
- **Investment assistance**
- **Procurement strategy**
- **Innovation management**
- **Business development**
- **Deployment**

Market research services

Fields of expertise

Mobility services	Car pooling Car sharing Smart parking	Multimodal mobility Ride hailing	Road side assistance Tax refund
Vehicle services & telematics	bCall eCall FMS SVT / SVR	VRM Concierge In-car Wi-Fi Fuel cards	Parking Navigation Speed cameras Traffic information
Usage-based charging	Car As A Service Electronic Toll Collection	Mobility-as-a-Service Road charging	UBI / PAYD Vehicle rental Vehicle leasing
Vehicle data & analytics	AI CAN-bus Crowd-sourcing Data protection	Driving behaviour OBD Predictive analytics	Remote diagnostics xFCD
Vehicle automation	ADAS	Autonomous cars	Autonomous trucks
Enabling technologies	Positioning (GNSS / WiFi / cellular)	M2M / connectivity Smartphones	Telematic devices V2X

Our clients come from across the mobility ecosystem

Analytics, maps & applications providers

AAA · arity · BMJ Group · CCC Information Services Inc. · Cognizant · COYOTE · Dynamic Map Platform · Google · here Maps for Life · ESRI · Increment P · LexisNexis · MOVELO · PASCO · RMS · SAS · tdf · TomTom · Towers Watson · TrueMotion · Verisk Analytics · wejo · ZENRIN

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Telematics solution providers

ARKAN · arvento Mobile Systems · DANLAW · DigiCore · drivefactor · drust · Eliocity · FleetComplete · Fleetmatics · LOJACK · mobile devices · OCTO · HIMEX · IMS · META SYSTEM · SafeFleet · simobil · SISTEMA · ORION · Quartix · Queclink · Scope Technologies · Tantalum · VIASAT · Watchstone.

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Device & location suppliers

ANDREW · cnes · LOCATION SMART · NAVIZON · NOKIA Connecting People · gmv · HUAWEI · SAMSUNG · ThalesAlenia Space · Telespazio · DEVERYWARE · SYSNAV Navigation Solutions · TruePosition

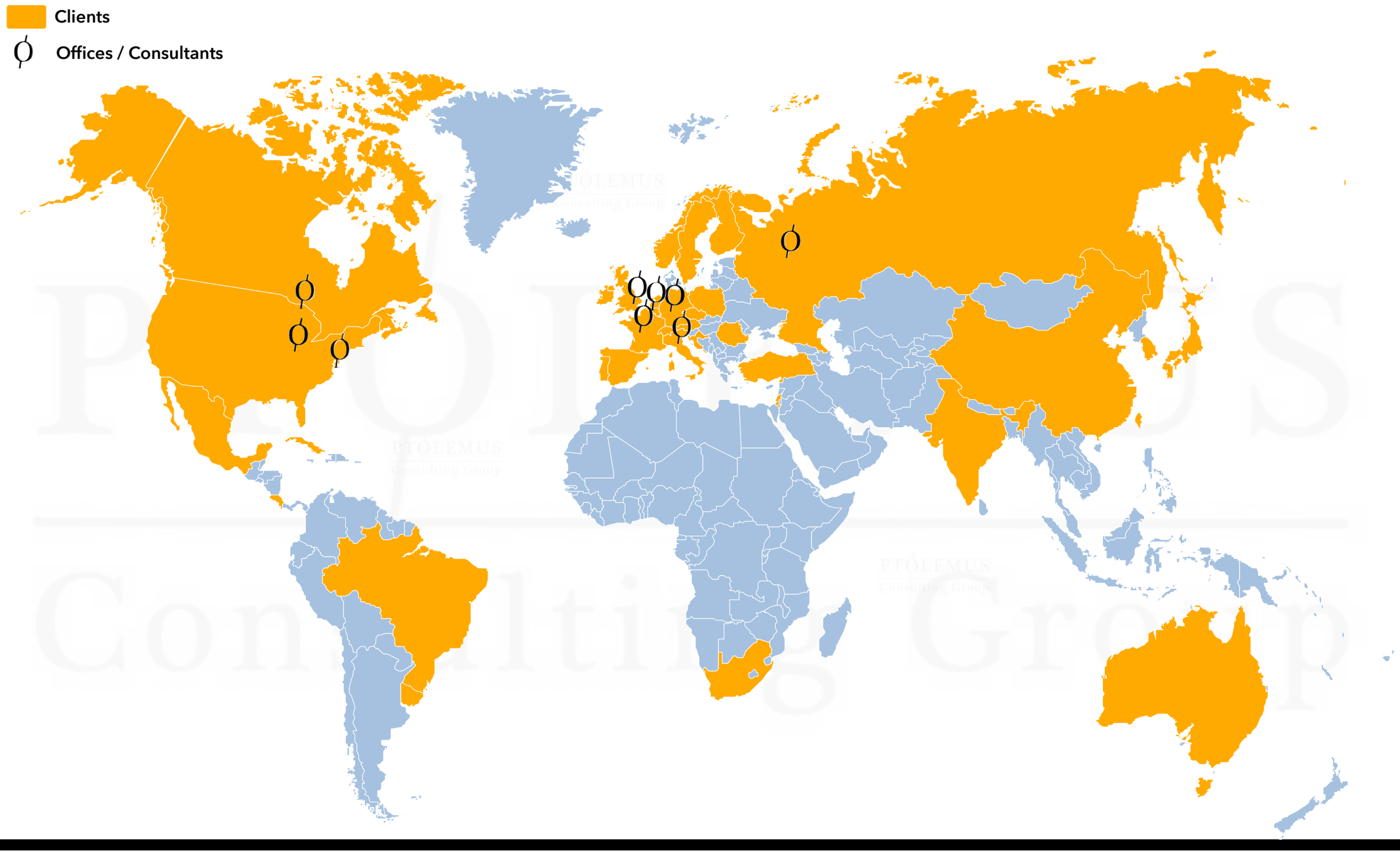
Insurers, aggregators & assistance providers

AAA Insurance · ADMIRAL · Agero · Aioi Nissay Dowa Insurance · MS&AD INSURANCE GROUP · Allianz Global Assistance · Allstate · AXA · Baloise Insurance · carrot · covea · CRÉDIT AGRICOLE ASSURANCES · Desjardins · europ assistance · FIA · GENERALI · The Hartford · IAG · intact · INTER MUTUELLES ASSISTANCE · ИНГОССТРАХ Ingosstrakh · Liberty Mutual · MACIF · Matmut · HUK · MENORAMIVTACHIM · MONDIAL ASSISTANCE · Munich RE · PROMUTUEL · OUT SURANCE · RAC · RSA · SOMPO JAPAN · Swiss Re · smile direct · telesure · TOKIO MARINE · youi · ZURICH

Banks & private equity investors

Amadeus Capital · Amundi · BainCapital · Bank of America Merrill Lynch · BARCLAYS · THE BAUPOST GROUP® · Cinven · DISRUPTIVE · citigroup · HELLMAN & FRIEDMAN · J.P.Morgan · Goldman Sachs · INTEK GROUP · INVESTCORP · HUTTON COLLINS · Leonardo & Co. · MONTEZEMOLO & PARTNERS · NEW AMSTERDAM GROWTH CAPITAL LLC · NOMURA · RENOVA GROUP · PAMPLONA CAPITAL MANAGEMENT · SILVERLAKE · TIME FOR GROWTH · THOMA BRAVO

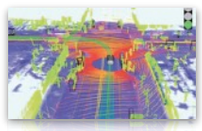
A team of 25 consultants, experts & researchers with 14 nationalities serve our clients worldwide



We help our clients define & implement their strategies in connected mobility & automation

Defining strategic positioning in insurance telematics value chain

Global tier-1 automotive supplier



Evaluated the market potential of HD maps for autonomous vehicles

Consortium of OEMs & map makers

Defined the strategy & business plan of its telematics programme

Global insurance company

Helped the company's Board understand the impact of telematics

European insurance group

Detected opportunities from connected & autonomous vehicles for the space industry

Defined its global data & analytics strategy to predict incidents

Major road operator

Appraised future telematics technology & market trends and their impacts

Leading EU insurance group

Evaluated the impact of telematics on claims losses

Insurance carrier

Evaluated the analytics solution of a global insurance TSP

Private equity fund

Appraised the impact of future automotive technologies on insurance

Leading insurance group

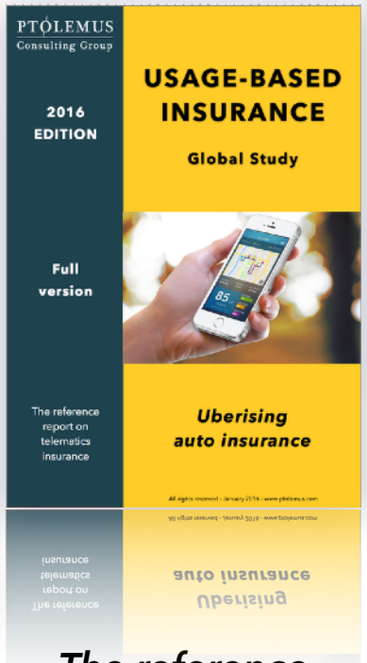
Helped the company define its strategy towards OEMs

Major insurance TSP

Built insurance telematics business plan in 5 EU countries

PTOLEMUS brings unparalleled depth of knowledge in connected and autonomous vehicle services

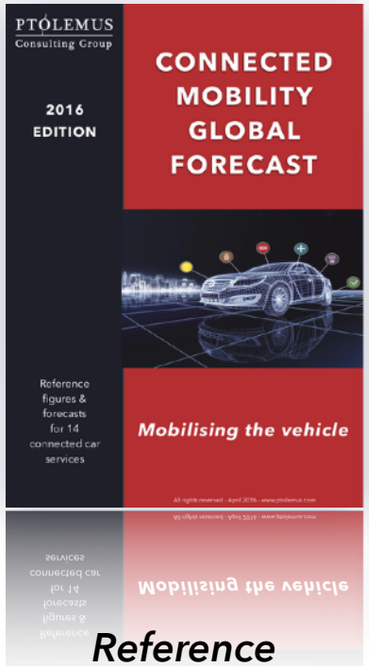
The most comprehensive report on truck fleet services



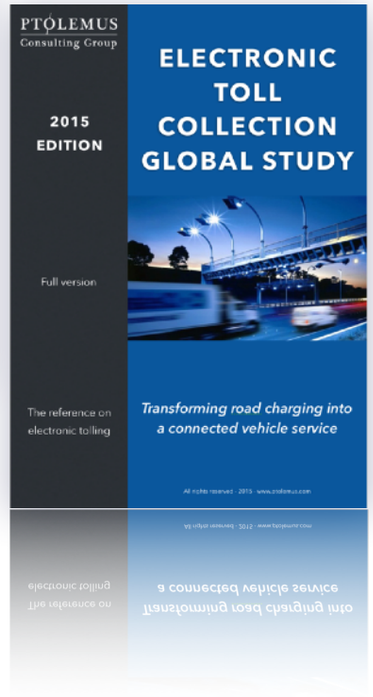
The reference report on UBI, quoted by The Economist, the Financial Times & the Wall Street Journal

The most comprehensive research on insurance analytics

The most thorough analysis of ADAS and AVs



Reference figures & forecasts for 14 connected car services



The reference on vehicle payment services

Most of the insights of this presentation come from our Autonomous Vehicle Global Study

The most thorough investigation of the driverless future

- **600+ pages of research using:**
  - 60 interviews in 8 countries
  - 12 months of research performed by 10 consultants
  - A uniquely precise and complete methodology
  - over 200 figures (charts, tables, etc.)
- Assessment of the **key factors affecting the start, the acceleration speed and the penetration** of the different level of automation from today to 2030
  - Overview of the regulatory background, applicable regulation, evolution and trends globally
  - Complete analysis of the technology building blocks including suppliers and cost analysis
  - A global quantitative analysis of the mobility market and its role in delivering driverless cars
- **27 ADAS explained** and their impact on claims analysed
- **21 OEMs and technology providers** analysed and their AV strategy compared
- **A qualitative & quantitative evaluation of the impacts of automation on**
  - Safety
  - Personal data protection
  - Connected services
  - The automotive industry
  - The risk sector
- **2015-2030 bottom-up ADAS & AV market forecasts**
  - Global forecast over 18 markets
  - ADAS and AV **penetration forecast by level and car segment**
  - Forecast on crash volumes and severity, claims costs and insurance premiums

PTOLEMUS has built the most comprehensive analysis of the impact of automation on insurance risks

BUILDING BLOCKS

Environment

- Country-by-country regulatory analysis
- Country-by-country market readiness analysis
- Global safety rating landscape analysis
- Value chain definition
- Map of M&A and partnerships

Process

Supply & demand

- 60 interviews of the key players
- 2000 hours of desk research and analysis
- 3 adoption scenarios
- ADAS impact on claims model
- ADAS impact on premium components model
- ADAS impact on driving score model

Technology

- ADAS features supply database
- Customer ROI per level
- Timeline of launch by country by level
- Strategic analysis of 14 car manufacturers

- ADAS features examination
- Technical building block analysis
- Technology cost model
- Global supplier database

KEY OUTPUTS

1. Assessment of core technologies required for automation
2. Timeline of the key market triggers from 2015 to 2030
3. Route-to-market analysis
4. Analysis of the key trends
5. AV adoption scenarios by level
6. AV market forecasts by level
7. Accident reduction forecast
8. Impact of automation on the automotive market
9. Claims reduction forecast
10. Insurance premium forecast by level

Our model focuses on passenger cars until 2030

PTOLEMUS Autonomous Vehicle Market Forecast

Vehicle segments

Small: Mini, Fiat500

Lower medium: Ford Fiesta, Opel Corsa

Upper medium: Opel Astra, BMW 3

Executive: BMW 5 and 7 series, Audi Q5

ADAS levels

Level 1: Car with driver assistance L1

Level 2: Car with partial automation L2

Level 3: Car with conditional automation L3

Level 4 - driven: Car with high automation L4

Level 4 - driverless: Car with high automation L4

PTOLEMUS framework to score countries

Adoption score

Commercial availability index

Regions and countries

European Union
- France
- Germany
- Italy
- Spain
- UK
- Rest of EU

Russia

Rest of Europe

North America
- USA
- Canada

Latin America

Asia - Pacific
- China
- India
- Japan
- Australia
- Rest of APAC

South Africa

Rest of Africa

Granularity of the model

Private passenger cars

- Level 1
- Level 2
- Level 3
- Level 4 - Driven
- Africa
- Aisa - Pacific
- Latin America
- North America
- Europe

Fleet company cars

- Level 1
- Level 2
- Level 3
- Level 4 - Driven
- Level 4 - Driverless
- Africa
- Aisa - Pacific
- Latin America
- North America
- Europe

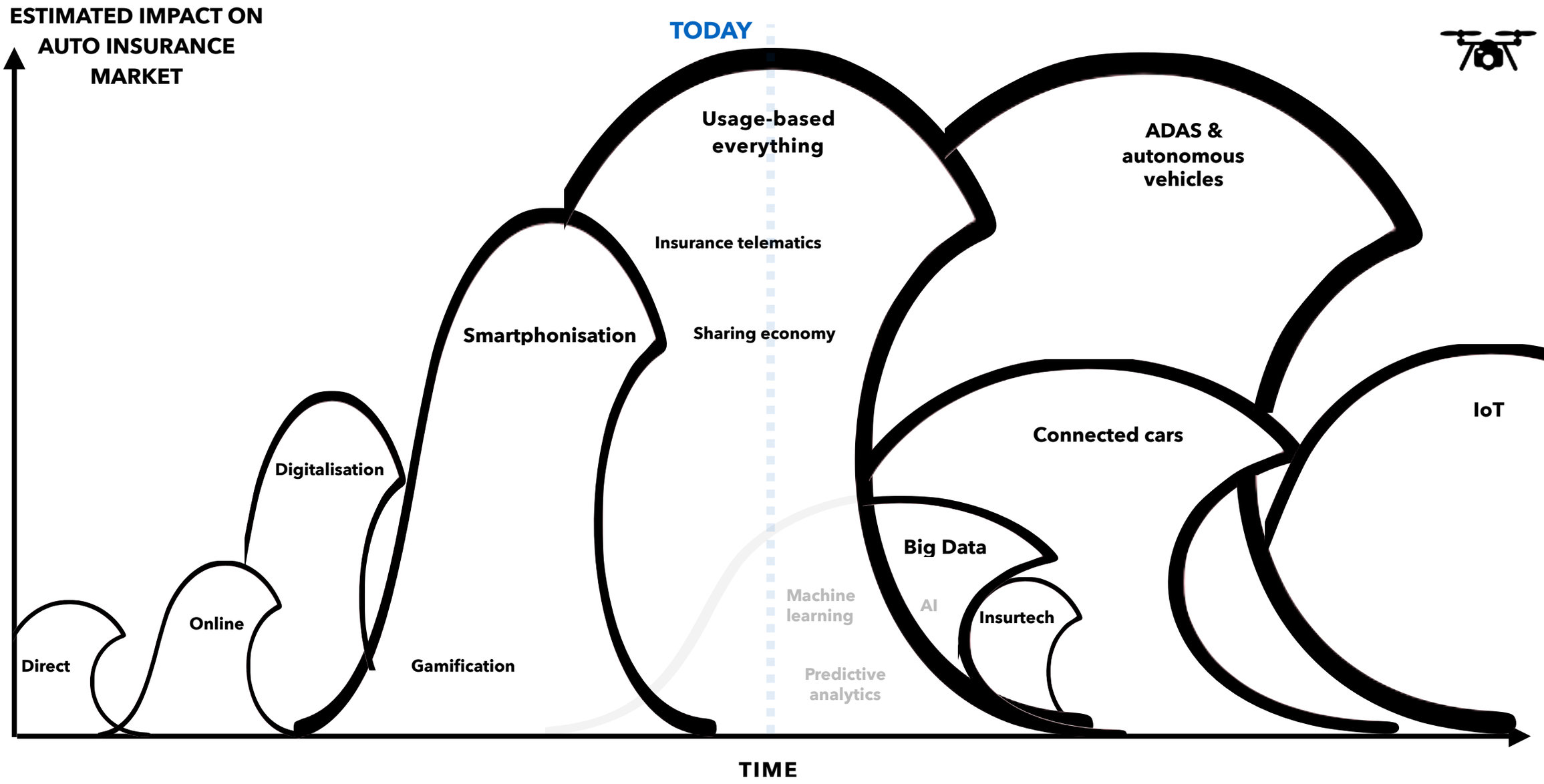
Outcomes

Automotive market
- **Penetration** and **volumes**

Insurance market
- **Impact** on **claims**
- **Impact** on **premiums**

No sign that the sea is getting quieter...

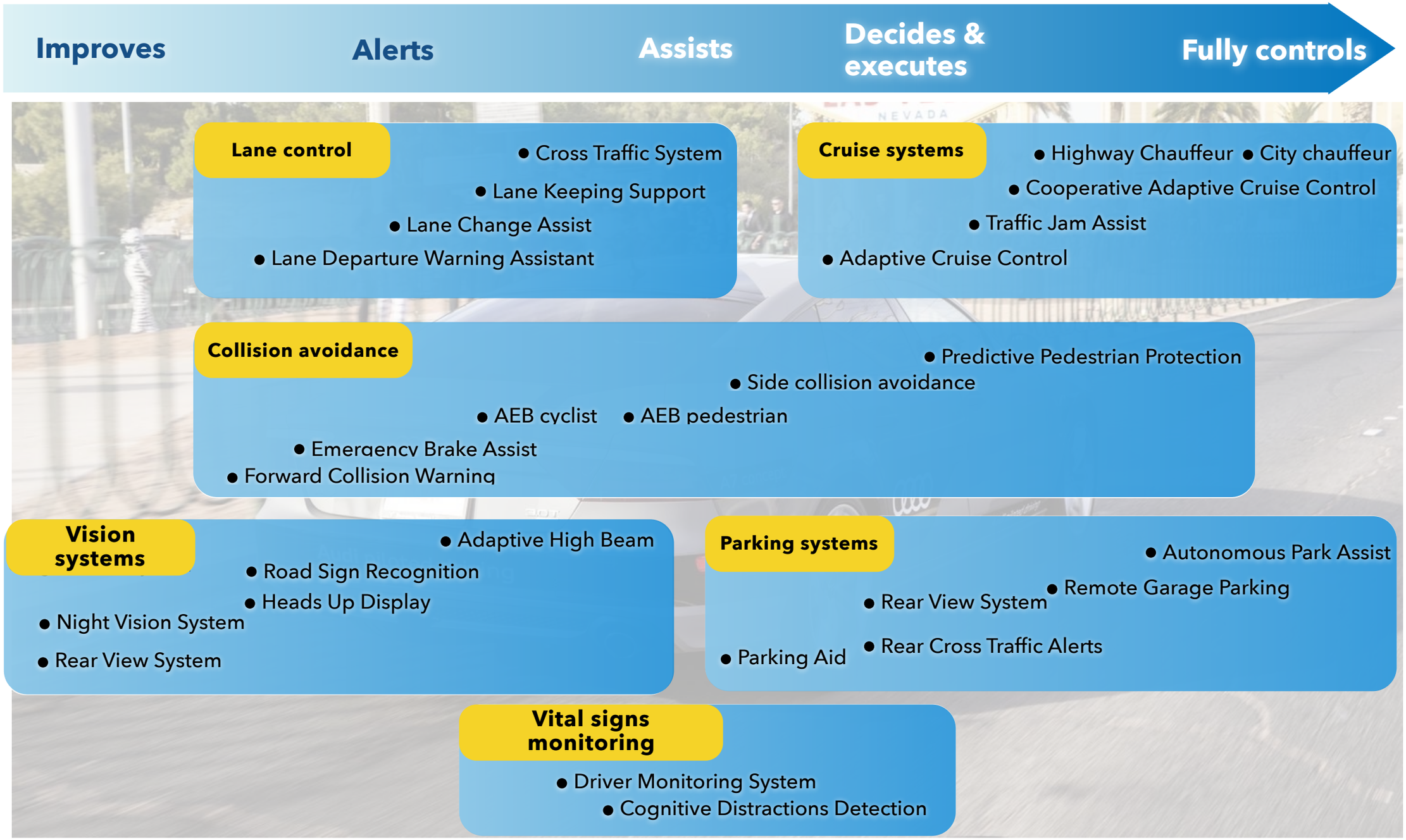
The waves - Major trends affecting the auto insurance business



PTOLEMUS

Source: PTOLEMUS

The autonomous trip starts with ADAS features



Source: PTOLEMUS. *ADAS: Advanced Driver Assistance Systems

The levels of automation depend on the car's capabilities and working conditions

	Level 1	Level 2	Level 3	Level 4	Level 5
					
System capabilities	**Steering OR Acceleration/ Deceleration**	**Steering AND Acceleration/ Deceleration**	**Monitoring the environment**	**FULL fallback control**	**Perform ALL dynamic driving tasks**
Working conditions	***In certain circumstances only****				***In all circumstances***
Example	*Adaptive cruise control Automated Emergency Braking*	*Audi Traffic Jam Assist Tesla Autopilot Mercedes-Benz Driver Assistance Systems*	*Audi Traffic Jam Pilot*	*Waymo / Chrysler Pacifica*	*BMW iNext Vision prototype*

Source: SAE, PTOLEMUS - Note: * Depending on road, traffic and weather conditions

We expect L4 to start first on roads with driverless shuttles and taxis

	Level 2	Level 3	Level 4 Driverless	Level 4	Level 5
					
System capabilities	**Steering AND Acceleration/ Deceleration**	**Monitoring the environment**	**FULL fallback control**	**FULL fallback control**	**Perform ALL dynamic driving tasks**
Working conditions	***In certain circumstances only****				***In all circumstances***
Degree of driver liability	**Full liability**	**Full liability**	**No liability**	**Partial liability**	**No liability**
Expected launch date	**2010**	**2018**	**2021**	**2023**	**2030?**
Example	*Audi Traffic Jam Assist* *Tesla Autopilot* *Mercedes-Benz Driver Assistance Systems*	*Audi Traffic Jam Pilot*	*Navya Arma shuttle* *Google's Firefly pod-car prototype*	*Waymo / Chrysler Pacifica*	*BMW iNext Vision prototype*

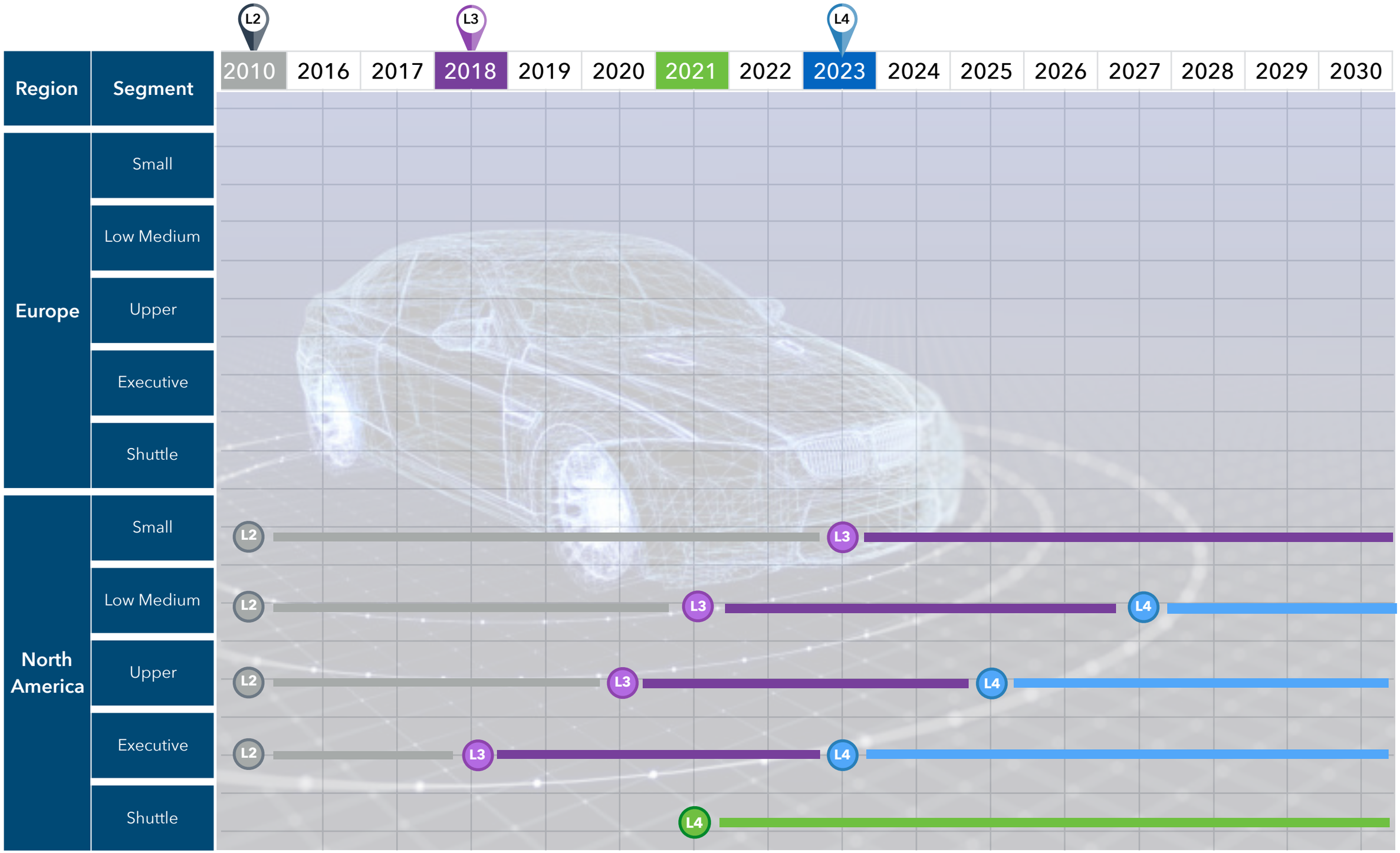
Source: PTOLEMUS - Note: * Depending on road, traffic and weather conditions

The Operating Design Domain (ODD) defines when and where the car can be expected to work autonomously

	Level 2	Level 3	Level 4 Driverless	Level 4	Level 5
					
Within ODD	*Motorway, slow traffic*	*Single stretch of road*	*Country*	*Well-defined urban areas*	*All conditions*
Outside ODD	*Adverse weather*	*Traffic, single event*	*Heavy weather*	*Un-mapped, non-urban locations*	*None*
Degree of driver liability	Full liability	Full liability	No liability	Partial liability	No liability
Expected launch date	**2010**	**2018**	**2021**	**2023**	**2030?**
Example	*Audi Traffic Jam Assist* *Tesla Autopilot* *Mercedes-Benz Driver Assistance Systems*	*Audi Traffic Jam Pilot*	*Navya Arma shuttle* *Google's Firefly pod-car prototype*	*Waymo / Chrysler Pacifica*	*BMW iNext Vision prototype*

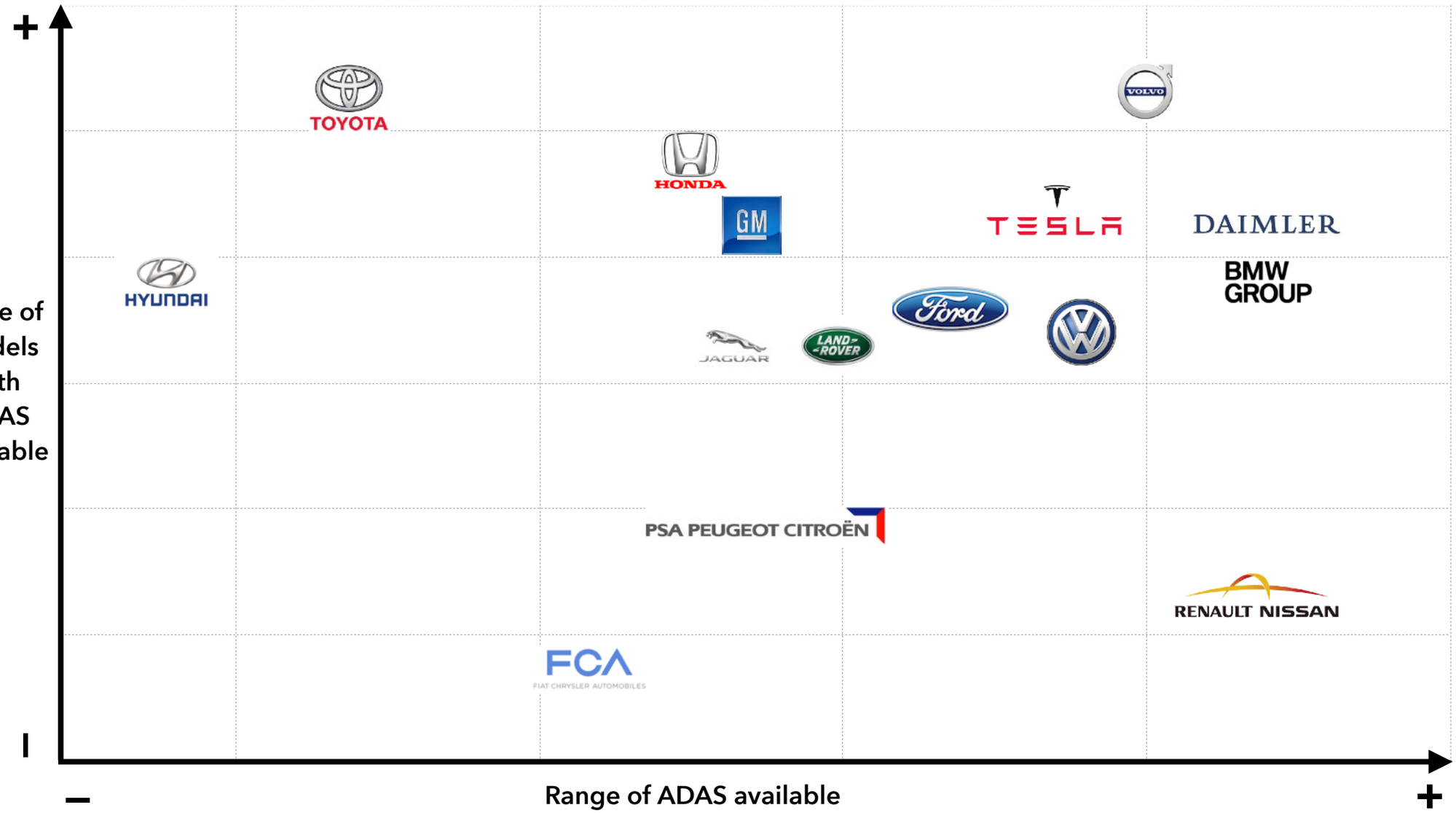
Source: PTOLEMUS - Note: * Depending on road, traffic and weather conditions

Level 4 driven vehicles are expected to emerge in 2023…



… but ADAS is there already, starting with premium brands

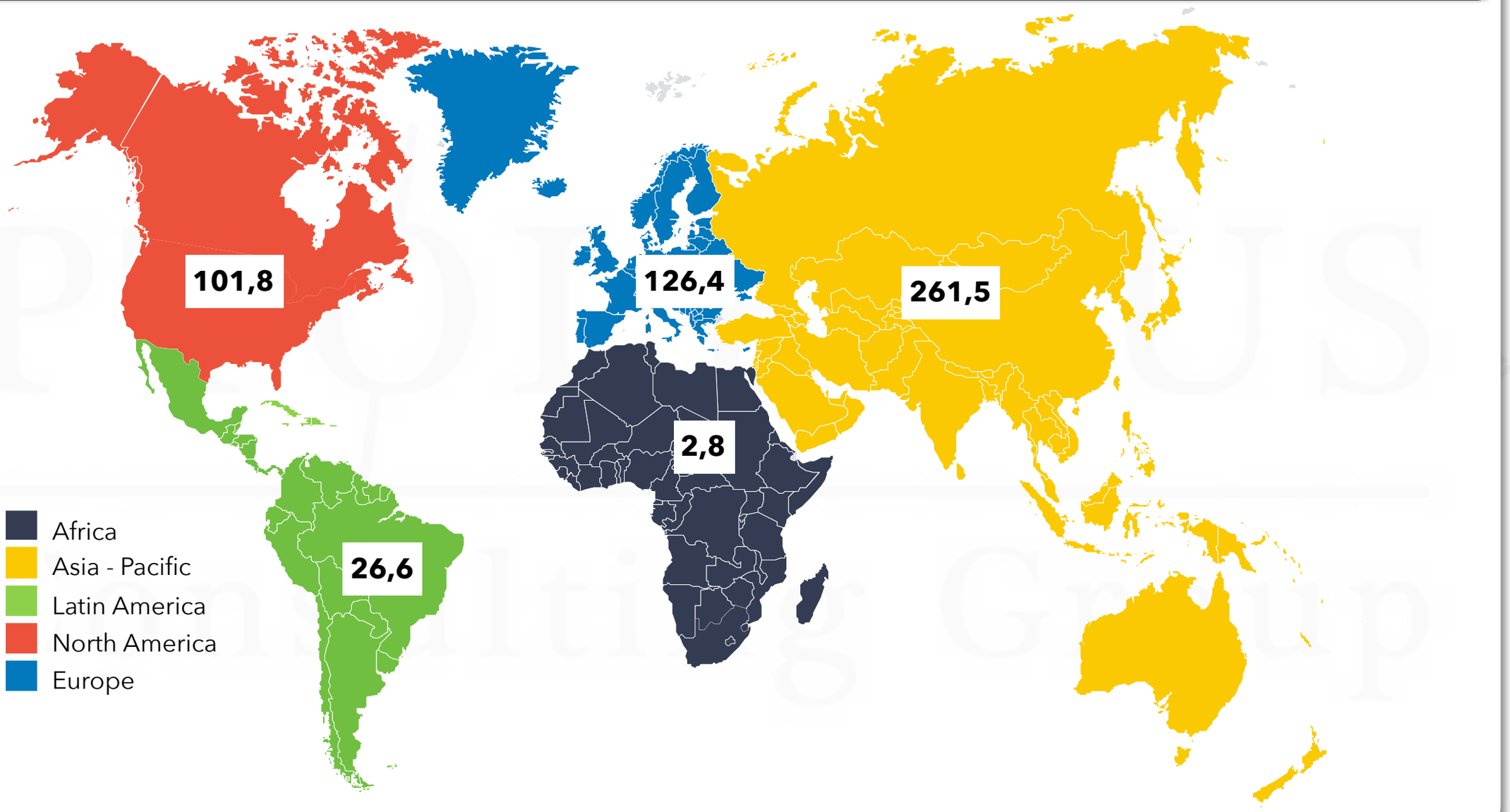
OEM involvement in ADAS in 2017



Source: PTOLEMUS research based on most representative ADAS and the most equipped version of each model only for Europe and North America

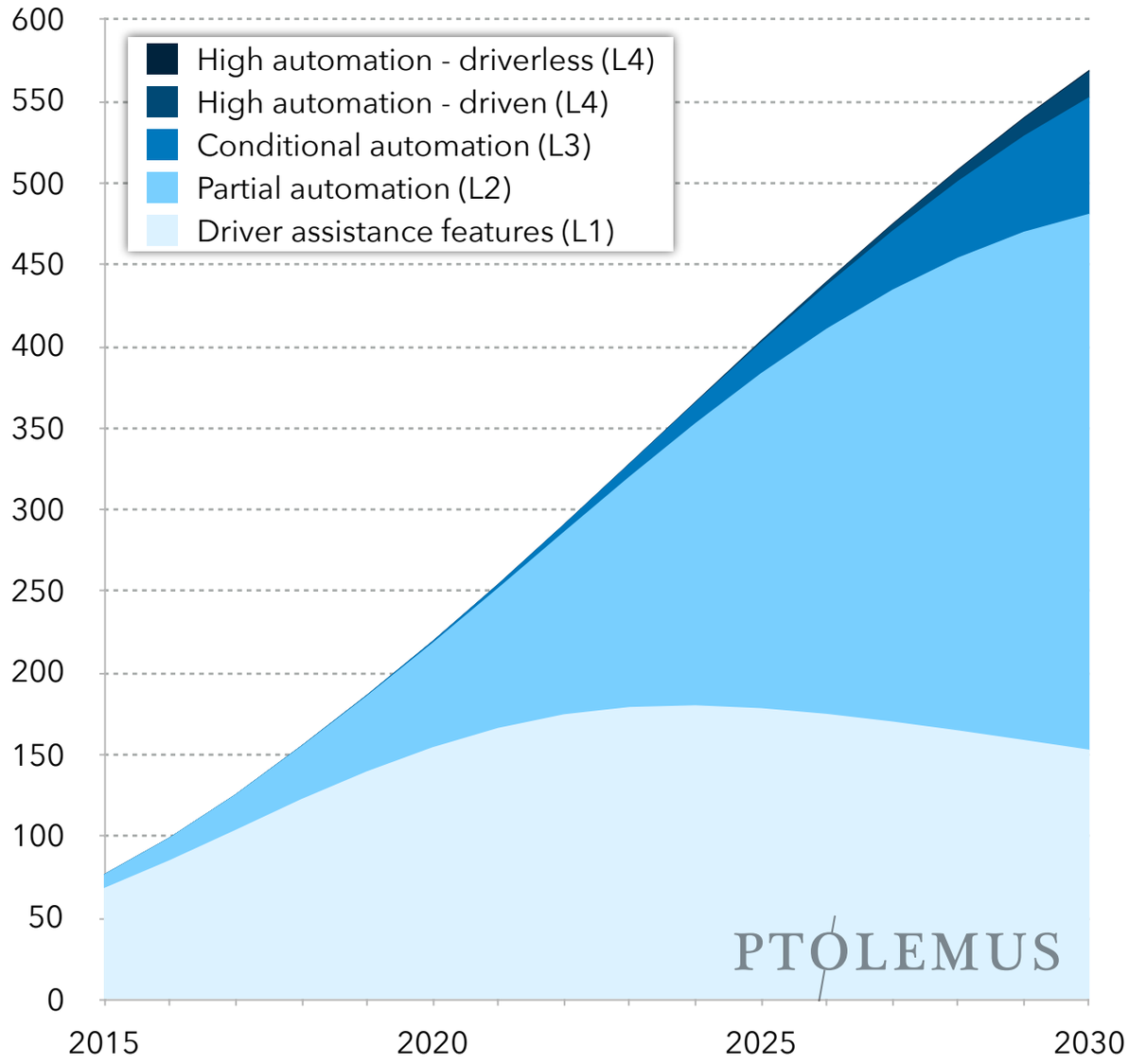
In 2030, 13 million fully autonomous cars will be on the road but 520 million will have some automation features then

Total passenger cars on the road with automation features (million, 2030)



There will be 87 million level 3-4 cars on the roads in 2030

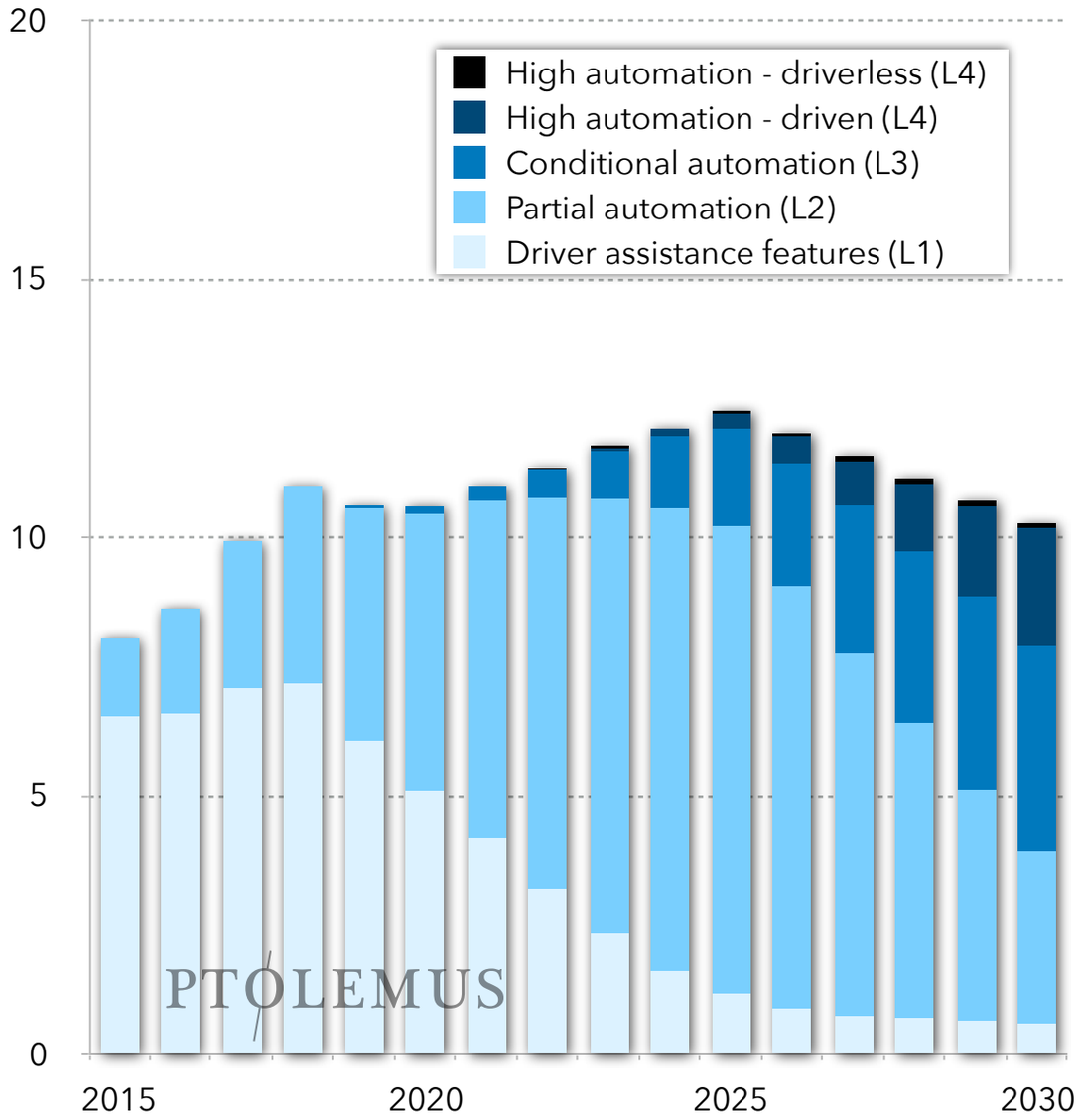
Passenger cars on the road with assistance & automated driving features
(L1 to L4 vehicles, in million, worldwide)



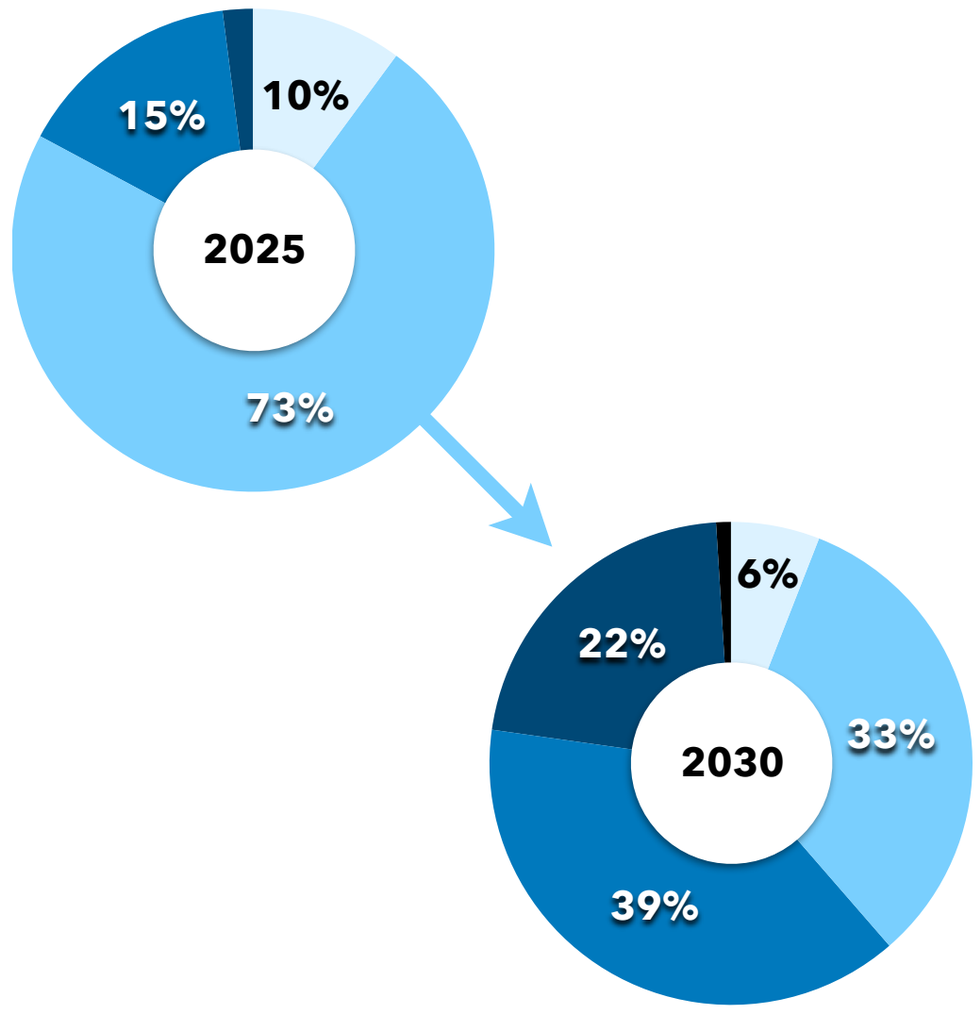
- The total **number of cars** with **at least L1 technology** on the road will **exceed 550 million units by 2030**
- **From 2018,** US OEMs will introduce **Automated Emergency Braking** systems as a **standard feature on new cars sold** and we expect OEMs in Europe to follow a similar path, which will **accelerate the growth of L2 vehicles sold**
- From **2024 onward** we will observe a reduction of the number of **L1 cars** on the road as the **number of vehicle sold with this level of ADAS will be smaller than the ones destroyed**
- By **2025,** we expect the total number of **passenger cars used with L3 functions to reach almost 20 million units worldwide**
- While we expect the first **L4 cars to enter the market from 2021**, they **will represent less than 3% of passenger cars** on the road by 2030 in EU, Japan and North America

In North America, total sales of L4 driven cars will pass the 2 million mark by 2030

New passenger car sales - North America
(mutually exclusive categories, million)



Breakdown of total AV cars sales by levels



Insurers face several challenges on the road to pricing premiums based on ADAS

Identifying ADAS in vehicles

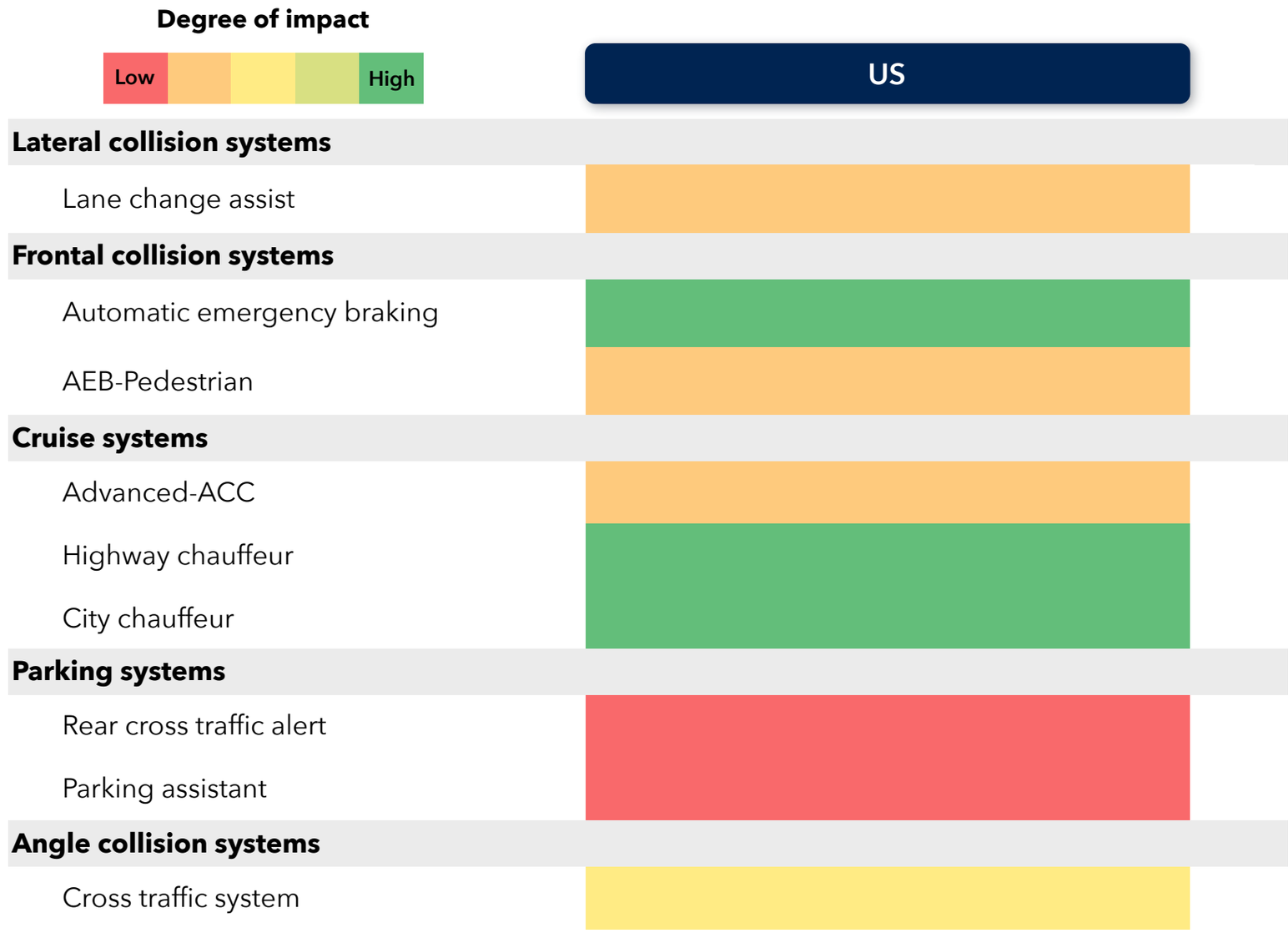
- Very few ADAS are equipped as standard, making it difficult for insurers to track which vehicles are equipped with safety technologies
- Even in vehicles with standard ADAS, customers still have the choice to add additional ADAS packages
- Vehicle models on the road will then be equipped with different ADAS and have different risk profiles
- Some ADAS must be turned “on” to have an effect, which will be difficult for insurers to track

Defining the impact of individual ADAS or ADAS combinations

- It is not clear to what extent each ADAS can reduce the risk of crashes
- ADAS from different car brands or suppliers can often function differently and have various levels of effectiveness
- There is a lack of real-world data that is identifying the actual impact of ADAS on crash mitigation
- It is even more complex to calculate the risk mitigation potential on a system-wide level (i.e. with multiple ADAS)
  - ADAS can have overlapping effects (cruise control can mitigate frontal collisions in a similar way that AEB can mitigate frontal collisions)

The ADAS transition must begin with AEB and go through pedestrian and cross traffic safety technologies

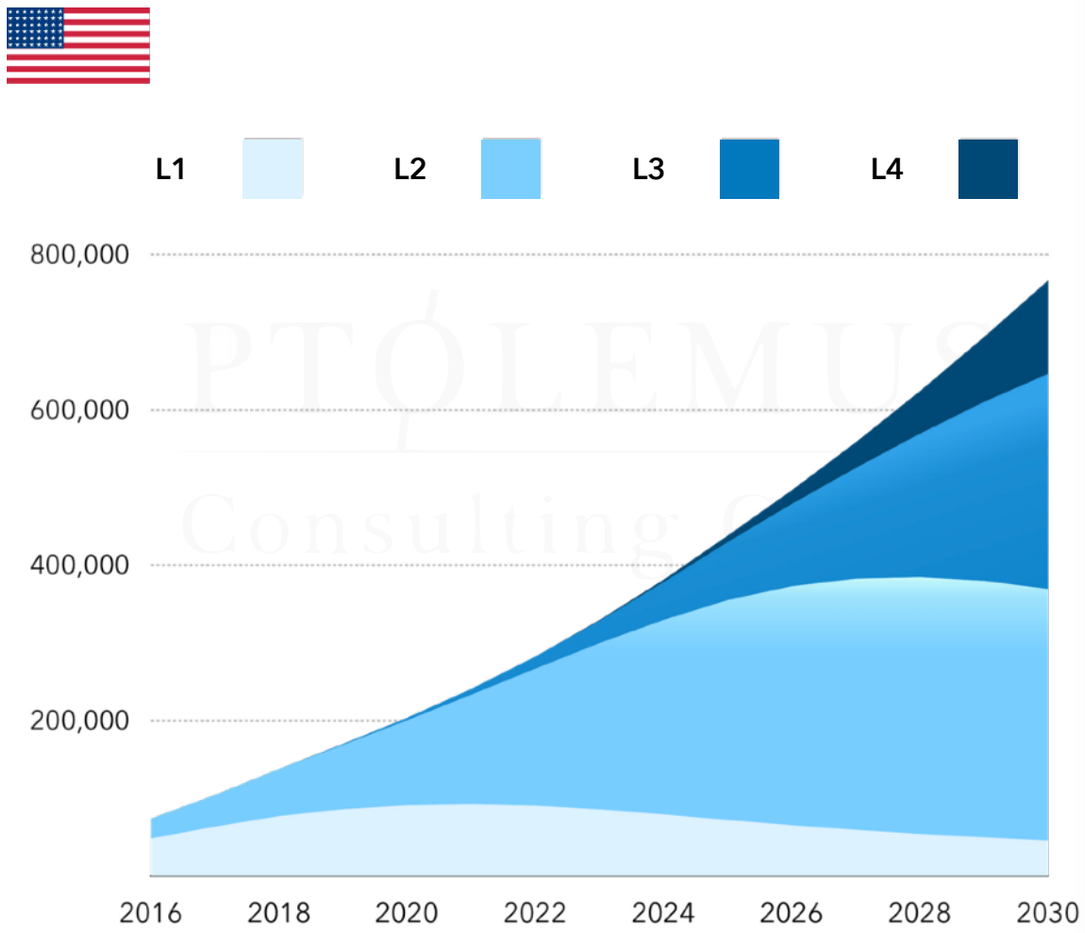
Estimated impact of core ADAS functions in the US



- There is a clear hierarchy of ADAS that present high potential for improved safety
- AEB is the only ADAS that is currently widely available, making a significant impact on reducing vehicle risk
- Before reaching full autonomy, there are few ADAS that will prove to have significant impact individually on reducing insurance claims losses
- The US market will only see significant improvement after AEB with the advent of advanced cruise systems

Nearly 800,000 crashes avoided *every year* in 2030!

US crashes avoided thanks to ADAS & autonomy

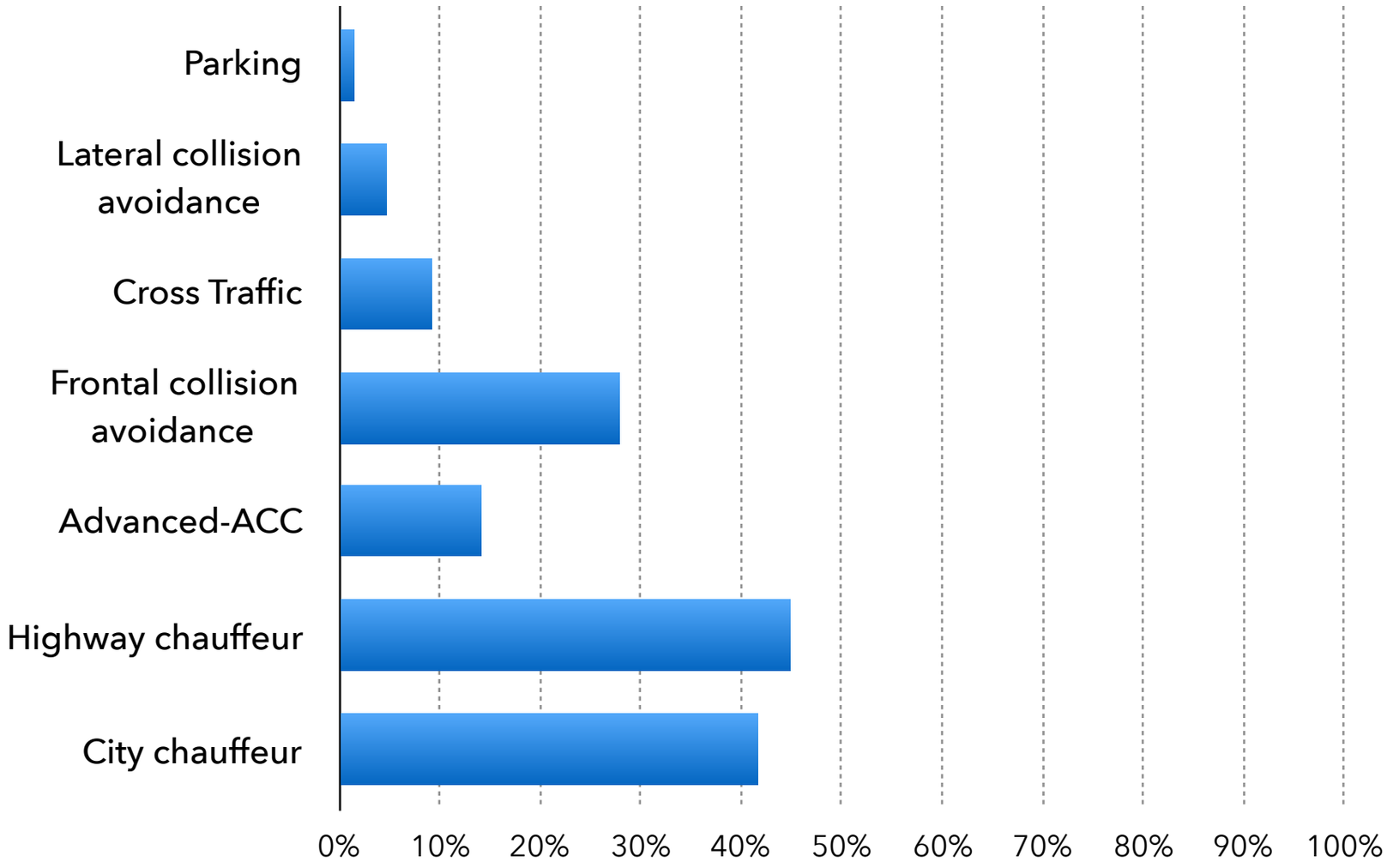


Rationale and comments

- **ADAS has the biggest impact on safety**
- Autonomy will not only mitigate crashes, it will avoid many crashes altogether
- L4 vehicles have the greatest potential to reduce crashes but **low penetration** will limit its overall impact until 2030
- ADAS will still be responsible for the **majority of crashes** avoided in 2030
- L3 and L4 have a much higher potential of accident avoidance, so will **grow much faster after 2030**

Limitations still exist to ADAS' impact on claims

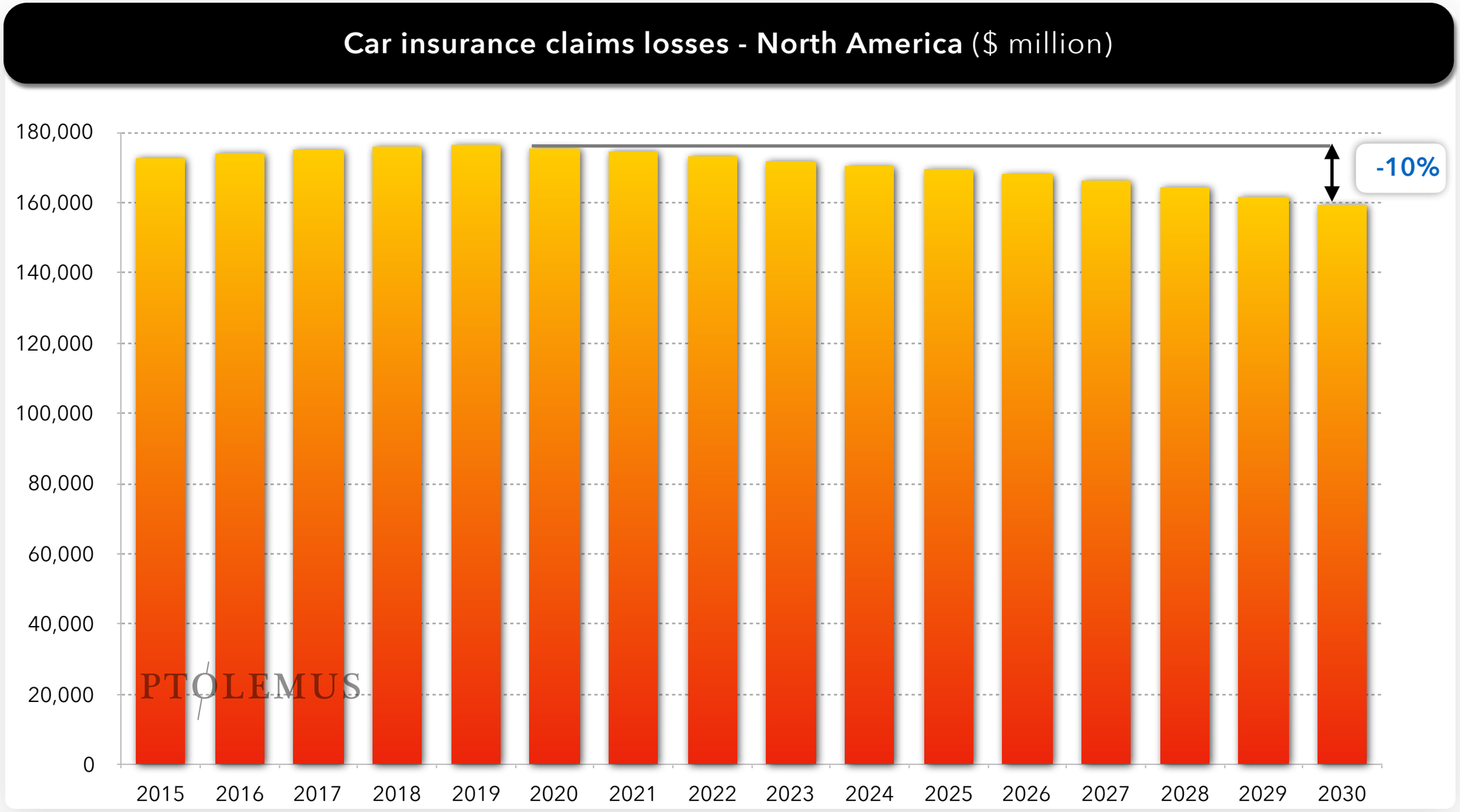
Impact of ADAS on claims cost reduction by category (%)



- ADAS technologies are at different stages of development and maturity
- Only AEB has a tangible impact on risk today
- We estimate that it can reduce claims losses by up to 20%
- Lateral collision avoidance category can provide upwards of 5% impact on insurance claims
- Whiplash-related claims would be the most affected by a mandate on AEB
- However, ADAS cannot correct bad driving behaviour

Source: PTOLEMUS autonomous vehicle market forecasts - 2017

In North America, we expect a 10% decrease in the total amount of claims paid between 2020 and 2030



AEB already leads to premium discounts in certain markets

Case study - Current ADAS-based premium reduction in the UK

From 2013, Volvo fitted their City Safety AEB system to all new Volvo models:

- Their models had their insurance groupings reduced by up to 4 levels
- The corresponding reduction in premiums was up to £161.81

Insurers are already acknowledging and anticipating the risk-changing consequences of ADAS.

However there is also an **element of positive selection** at this stage of early adoption; customers who are willing to pay for additional safety features tend to be more risk averse.

Volvo model	Group ratings drop	Potential insurance savings
V70 SE Lux D5	From 35E to 32E	154.93 £
S60 R-Design Nav D5	From 34E to 30E	154.96 £
XC60 R-Design Lux Nav D5	From 35E to 31E	161.81 £
XC70 SE Nav D5	From 33E to 30E	154.21 £

How should insurers respond to the changes in automation?

Insurer strategies for the future of mobility

1. Incentivise ADAS

Insurers will benefit from adoption of ADAS amongst their customers, so it is key for insurers to incentivise their customers to embrace ADAS.

2. Be ready for automotive product liability

With the adoption of ADAS, product liability coverage for OEMs could be chosen in certain countries

3. Build relationships with mobility service providers

Insurers need to prepare for a future of mobility with no personal insurance policies by securing contracts with mobility service providers.

4. Prepare for new insurance categories

The motor industry is about to enter a phase of rapid transformation. New insurance categories will result such as cyber security coverage.

5. Develop analytics capability

The future of policy issuance and servicing will require much more data and trained algorithms. Insurers must either develop analytics in house or develop partnerships with data science specialists.

6. Strategically price risks

Price levels should be piloted and premiums priced strategically to make the most of the benefits of the ADAS vehicles that are actually on the road and reducing crashes.

Source: PTOLEMUS

The end of auto insurance?

Thank you!

- **The impact of autonomy and ADAS on collisions will be considerable** in all advanced countries
- Our estimates show that the increase in accident costs due to ADAS equipment costs will be more than compensated by reduction in claims frequency
- **However, we do not expect product liability to replace car insurance**
- Policyholders will still require independent insurers to claim against any OEM system failures

PTOLEMUS Consulting Group

Strategies for Mobile Companies

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