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Automotive Overview

Developed in collaboration with

FROST & SULLIVAN

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Market Highlights

AI in cars

Self learning technology to take the car beyond autonomy, enhancing the users' experience via the provision of a range of infotainment features

Ecommerce in the AM

Online channels to focus on the B2B market with innovative market participants providing a broader range of spare parts to the Do It For Me customer

Biometrics in cars

Fingerprint, iris and face recognition technologies to enable next generation security features including keyless entry and ignition recognition systems

Ridesharing

Web- and app-based services to support ridesharing, saving money for consumers, taking cars off the road and contributing to sustainable transportation

Women as a customer

Economic and social empowerment to create a generation of women car buyers with specific preferences in terms of the product and retail experience

Wearables in cars

Watches and other devices to change the way in which drivers interact with their vehicles with use-cases in areas such as navigation and HVAC

E-hailing

Web- and app-based services to support e-hailing, providing greater convenience for customers and generating revenues for drivers who embrace the model

Autonomous driving

Level 3 automation to enter European and North American markets in 2017 with level 4 expected to make an impact from 2020 onwards

AI = Artificial Intelligence; AM = Aftermarket
Source: Frost & Sullivan

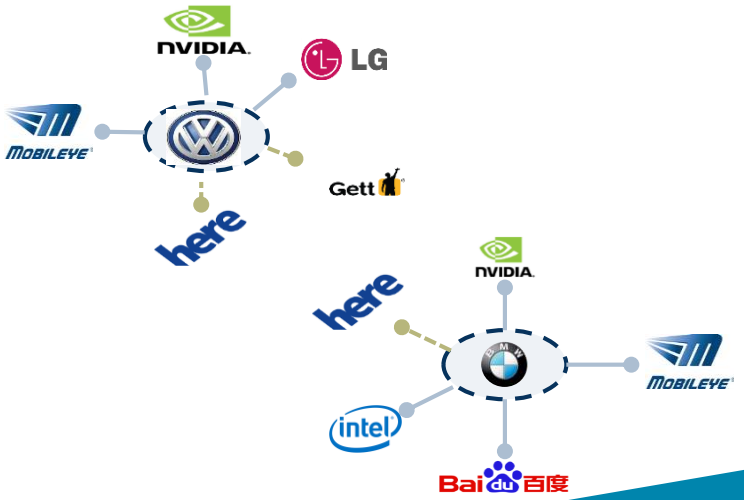
Market Trend #1
Artificial intelligence in cars

Self learning technology to take the car beyond autonomy, enhancing the users' experience via the provision of a range of infotainment features; level 4 AI will offer a $24.3 b market opportunity by 2025 with OEMs and technology companies partnering to provide value-added connected services to drivers

Size and outlook

1. Basic Function	…	4. Vehicle Control
Basic functionalities of the vehicle's operation performed by the self-learning AI		**All functionalities** of the vehicles performed by the self-learning AI
• Natural language processing • User preferences • Gesture recognition		• The car acts as a personal assistant and is fully autonomous.
• **35 million vehicles by 2025** • **Revenue opportunity: $8.9 billion**		• **2 million vehicles by 2025** • **Revenue opportunity: $24.3 billion**

Market Participants



Selected OEM/technology company partnerships
Source: Frost & Sullivan

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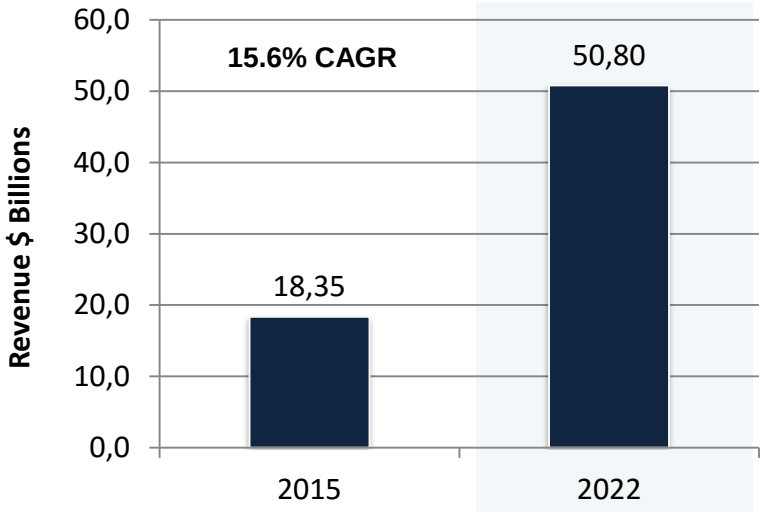
Market Trend #2
Ecommerce in the aftermarket

Online channels to focus on the B2B market with innovative market participants providing a broader range of spare parts to the Do It For Me customer; the global e-Retailing market will be valued at $50.8 b in 2022 with specialists such as Yakarouler and Tyres24 competing with e.g. Amazon.com

Size and outlook



Market Participants

TYRE 24.COM MARKETPLACE

yakarouler.com

DELTICOM Aktiengesellschaft

amazon

ebay MOTORS

Selected market participants
Source: Frost & Sullivan

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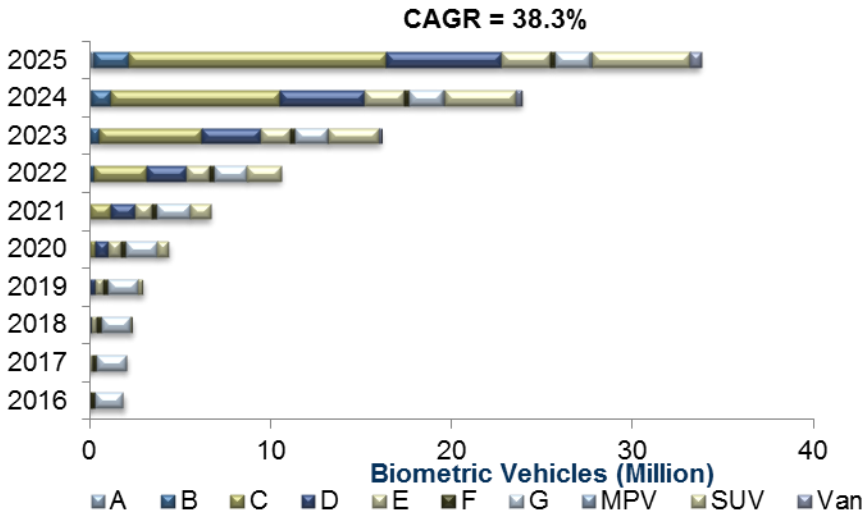
Market Trend #3
Biometrics in cars

Fingerprint, iris and face recognition technologies to enable next generation security features including keyless entry and ignition recognition systems; 34 million cars will have biometric technologies by 2025 as suppliers such as VOXX are developing iris recognition driver authentication systems

Size and outlook



Market Participants

VOXX Electronics Corporation — Iris recognition technology for driver authentication

Visteon — Facial recognition technology for driver authentication

HITACHI Inspire the Next — Finger vein identification technology

DELPHI — 2D facial recognition system for driver authentication

Selected market participants
Source: Frost & Sullivan

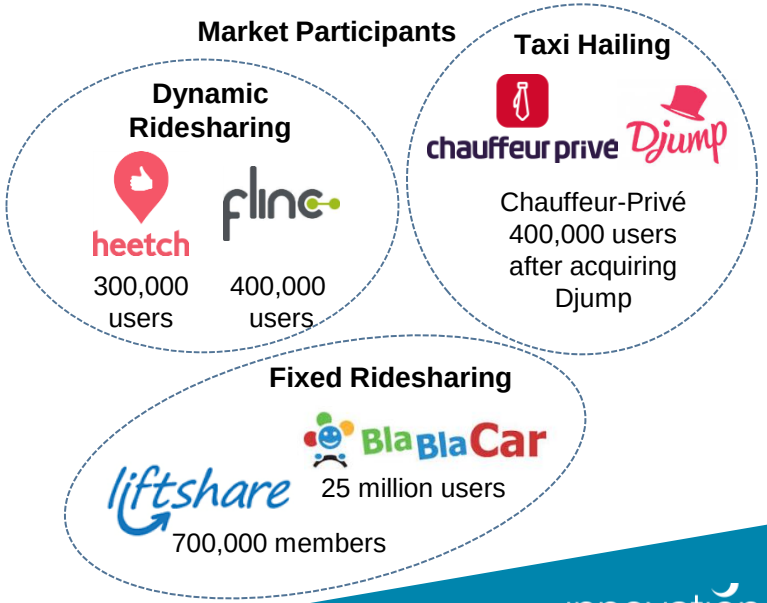
Market Trend #4
Ridesharing

Web- and app-based services to support ridesharing, saving money for consumers, taking cars off the road and contributing to sustainable transportation; membership of schemes will grow rapidly to 2025 with CAGRs of more than 12% and BlaBlaCar leading the way with 25 million users

Size and outlook

COUNTRIES	MEMBERSHIP CAGR (2015–2025)
France	12.2%
UK	19.0%
Germany	15.9%
Spain	15.1%
Italy	16.0%

Market Participants

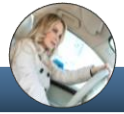


Selected market participants
Source: Frost & Sullivan

Market Trend #5
Women as a customer

Economic and social empowerment to create a generation of women car buyers with specific preferences in terms of the product and retail experience; OEMs are adapting their strategies to take into account the decision making process of feminine and personalised vehicle seekers amongst others

Buyer segments



	Feminine Vehicle Seeker	Personalization Seeker
Preferred femininity of vehicle	Vehicle designed specifically for women	Vehicle with option to add a feminine feel
Age profile	Younger: 63% are 18 to 34 years old.	Average age profile: 33% are 25 to 34 years old; 31% are 35 to 44 years old.
Geographic profile	Urban: 86% are urban-based, with 68% in larger cities (over 500K).	Mix of Urban • 46% urban in larger cities (more than 500K) • 32% urban in smaller cities (less than 500K)
Technology adoption profile	Mostly early adopters (61%)	Tested technology adopter (50%)
Marital Status	47% have children at home. Highest proportion of single women (38%)	61% have children at home. Highest proportion of married women with children (42%)

Vehicle preferences

- Rise of the SUVs and CUVs
- Desire for personalization and customization
- Social connections leading to sales conversions
- Digital journey, an integral element of the sales process

Selected segments and preferences
Source: Frost & Sullivan

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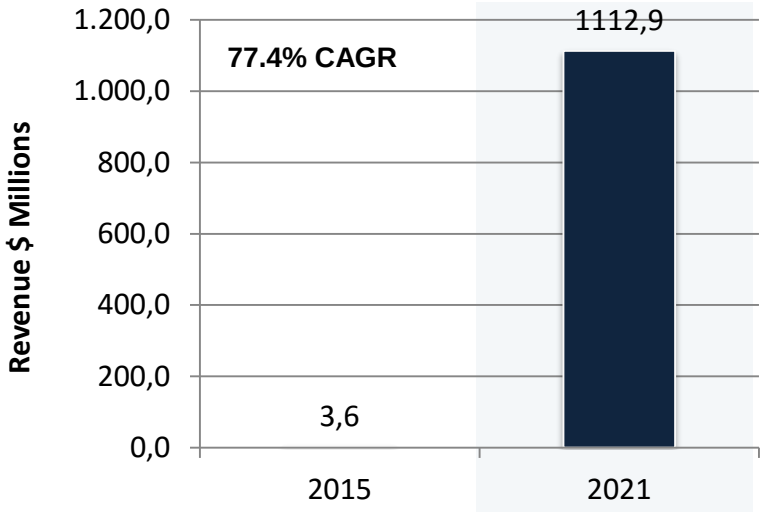
Market Trend #6
Wearables in cars

Watches and other devices to change the way in which drivers interact with their vehicles with use-cases in areas such as navigation and HVAC; from just $3.6 m in 2015, the market will reach $1.1 b by 2025 with inputs from players across the automotive, technology, telecom and IT industries

Size and outlook



Market Participants

Tesla and Apple's Remote S Solution

- **Monitor Car Location and Speed**
- **View Charge Info**
- **Vehicle Range and Dash Stats**

Selected market participants
Source: Frost & Sullivan

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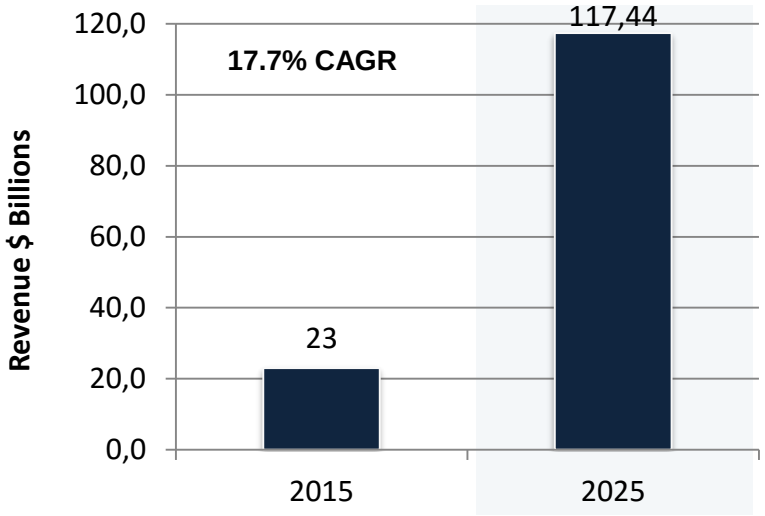
Market Trend #7
E-hailing

Web- and app-based services to support e-hailing, providing greater convenience for customers and generating revenues for drivers who embrace the model; consolidation among app providers will contribute to revenue growth of 17.7% (2015-25) as illustrated by Hailo's merger with Mytaxi

Size and outlook



Market Participants

Company	Business Model	Vehicles/ Drivers
HAIL O / mytaxi	Public taxi; 3rd party	60,000 drivers
Gett	Public taxi; 3rd party	45,000 taxis
taxi.eu	Public taxi; 3rd party	50,000 taxis
taxify	Taxi & P2P; 3rd party	62,000 drivers

Selected market participants
Hailo merged with Mytaxi in early 2017
Source: Frost & Sullivan

Market Trend #8
Autonomous driving

Level 3 automation to enter European and North American markets in 2017 with level 4 expected to make an impact from 2020 onwards; globally, 30 million vehicles will be autonomous by 2025 with established and emerging OEMs working closely with start-ups to bring solutions to market

Size and outlook

Level		
4	SAE Definition	The driving mode-specific performance by an automated driving system of all aspects of the dynamic driving task, even if a human driver does not respond appropriately to a request to intervene
	F&S Definition	System can bring vehicle to safety while in automated mode even if driver does not intervene when requested
	Capability	• City and highway pilot, with minimal driver involvement • Fully auto parking

Market Participants

	AUDI	BMW
Today	Level 3 (2017-18)	Level 3 (2017-18)
Focus	Audi Piloted Driving City	Focused primarily on L3, L4 for fleet
Takeaway	Audi has been teaching its automated vehicles to drive more like humans in an effort to make them safer on roads	To introduce by 2021, a fleet of L4 automated vehicles that will drive on both highways and in urban environments

Cyber Security

ARGUS, VIDDER, Karamba Security, VisualThreat

Driver Safety

WAYRAY, Heads up, Sober Steering, navdy

Selected market participants
SAE = Society of Automotive Engineers
Source: Frost & Sullivan

ARTIFICIAL INTELLIGENCE IN CARS

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By 2025, four levels of self-learning cars will enable a fully autonomous vehicle with advanced driver assistance capabilities

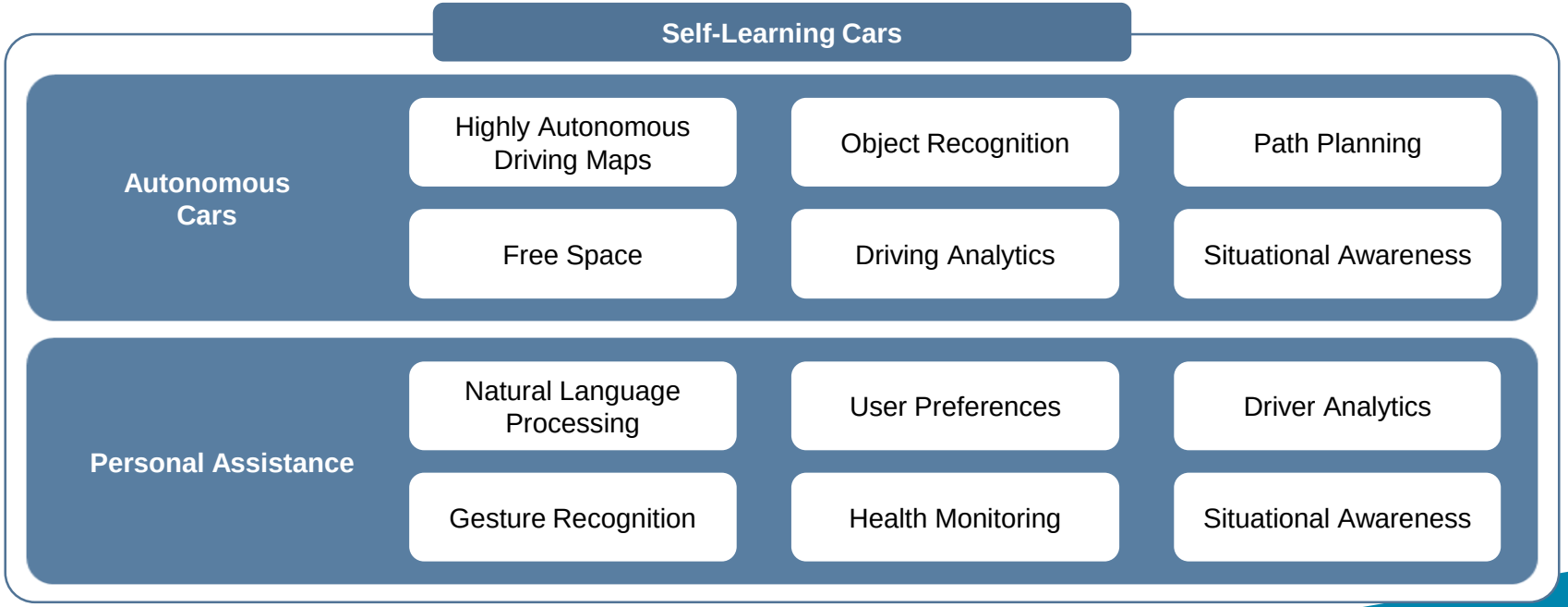
Self-learning Cars: Levels of Self-learning Cars, Global, 2016–2025

Levels	1. Basic Function	2. Complex Function	3. Critical Function	4. Vehicle Control
Functionalities	**Basic** functionalities of the vehicle's operation is performed by the self-learning AI	**Complex** functionalities are performed using s elf-learning AI	**Critical** functionalities of the vehicle's operation is performed by the self-learning AI	**All functionalities** of the vehicles are performed by the self-learning AI
Applications	• Natural language processing • User preferences • Gesture recognition	• Driver assistance • Object recognition • SAE level 2 autonomous	• HAD Maps • Object recognition • SAE level 3 and level 4 autonomous	• The car acts as a personal assistant and is fully autonomous.
Key OEMs	• JLR • Daimler • Audi	• JLR • Renault	• TESLA • Volvo • Ford • Audi	• JLR • Toyota • Tesla

Source: Frost & Sullivan

Self-learning technology promises to take things even further, enhancing the user experience by supporting a range of infotainment functions

Self-learning Cars: Self-learning Cars Capability, Global, 2015–2025



Source: Frost & Sullivan

Data ownership, software validation and security risks are the most significant obstacles to greater adoption and uptake

Self-learning Cars: Key challenges, Global, 2016–2025

Legal Ambiguity

- Currently, companies rely on benchmarking competitions such as Imagenet and KITTI to validate the capability of their algorithms. Frost & Sullivan anticipates, by 2025, government bodies will validate and standardize the databases.
- Data ownership and usage rights is another key concern for end users. Currently, all data gathered is owned by the OEMs.

Software Training and Validation

- It is difficult for the programmers to validate what the system has learnt after training. Several simulations are required to assess the software capability.

Security Risks

- Direct access to cars enables hackers to compromise the security of the vehicle and user. These risks are reduced by preventing such attacks on multiple vehicle or vehicle fleets.
- Another approach could be to train the algorithms to recognize patterns that would enable the vehicle to alert the user incase of any hacking.

Source: Frost & Sullivan

Nonetheless, self learning will enable revenues of $78.6 billion from subscriptions, licensing, data analytics and new mobility services by 2025

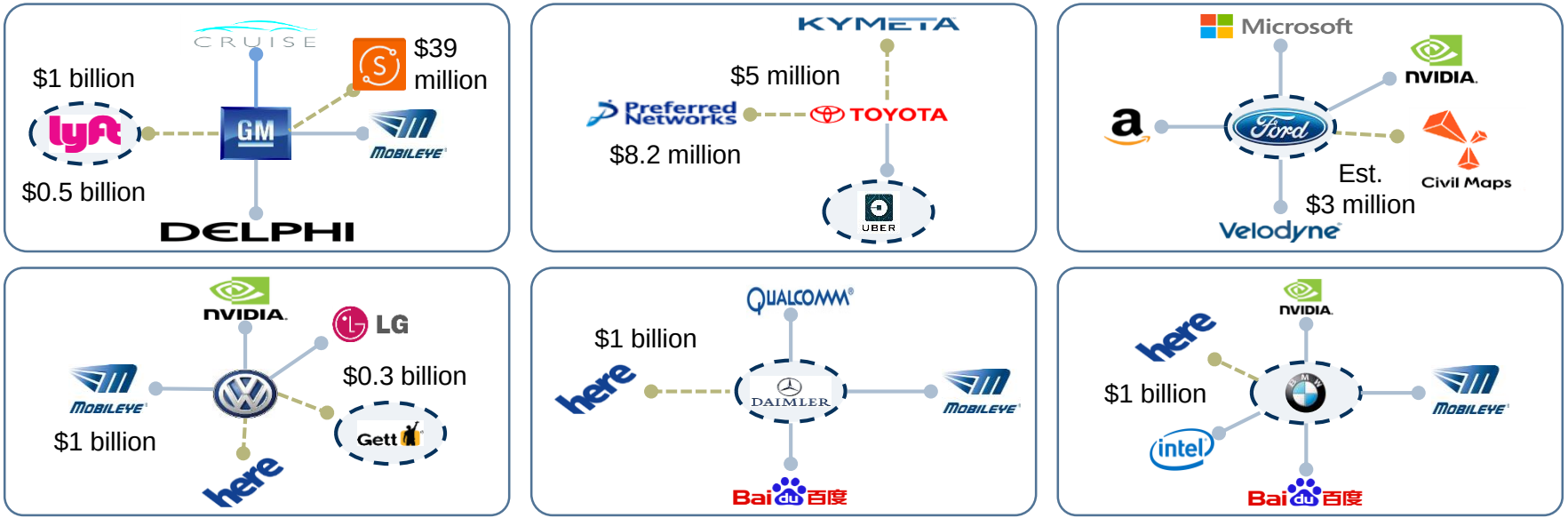
Self Learning Revenue Opportunities: Overview, Global, 2016–2025

Level 1	Revenue Models → Subscription + Licensing	• 35 million vehicles by 2025 • Revenue opportunity: $8.9 billion
Level 2	Revenue Models → Subscription + Data Analytics	• 12 million vehicles by 2025 • Revenue opportunity: $21.7 billion
Level 3	Revenue Models → System solutions + Licensing + Data Analytics	• 4 million vehicles by 2025 • Revenue opportunity: $23.6 billion
Level 4	Revenue Models → End-to-end solutions + Licensing + New Mobility Services	• 2 million vehicles by 2025 • Revenue opportunity: $24.3 billion

Source: Frost & Sullivan

OEMs are partnering with technology companies to provide value-added, connected services to drivers, and to maximise profit

Self-learning Cars: OEMs Partnerships, Global, 2015–2025



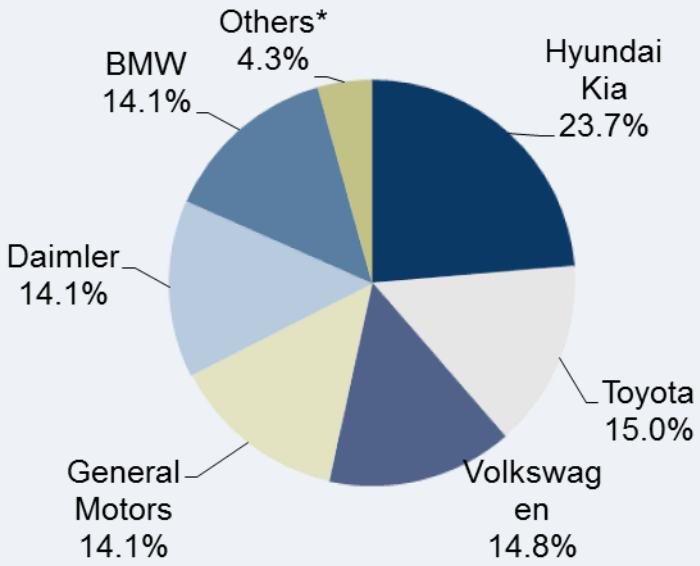
OEMs investing in new mobility services as a key market strategy

Acquisition **Strategic Investment** **MOA/Partnership**

Source: Frost & Sullivan

Thirteen constructors are investing a combined $7.1 billion on developing self-learning Artificial Intelligence in cars with a focus on HAD maps

Self-learning Cars: Investments in Technology, Global, 2016–2022



$7.1 billion by 13 OEMs for technology development through 2022

- Companies are focusing on strategic acquisition to develop in-house competence in AI technology.
- Toyota is focusing on a partnership model with strategic investments in preferred networks to develop AI capability.
- Three primary use cases are being developed for the medium term:
  - Near field vision
  - HAD maps
  - Driver behavior and preferences

Others include Ford, Renault Nissan, Honda, Jaguar Land Rover, Volvo, Tesla, and PSA
HAD = Highly Automated Driving
Source: Frost & Sullivan

Major technology players with a presence in the space include Baidu, Cloud Made, Preferred Netowrks and Comma.ai

Self-learning Cars: Technology Companies Strategy, Global, 2015–2025

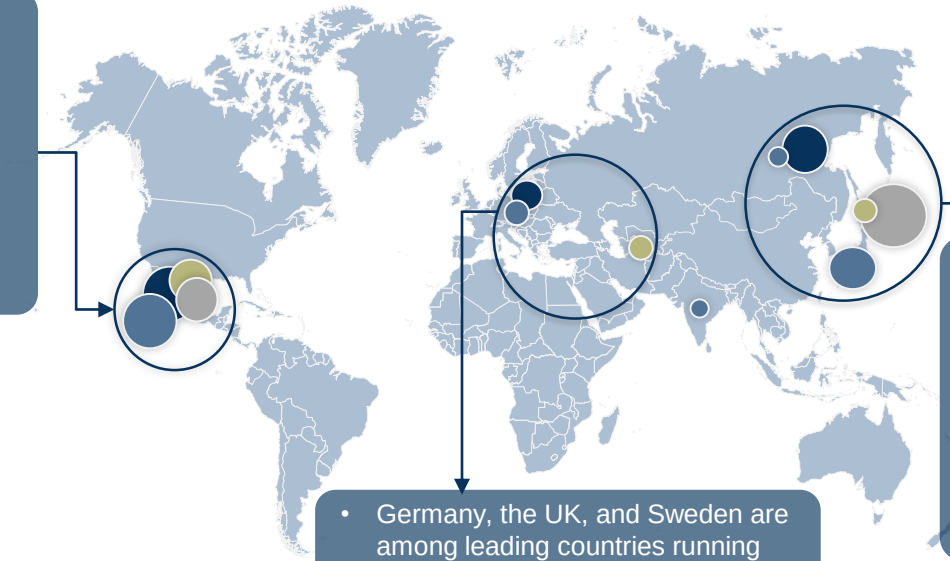
Key companies	Strategy	Key Products	Investments
Baidu 百度	Develop and license self-learning AI to OEMs. key partner - Uber	Baidu Autobrain	Estimated $120 million
G	Develop self-learning OS to cars that can be licensed to various OEMs. Key partner - Uber	HAD maps, Google Self-driving brain, Google self-driving cars	$400 million in acquisition of deep mind
CLOUD MADE	Develop a partnership eco-system that gives connected cars to evolve into self-learning cars leveraging cloud	Predictive learning systems, car driver analytics, Map data enrichment, Connected PND, Map portals	$12.3 million invested by Intel Capital
	Self-learning electric cars for new mobility services. Key partner - Didi Chuxing	Titan	$1.4 billion in-house investment
Preferred Networks	Leverage on connected cars platform and deep learning to provide autonomous drive solutions	DIMo platform for self driving, ADAS/maps, connected cars	$8.2 million invested by Toyota Group
Nauto	Using crowdsourcing, develop the required data to enable various levels of drive functions	Driver data analytics using deep learning	$12 million in investments
COMMA.AI	Develop a low-cost aftermarket product for self-driving cars using deep learning	Develop level 3 autonomous systems for cars	$3.1 million invested by venture capitalists
drive.ai	Develop aftermarket self-driving systems using deep learning		$12 million invested by venture capitalists

Source: Frost & Sullivan

From a geographical perspective, the US leads the way with the its concentration of startups, skilled workforce and numerous pilot projects

Self-learning Cars: Adoption/Rollout Roadmap, Global, 2015–2025

- $4 billion in investments from the US Government to help shape the policies by 2025
- MIT leading in nurturing startups for self learning AI in cars (8 prominent startups)
- Thirty companies running pilot projects in the US on level 3 self learning



- China plans to allow self-driving cars on road by 2020.
- Pilot projects limited to Baidu-BMW partnership
- Japan is the world leader in AI in robots. Companies such as Honda leveraging on the capability

- Germany, the UK, and Sweden are among leading countries running pilot projects
- Limited human resource availability key area of improvement for the European regions

Educational Institutions

Start ups

Pilot projects

AI development

Source: Frost & Sullivan

ECOMMERCE IN THE AFTERMARKET

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There is a range of established and emerging models in aftermarket eRetailing which historically has been focused on the B2C channel

eRetailing in Automotive Aftermarket: Key Business Models, Global, 2015–2022

Subscription-based Engagement

Business Model: Subscription-based purchasing from online portals
Value Proposition: Significantly increased customer engagement and convenience
First Movers: Tyre24, Amazon

B2B eCommerce

Business Model: Selling directly to installers and garages; next wave of eCommerce in aftermarket
Value Proposition: Fast-growing retail space and increased price competitiveness
First Movers: Allopneus, Yakarouler

Crowd-sourced Delivery

Business Model: Engaging individuals heading in a certain direction in delivery of online orders and pay per order
Value Proposition: Fast order fulfillment
First Movers: JD.com, Amazon Flex

In-vehicle Sales

Business Model: Connected vehicles with in-vehicle ordering capabilities and visionary selling platform for retailers
Value Proposition: Increased customer touch points and alternate channels to market
First Movers: General Motors

Online-to-offline Integration

Business Model: Brick-and-mortar presence to complement online retail
Value Proposition: Optimization of physical space for OEMs and traditional sellers
First Movers: Halfords, BMW

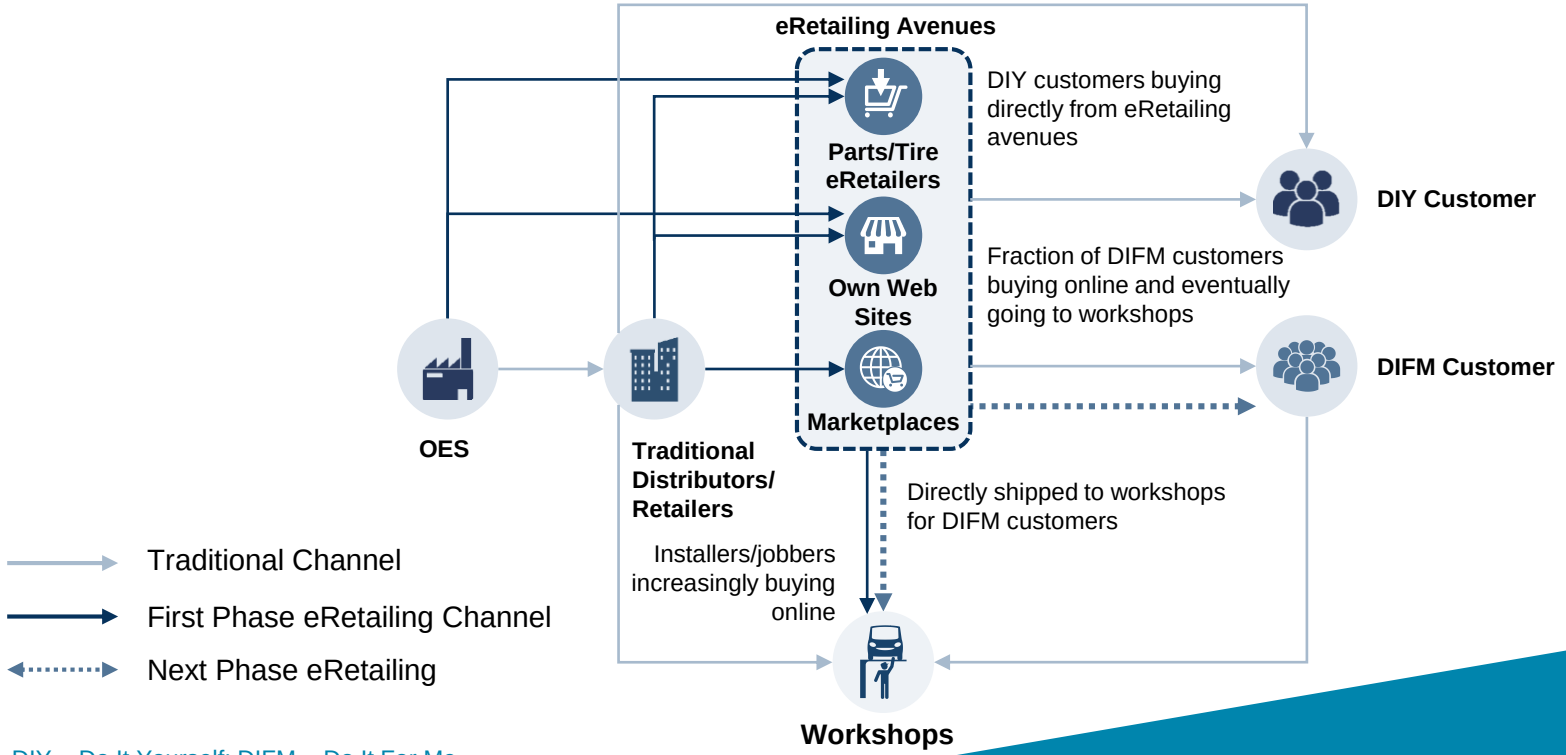
Service Aggregation

Business Model: Online service shop locater with real-time quote generation
Value Proposition: Ideal for eRetailers to penetrate DIFM customers segment
Example: eBay, Autobutler (Germany)

Source: Frost & Sullivan

While the first phase of transition targeted DIY customers, the next phase outlines opportunities for selling to DIFM customers

eRetailing in Automotive Aftermarket: Parts Distribution in eRetailing, Global, 2015



DIY = Do It Yourself; DIFM = Do It For Me
Source: Frost & Sullivan

Market participants will need to develop innovative solutions to overcome channel bottlenecks and effectively address the B2B opportunity

eRetailing in Automotive Aftermarket: Customer Group Fit, Global, 2015–2022

	B2C	B2B
Type of Customer	• **Enthusiasts:** Usually tech savvy and aware of part fit and functionality • **Value Seeker:** Mostly looking for a better deal on replacement parts (both DIY and DIFM)	• **Installers/Workshop**: Professionals buying online for fitment in customer's vehicle
Expectations from the Channel	• Competitive pricing, product and pricing comparison tools, and low shipping cost • DIY support, detailed part-related information, extensive brand portfolio • Strong delivery commitment	• Bulk buying offers, flexibility in credit terms, best deals on pricing • Fast delivery (mostly same day), low shipping costs • Extensive brand portfolio and aftersales support
Channel Bottlenecks	• Limited comparison tools, competitive pricing commitments, click-and-collect options • Inadequate DIY support • Process too complex for DIFM customers	• Lack of dedicated parts programs • Complicated returns and reverse pick-ups • Limited credit payment policies • Inadequate aftersales service
Future Possibilities	• Integration with service aggregation platforms and remote diagnostics platforms • In-vehicle purchase options • Subscription-based selling	• Automated replenishment of fast-moving parts • Integration with service aggregation platforms and remote diagnostics platforms • Targeted brand promotion activities • Subscription-based packages to adjust shipping costs

Source: Frost & Sullivan

French eRetailer Yakarouler has been growing its customer base by providing active training and online diagnostic tools

Customer Acquisition Strategy

Free Workshop for General Public

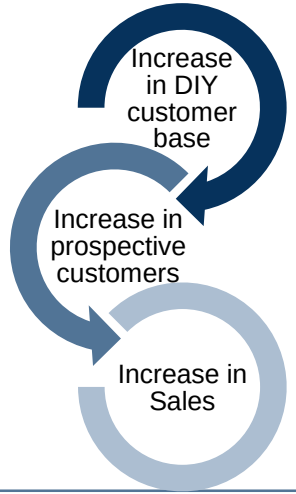
- Conducted by expert mechanics
- Covers one category every session
- Hands-on experience, giving confidence to pursue auto maintenance and replacement by self in future

'Diagnose Yourself'

- Has 4 steps: research, possible issue, identification, and repair
- Offers step-by-step method to diagnose and narrow down to the possible issue, based on car behavior

Replacement Guide

- Guides to change car parts and accessories by a step-by-step procedure
- Has the procedure for most of the DIY replacement types
- Provides video guides for certain parts



Benefits for Garages and Professionals

- YakaPro—exclusive portal for workshops and professionals
- Monthly newsletter with customer portfolio in respective catchment areas
- Can organize free training sessions in its garages
- Dedicated aftersales support
- Exclusive price discounts and delivery options

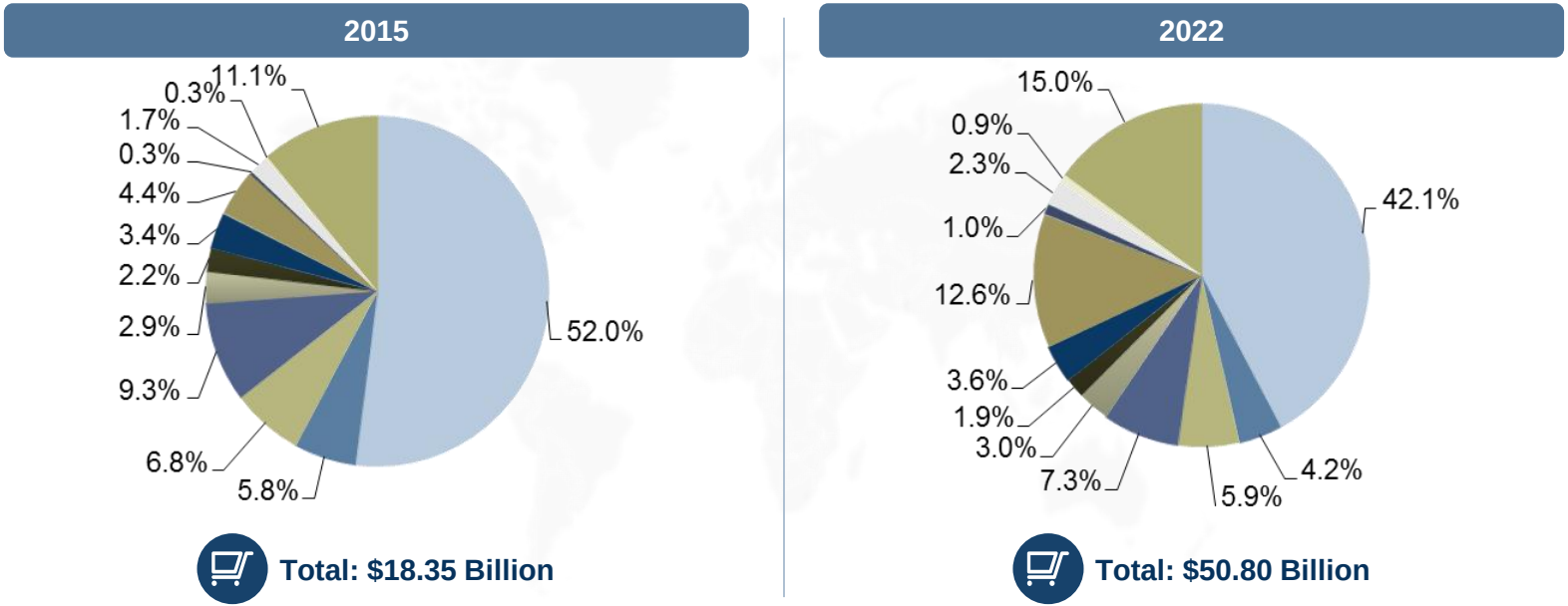
Other Key Metrics

- Partners with 1,700 garages in France
- Catalog of more than 800,000 products
- Started with motorcycle category in 2015
- Two physical stores in Thiais and Chassieu

Source: Frost & Sullivan, Yakarouler

Globally, the automotive eRetailing aftermarket will generate $50.8b in 2022, up from $18.4b in 2015, corresponding to a CAGR of 15.6%

eRetailing in Automotive Aftermarket: eRetailing Region-wise Revenues, Global, 2015 and 2022



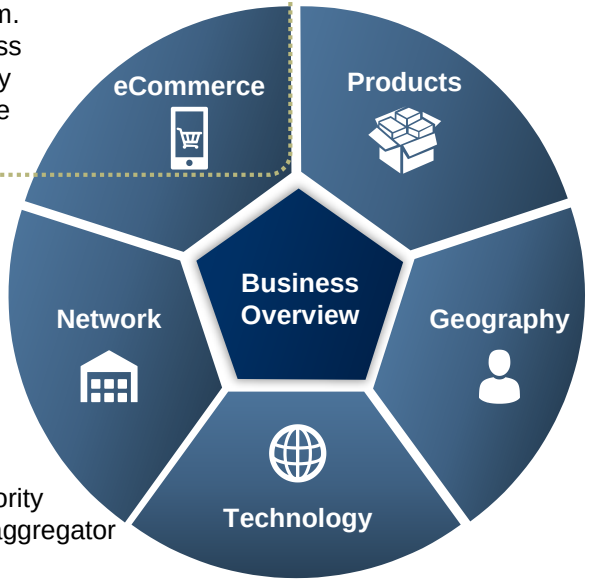
Source: Frost & Sullivan

Aftermarket eRetailing is also regarded as high potential by OEMs, forming a key part of PSA's Push to Pass strategy

eRetailing in Automotive Aftermarket: PSA's 'Push to Pass' Aftermarket Retailing Strategy, Global, 2015

Push for Mister Auto
- There is a renewed push for misterauto.com.
- The portal is operating in 13 countries across Europe; PSA is boosting parts availability by offering its multi-brand portfolio via its online channel.

Expansion Service Network
- In an endeavour to extend the service relationship with customers beyond the warranty period, the company plans to make its service network accessible to a larger customer base.
- The plan is to increase its service stores from 2,000 in 2016 to 10,000 by 2021.



Multi-brand Parts Portfolio
- There is comprehensive parts coverage for competitor brands, adding approximately 9000 parts to the existing Euro Repair multi-brand range.
- This will complement the auto parts distribution network, setting up 140 hubs, providing delivery service.

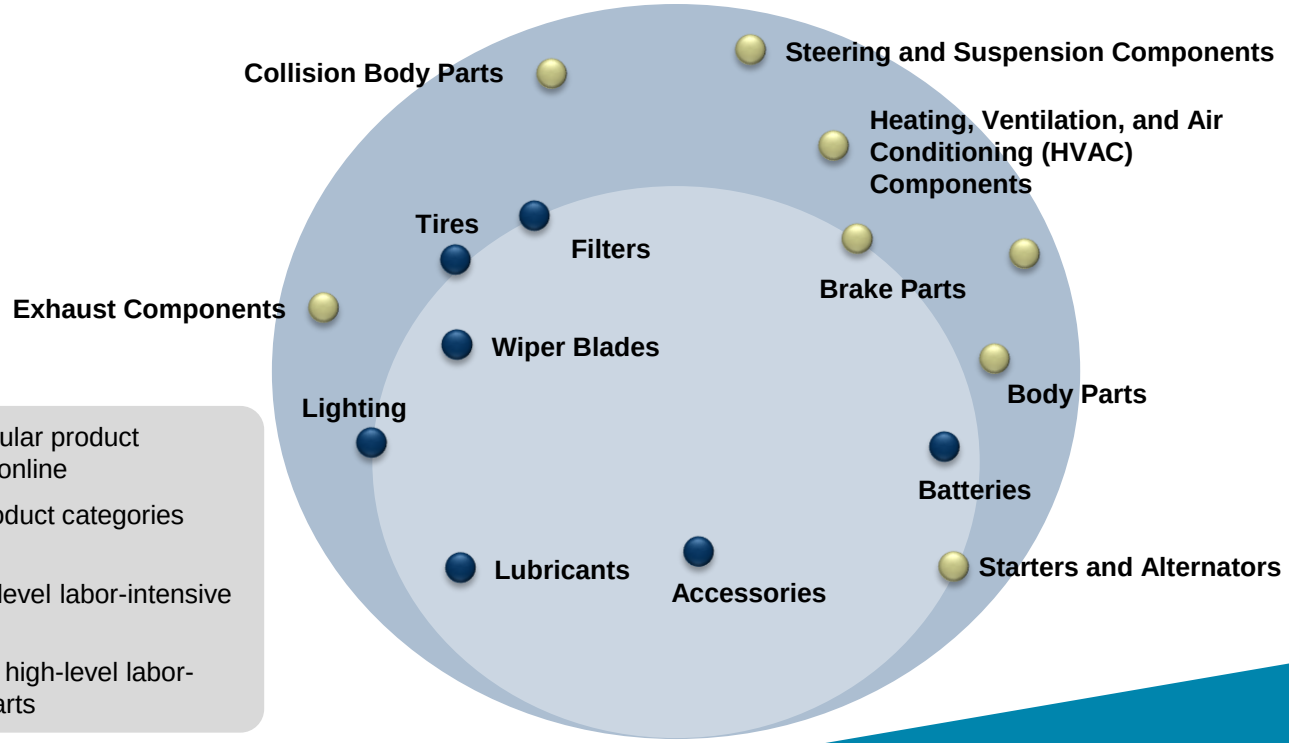
Reduced Dependence on Europe
- It is setting new vehicles sales targets in regions outside of Europe.
- It is strengthening its focus on China and Southeast Asia, while pushing for a significantly increased presence in India-Pacific, Eurasia, Middle East, and Africa, especially Algeria and Morocco.

Acquisition of Autobutler
- In June 2016, the company acquired a majority stake in Autobutler (online vehicle service aggregator platform).
- The acquisition fits well in its 'push to pass' strategy, catering to the needs of all types of customer, regardless of the vehicle brand.
- Apart from helping develop more business for the company's existing vehicle service network by bringing in new customers, it will also lead to enhancing PSA's own expertise in aftermarket digitization.

Source: Frost & Sullivan

From a category point of view, the market is increasingly showing an affinity for replacement parts which require professional fitting

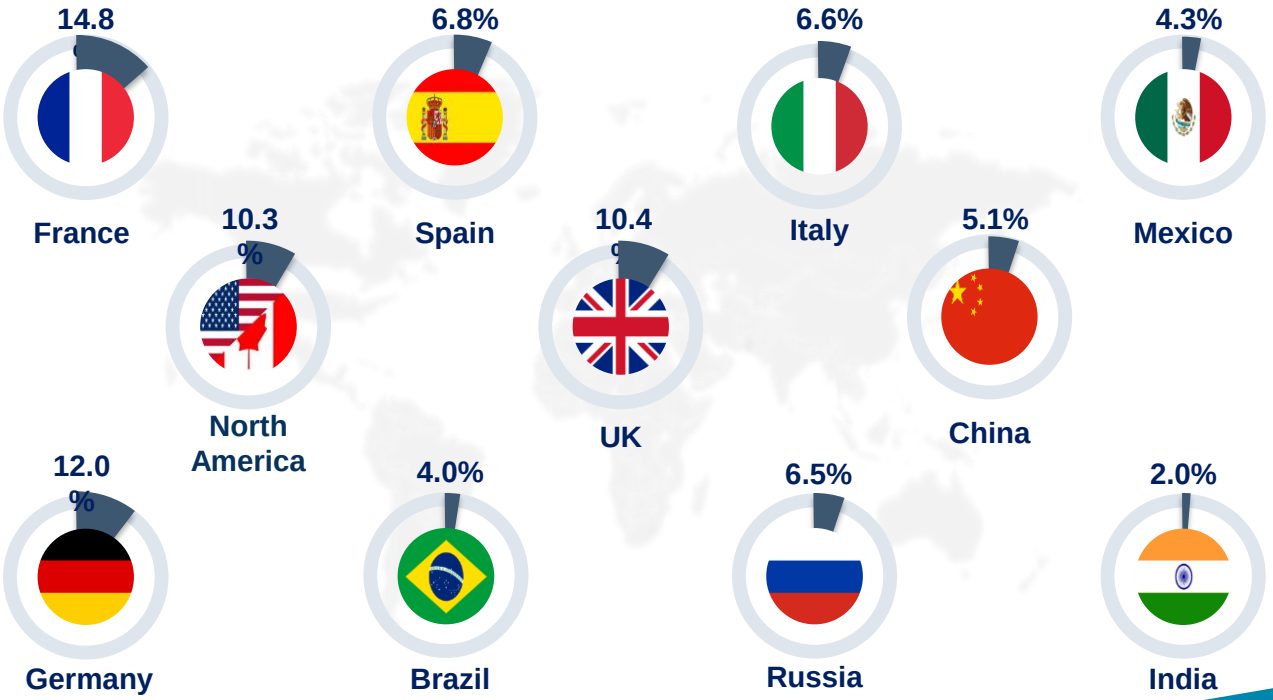
eRetailing in Automotive Aftermarket: Parts Preference Scenario, Global, 2015



Source: Frost & Sullivan

North America and Western Europe will continue to lead in terms of eRetailing penetration levels globally up to 2022

eRetailing in Automotive Aftermarket: eRetailing Penetration Level, Global, 2022



Source: Frost & Sullivan

ECOMMERCE IN THE AFTERMARKET
ITALY SNAPSHOT

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In Italy, comparatively low levels of connectivity and the limited use of electronic payments have restrained growth in eRetailing historically

Italy

Internet Users: 36.2 Million

Online Shoppers: 16.2 Million

Per Capita Online Spend: $827.1

Smartphone Penetration: 57%

Total B2C eRetailing Revenue (2015): $13.41 Billion

(Total sales of goods and services online; excludes travel and event ticket booking)

Automotive Aftermarket Online Sales Revenues
2015: $0.53 Billion
2020: $1.54 Billion
CAGR (2015–2022): 16.4%

(Includes sales of replacement parts and accessories alone)

Demographics (2015): 43% population between 25–54 years of age

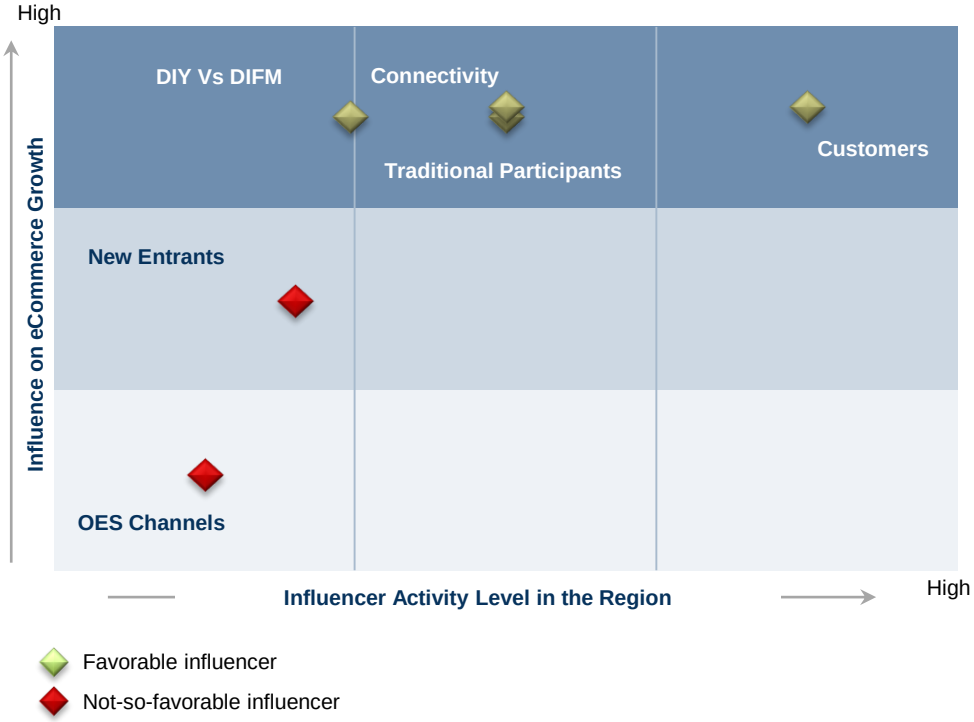
(Age group with the highest probability to own a vehicle)

Market Outlook
Italian automotive aftermarket eRetailing growth is expected to gain momentum by taking cues from offline retailing practices such as creating better access and developing seller-buyer relationships.

Colours indicate the level of market favorability toward eRetail: Green—Supportive
Source: Frost & Sullivan, eMarketer

The lack of new market entrants and almost non-existent involvement of the OES channel have also thwarted uptake

eRetailing in Automotive Aftermarket: eRetailing Penetration Level, Global, 2022

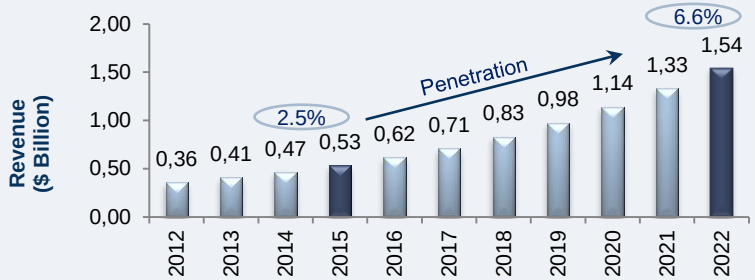


Influencer	Regional Outlook
Connectivity	With approximately 68% Internet connectivity, mCommerce the way forward for online sellers
Customers	42.8% of the population between 25–54 years of age, offering a sizeable addressable market
DIY Vs DIFM	• Limited DIY activity • Digitization of vehicle service channels to be a key influencer
Traditional Participants	Minimal involvement in the past; involvement necessary to push for increasing online sales
OES Channels	• OEMs not explored the channel locally • Lack of OEM activities contributing to muted promotion of online channel
New Entrants	No disruptive new entrants in the recent past

Source: Frost & Sullivan

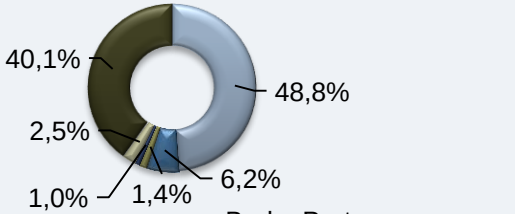
Nonetheless, aftermarket eRetailing revenue in Italy will grow at a CAGR of 16.4% between 2015 and 2022 to reach $1.5b, up from $0.5b

Automotive parts and services eretailing market: revenue forecast, italy, 2012–2022



Automotive parts and services eretailing market: percent revenue by component split, italy, 2015

*Others include wiper blades, lighting, powertrain components, and accessories, among others.



Growth Outlook

Tire eRetailers	Tires the most popular product category sold online; the trend to favor tire eRetailers
Auto eRetailers	• Slowly gaining share in the market • Will face challenges from emerging traditional sellers
Mass eRetailers	• Not the most popular choice • Active presence to contribute to overall channel growth
Traditional Participants	• Last to evolve and adopt the transition • Will play a vital role in shaping the growth outlook in the eRetailing space
OES Channels	• SNot very active • OEM and OES could start with marketplace presence to test the market
Dealers	• SNo significant presence • Dealer level activity could be boosted by marketplace expansion
Suppliers	• No online sales presence yet • Tire manufacturers might show interest in selling online

Source: Frost & Sullivan

Currently, there is a range of small players in the space but a new focus on O2O commerce will give the market a boost

KEY PARTICIPANTS		PARTICIPANT TYPE	BUSINESS MODEL
Autoparti.it	www.autoparti.it	Part eRetailer	Direct
Ricambi Auto Low Cost Ltd.	www.ricambiautolowcost.it	Marketplace	Listing Fee/Sales Commission
eGommerce.it	www.egommerce.it	Tire eRetailer	Direct
Cercaricambi.it	www.cercaricambi.it	Marketplace	Listing Fee/Sales Commission
Autogenius	www.autogenius.it	Traditional Distributor/Retailer	Direct
Autoricambi-online.it	www.autoricambi-online.it	Part eRetailer	Direct
Autodemolizione Bresolin	www.bresolin.com	Part eRetailer	Direct

Italy eRetailing Market Outlook

- The Italian aftermarket has been very slow to transition to online platforms and this has been evident from the low penetration levels.
- While traditional participants have opened direct eStores, the general perception around online selling has been pulling back the growth momentum of eRetailing.
- Frost & Sullivan analysis suggests that focus on O2O channel promotion could give the market a necessary push.

O2O = Online-to-offline
Source: Frost & Sullivan

BIOMETRICS IN CARS

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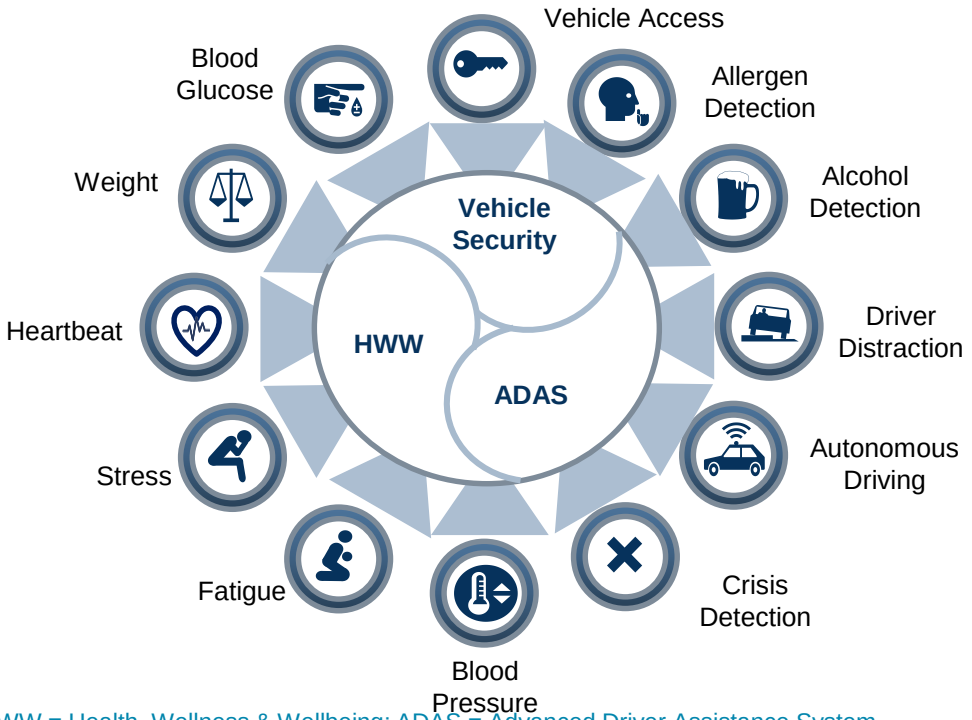
Applications arising out of the convergence of the automotive and biometrics industries can be segmented into HWW, ADAS, and security

Biometrics in the Automotive Industry: 3 Broad Opportunities, Global, 2016–2025



VEHICLE SECURITY: Thieves are adopting advanced technologies to hack into vehicles. Biometric security features such as heartbeat and brainwave recognition are poised to mitigate this risk.

ADAS: Accidents because of driver distraction, fatigue, and stress are on the rise. Biometrics such as eyelid monitoring and gesture recognition are addressing this issue.

HWW: Lifestyle and chronic diseases are increasing. Biometric features such as pulse, breathing rate, and blood pressure monitoring are ushering in preventive care applications to the vehicle.

HWW = Health, Wellness & Wellbeing; ADAS = Advanced Driver Assistance System
Selected applications
Source: Frost & Sullivan

Fingerprint technology is the most cost effective and is expected to achieve faster penetration in security applications

MEASUREMENT	TECHNOLOGIES				
	FINGERPRINT	PALMPRINT	IRIS	FACE	VOICE
Accuracy					
Cost					
Ease of use					
Flexibility					
User acceptance					
Challenges	Dryness, dirt, and age	Injury and age	Outdoor lighting	Hair, eyewear, and lighting	Noise and vocal changes

Iris biometrics is the most accurate technology; however, the cost of IR cameras required for iris recognition restrains widespread adoption.

Key:  **High**  **Medium High**  **Medium**  **Low**

Source: Frost & Sullivan

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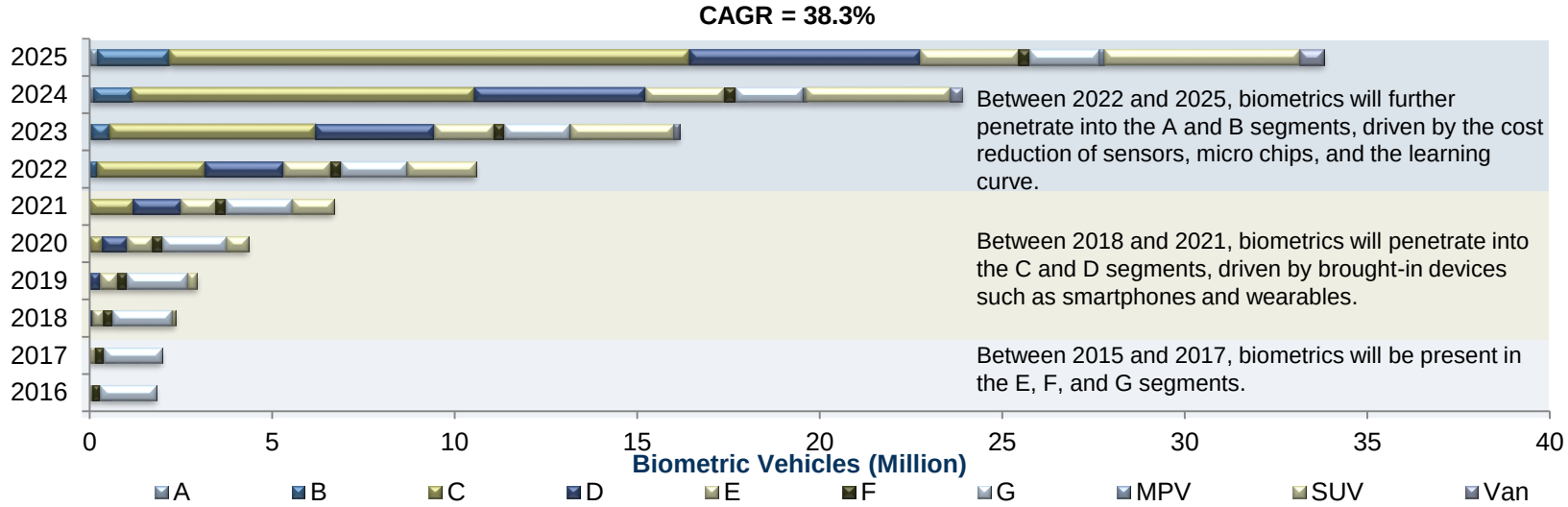
Almost 34 million passenger vehicles will have built-in, brought-in, cloud-enabled, or a combination of all 3 biometric technologies by 2025

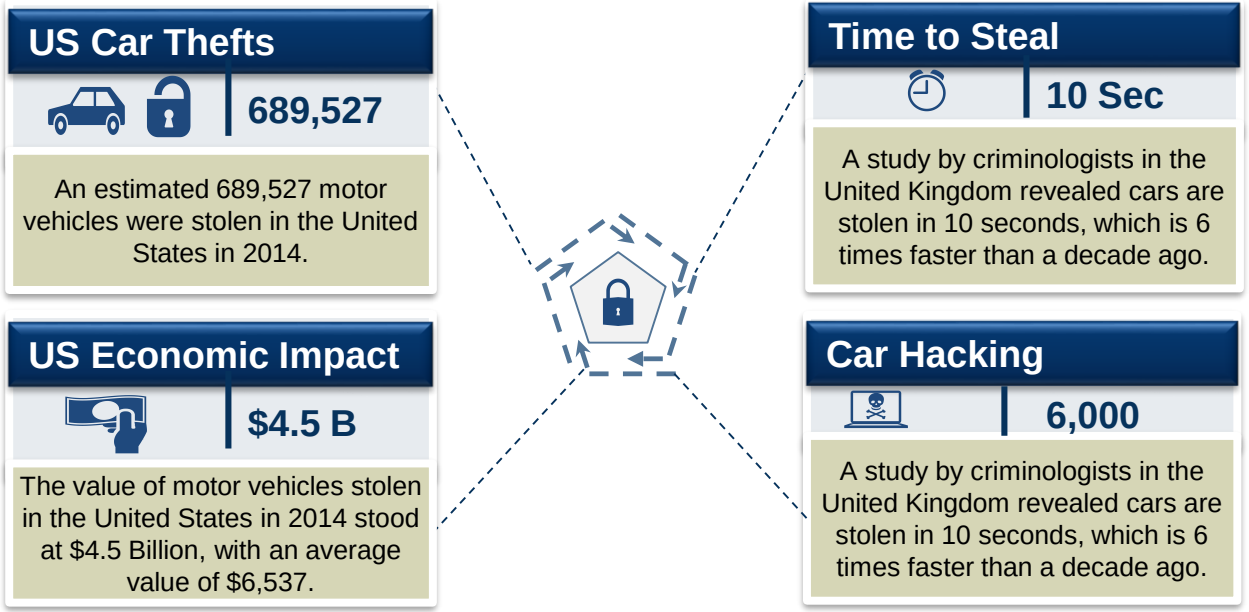
Biometrics in the Automotive Industry: Biometric Passenger Vehicle Forecast, Global, 2016–2025



MPV = Multi-purpose Vehicle; SUV = Sports Utility Vehicle
Source: Frost & Sullivan

Increasing car thefts, decreasing time-to-steal, and car hacking emphasise the need for advanced security solutions

Biometrics in the Automotive Industry: Drivers, Global, 2014–2025



Source: Frost & Sullivan, Insurance Information Institute; Office for National Statistics

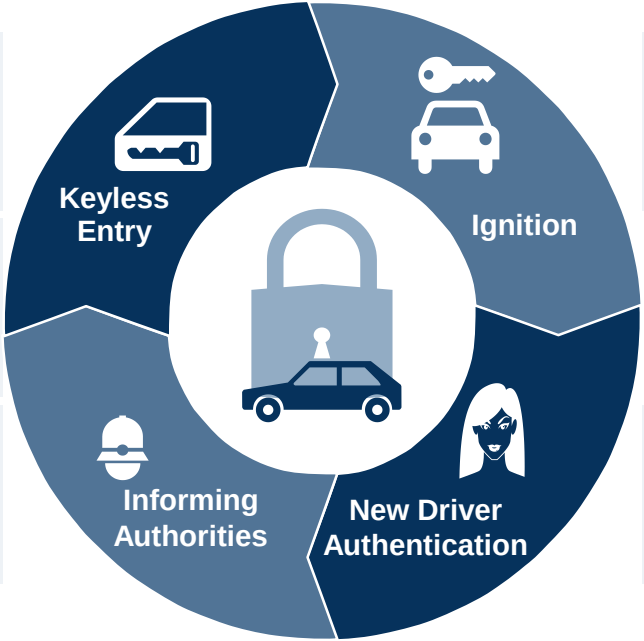
Keyless entry or ignition and automatic authority notification systems are amongst the main security features that biometrics are enabling

Biometrics in the Automotive Industry: Security, Global, 2016–2025

Keyless entry using fingerprints and palm veins

Entry using wearables that use biometric signatures

Notification to authorities in case of unauthorised vehicle entry



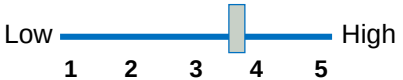
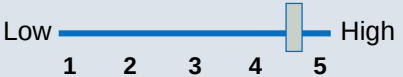
Ignition using iris recognition, facial recognition, body dimensions, and fingerprints

Facial recognition system takes a picture and sends to the vehicle owner's smartphone when detecting a driver with different features from the ones already in the database

Source: Frost & Sullivan

OEMs are working to integrating biometric security features in passenger vehicles through R&D and partnership activities

Biometrics in the Automotive Industry: OEM Activity—Security, Global, 2016–2025

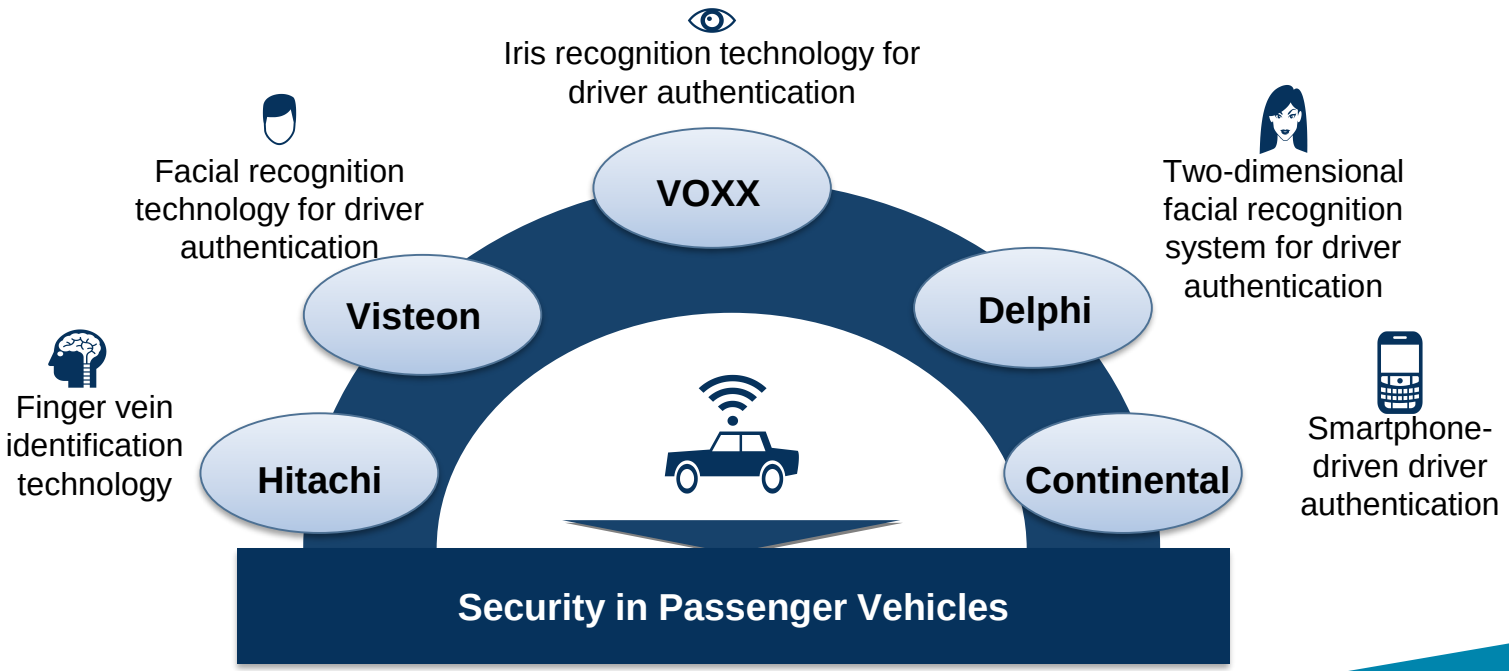
OEM	KEY FEATURES	CAPABILITY LEVEL	NOTES
BMW	Palm vein recognition authentication system for vehicle entry		Palm kept on driver side window glass to gain entry
Volvo	Fingerprint authentication system for vehicle entry		Mobile Bluetooth technology to unlock car doors remotely
Volkswagen	Facial recognition for driver authentication and to enable the ignition		Uses a technology that takes into account height and gender to authenticate a driver
Toyota	Body dimensions for driver authentication and to enable the ignition		Used in the DAR-V: automatically enables/disables ignition based on legitimacy
Ford	Facial recognition to authenticate the driver; sends photo of a new driver to owner for authentication		Working in partnership with Intel to develop the technology

Low/High indicates R&D expenditure, complexity of the technology, and how close it is to implementation.

Source: Frost & Sullivan

Suppliers such as VOXX are developing iris recognition systems that analyse over 240 points to authorise a driver to start their vehicle

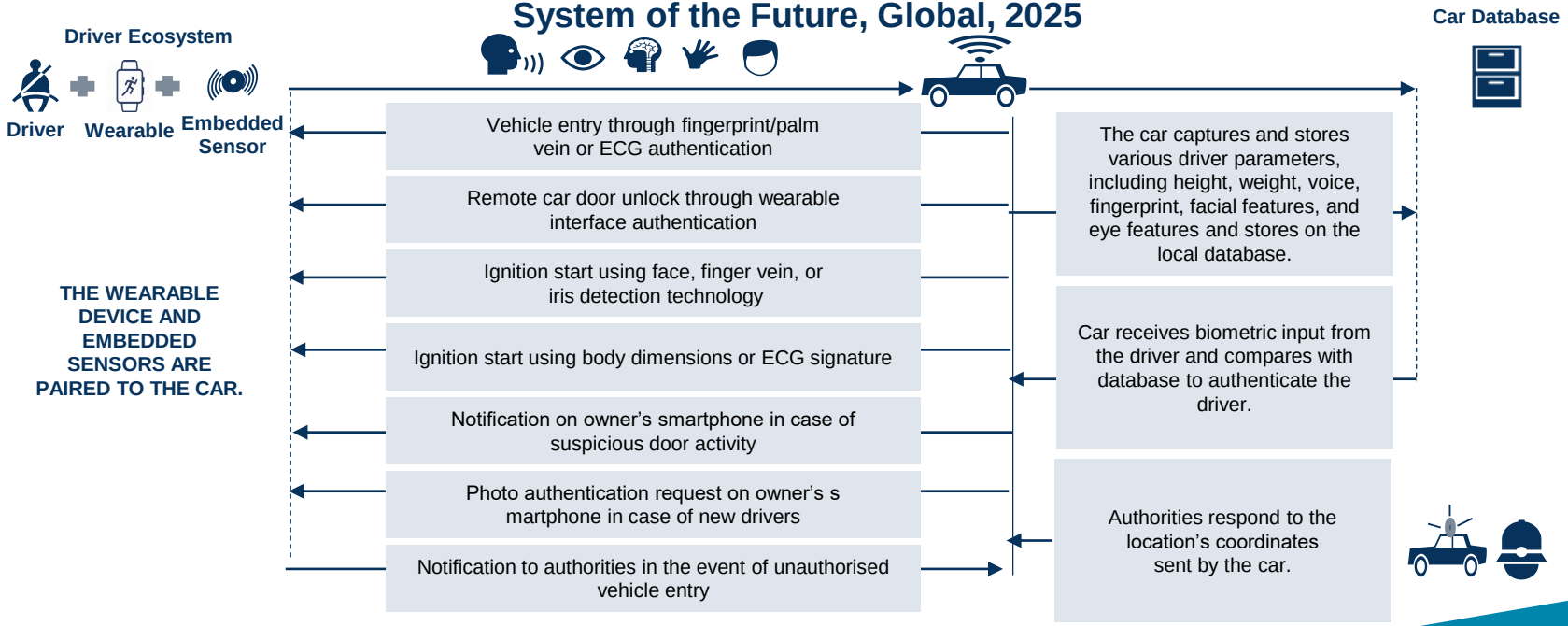
Biometrics in the Automotive Industry: Security and Supplier Activity, Global, 2016–2025



Source: Frost & Sullivan

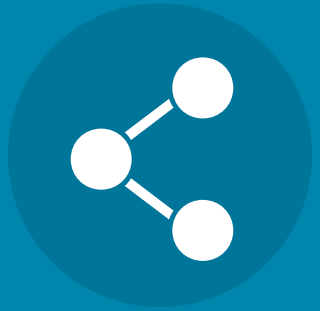
In the future, the security-enabled car will interact with a local database on board the vehicle to facilitate a quick response

Biometrics in the Automotive Industry: Illustration of the Biometrics Vehicle Security System of the Future, Global, 2025



Source: Frost & Sullivan

RIDESHARING



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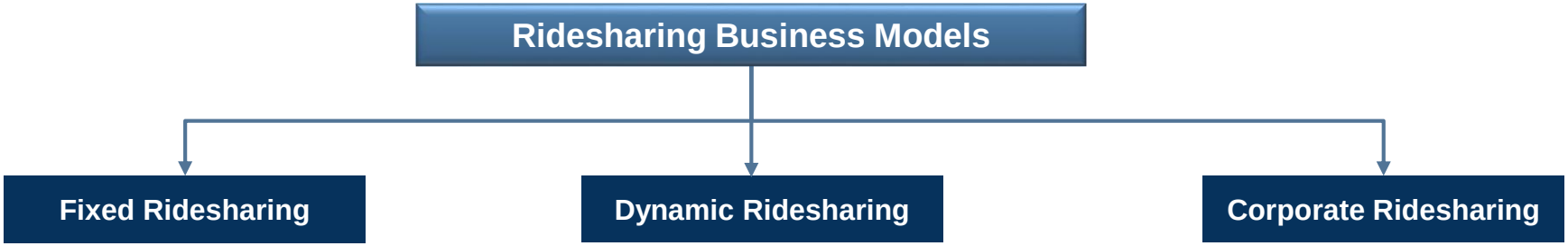
Ridesharing is broadly defined as grouping travelers into a private vehicle to share the cost of a ride between the driver and passengers

Ridesharing Market: Customer Segmentation, Europe, 2015



- Booked well in advance
- Both Web- and app-based
- Providers include BlaBlaCar, GoCarShare, GoMore

- Booked on very short notice
- Mostly app-based
- Providers include Heetch, Flinc, Citygoo

- Booked well in advance for the purpose of commuting
- Mostly Web-based
- Providers include Faxi, Liftshare, Twogo

Source: Frost & Sullivan

The concept offers savings for consumers and reduces the number of vehicles on the road which in turn supports sustainable transport

COST AND TIME SAVINGS FOR DRIVERS AND PASSENGERS

Ridesharing decreases the overall number of vehicles on road, reducing congestion and the time spent waiting in traffic. Since trip cost is an additional benefit.

GOVERNMENTAL POLICY SUPPORT SUCH AS HOV LANES AND TOLL FEE WAIVERS

Attractive incentives such as dedicated HOV lanes and toll fee waiver for ridesharing vehicles will play a crucial role in its acceptance by the masses. In addition, government regulations for users and businesses would help to encourage the adoption rate.

SUSTAINABILITY BENEFITS FROM LOWER EMISSIONS AND FEWER VEHICLES ON ROAD

Passenger vehicles contribute 50% of overall carbon emissions, with the typical vehicle emitting about 4.7 metric tons of carbon dioxide per year, according to the US Environmental Protection Agency. As megacities develop and suburban areas are urbanized, ridesharing will help reduce emissions and traffic congestion.

TECHNOLOGY ADVANCEMENTS TO AID SOFTWARE DEVELOPMENT

Technology advancements will encourage ridesharing companies to develop innovative additions to existing ridesharing software. Features such as auto-scheduling of rides, data analytics, and predictive algorithms will provide a better customer experience.

SMARTPHONE PENETRATION

The mobile industry continues to mature rapidly with the smartphone user penetration rates to be around 60.5% in Europe, providing a huge impetus for smartphone-based ridesharing services.

Source: Frost & Sullivan

Regulatory compliance will continue to be a hurdle to mass adoption whilst trust between passengers also remains a significant issue

LACK OF TRUST

Establishing trust between driver and passenger in the areas of safety, accuracy of ride times, and handling of payments will be important for the ridesharing industry to develop.

LACK OF AWARENESS OF THE CONCEPT IN RURAL AREAS

Large groups of prospective users are still relatively unaware of the ridesharing concept and the differences between ridesharing, hailing, and carsharing.

REGULATORY HURDLES AS RIDESHARING IS OFTEN CONFUSED WITH TAXI HAILING

Ridesharing companies need to prove that drivers cannot make a profit from driving their passengers. Many operators in Europe cap the fare that drivers can charge. The maximum fare that can be charged is limited to the cost incurred by drivers for fuel, vehicle operation, and tolls.

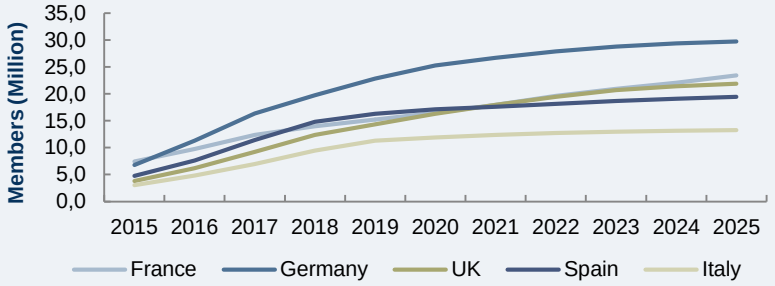
CRITICAL MASS TO ENSURE HIGH MATCHING OF RIDES

A point-to-point network is difficult to achieve without enough members and ride requests. Achieving this often requires operators to invest in costly marketing campaigns. Success also is contingent on user flexibility for time of travel or pickup location to accommodate several passengers per journey.

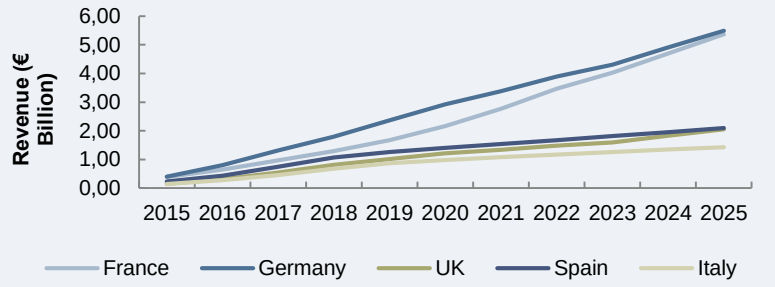
Source: Frost & Sullivan

Nonetheless, membership of ridesharing schemes is expected to grow rapidly to 2025 with rates of between 12.2% and 19.0% CAGR

Ridesharing Market: Membership Forecast by Country, Europe, 2015–2025



Ridesharing Market: Revenue Forecast by Country, Europe, 2015–2025



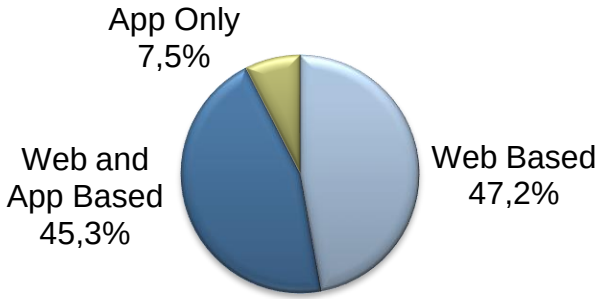
COUNTRIES	MEMBERSHIP CAGR (2015–2025)
France	12.2%
UK	19.0%
Germany	15.9%
Spain	15.1%
Italy	16.0%

- Germany is expected to have the highest share of members by 2025, with increasing fixed and dynamic ridesharing membership.
- Spain is the third-largest market for BlaBlaCar. The country's membership growth rate is expected to be high in the next 3 years and then stabilize.
- Growth in the United Kingdom mainly is expected in corporate ridesharing, provided that companies have an active policy to promote ridesharing. The top 3,300 UK companies employ a combined total of 9 million commuters. Research by Faxi has determined that there is a potential for 50 to 80% of commuters to share their journeys to work.

Includes only the top 5 countries represented, based on Faxi research
Source: Frost & Sullivan

In Europe, ridesharing is supported by new technologies with more than half of operators using a dual web- and app-based platform

Ridesharing Market: Percent of Web- and App-Based Services, Europe, 2015



Rides that are booked via smartphone apps are generally short-distance work commutes or leisure travel, such as a trip to the mall.

- The proportion of operators with an app-based platform is higher in Europe (52.8%) than in North America (31.9%).
- A number of smaller participants are slowly introducing app-based platforms to keep up with new, technology-savvy entrants.
- CarpoolWorld has introduced a mobile app, but it does not have full functionality and users are redirected to the Web site.
- Real-time ride matching operators such as Wunder and Heetch have only an app-based platform.
- Smartphones give users the convenience of booking rides anytime and anywhere. With almost 64% of the European population owning a smartphone, more Web-only companies will introduce app-based solutions as well.

Source: Frost & Sullivan

Moving forward, autonomous cars will play an important role, reducing accidents, increasing fuel efficiency, and lowering the total costs

Ridesharing Market: Percent of Web- and App-Based Services, Europe, 2015

Autonomous cars are expected to enter the ridesharing industry after 2025 and bring a new structure. When the driver is eliminated from the equation, the difference between the “drive yourself” models of carsharing and ridesharing and the “be driven” model of taxi hailing will cease to exist.

Combining automated driving and vehicle-to-vehicle communication technology can reduce common accident risks.

More people will be willing to share the ride, as the stress of driving or navigating is eliminated.

Self-driving cars can reduce congestion, increase fuel efficiency, and reduce pollution.

Demand for on-street parking and parking garages will decline with fewer cars on the road. Employers can save money on parking infrastructure.

Source: Frost & Sullivan

BlaBlaCar is the largest ridesharing company in Europe with 25 million registered users and is also rapidly expanding its services in Asia

Ridesharing Market: Overview of BlaBlaCar, Europe, 2015

Membership	25 million
Markets	France, Germany, Spain, UK, Italy, Netherlands, Russia, Denmark, Luxembourg, Hungary; 700 cities
Miles Shared	3 billion
Average Occupancy	2.8 per ride
C02 Saved	700,000 tons
Venture Capital Funding Raised	$336.52 million
Employees	360; 12 offices
Plans	Expansion to emerging markets: Latin America, Asia, Middle East

- Introduced an option in which the driver and all passengers are female.
- Follows an inorganic growth approach in its expansion strategy in Europe by acquiring smaller, region-specific companies.

BUSINESS MODEL

- Ride matching using Web interface, text messages, and mobile app
- Focuses on areas with low public transport connectivity; operates only fixed long-distance service

REVENUE MODEL

- Subscription-based, ride matching Web platform; fee per trip arranged (10-15%)
- Ad monetization

ACQUISITIONS

- Aventones, Carpooling.com, Autohop, Podorozhniki, Superdojazd, PostoinAuto.it, Jizdomat

Source: Frost & Sullivan, BlaBlaCar

Using Frost & Sullivan forecasts for the ridesharing market, 2.49 million vehicles a year could be eliminated from roads globally by 2025

Ridesharing Market: Impact Analysis, Global, 2015

	2015	2020	2025
Reduced Vehicle Kilometers Traveled (Billion)	6.12	22.73	40.19
Reduced Megatons of CO2	1.13	3.44	4.89
Savings from Reduced Mileage ($ Billion)	2.50	10.21	19.86
Gross Domestic Product Savings (%)	0.004	0.012	0.018
Cars Removed from the Road (Million)	0.38	1.41	2.49

Source: Frost & Sullivan

WOMEN AS A CUSTOMER

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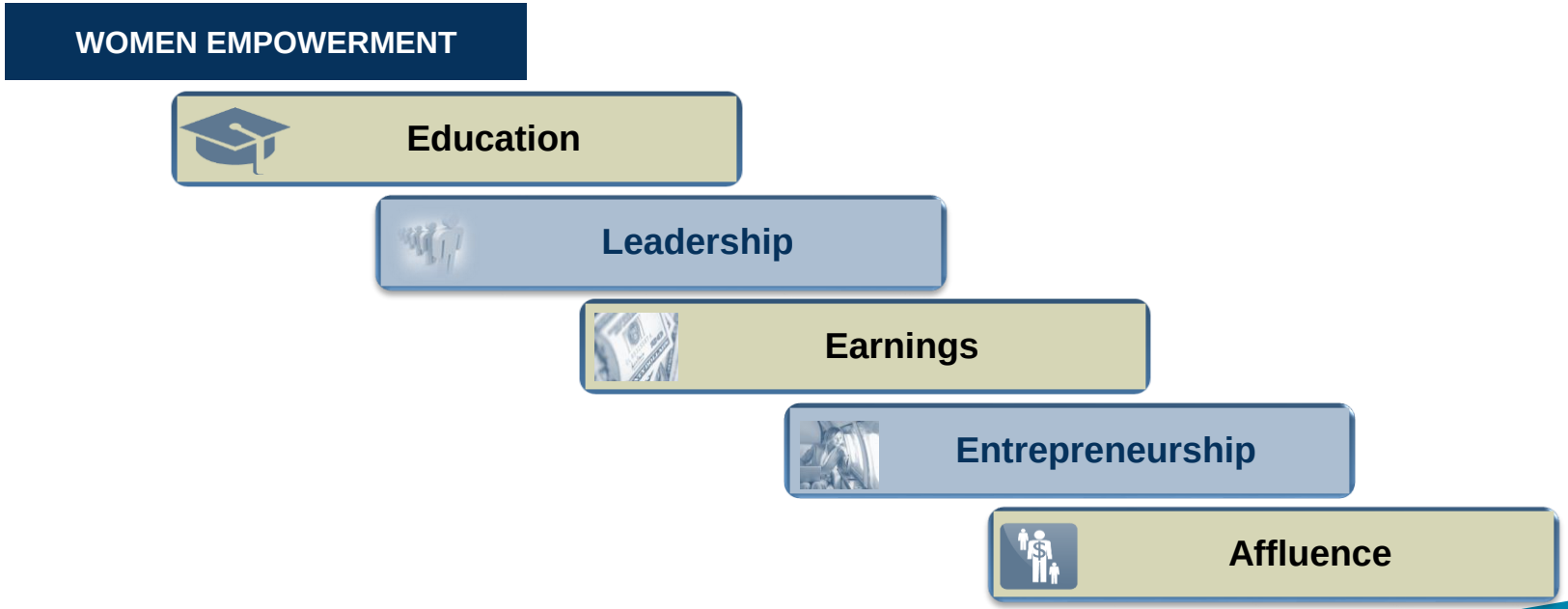
Greater economic and social empowerment means that women have increased purchasing power and influence when choosing a car

Women as Customers in the Car Industry: Women As Car Buyers, Europe, 2015



Source: Frost & Sullivan

Frost & Sullivan has identified three different types of women buyers according to their preferences and characteristics

Women as Customers in the Car Industry: Women Driver Segments, Europe, 2015

High Desire for Feminine Features ⟷ Low Desire for Feminine Features



	Feminine Vehicle Seeker	Personalization Seeker	Regular Vehicle Seeker
Preferred femininity of vehicle	Vehicle designed specifically for women	Vehicle with option to add a feminine feel	Vehicle with no feminine feel
Age profile	Younger: 63% are 18 to 34 years old.	Average age profile: 33% are 25 to 34 years old; 31% are 35 to 44 years old.	Older: 45% are 45 to 65 years old
Geographic profile	Urban: 86% are urban-based, with 68% in larger cities (over 500K).	Mix of Urban • 46% urban in larger cities (more than 500K) • 32% urban in smaller cities (less than 500K)	Mix of Urban and Suburban • 36% urban in larger cities (more than 500K) • 27% urban in smaller cities (less than 500K) • 20% suburbs
Technology adoption profile	Mostly early adopters (61%)	Tested technology adopter (50%)	Tested technology adopter (43%); only 11% are adopters and 18% are uninterested in technology.
Marital Status	47% have children at home. Highest proportion of single women (38%)	61% have children at home. Highest proportion of married women with children (42%)	58% have children at home; highest proportion of married women without children at home (27%).

Source: Frost & Sullivan

Members of each of the three groups share a common interest in features such as the reliability and cost efficiency of their future vehicle

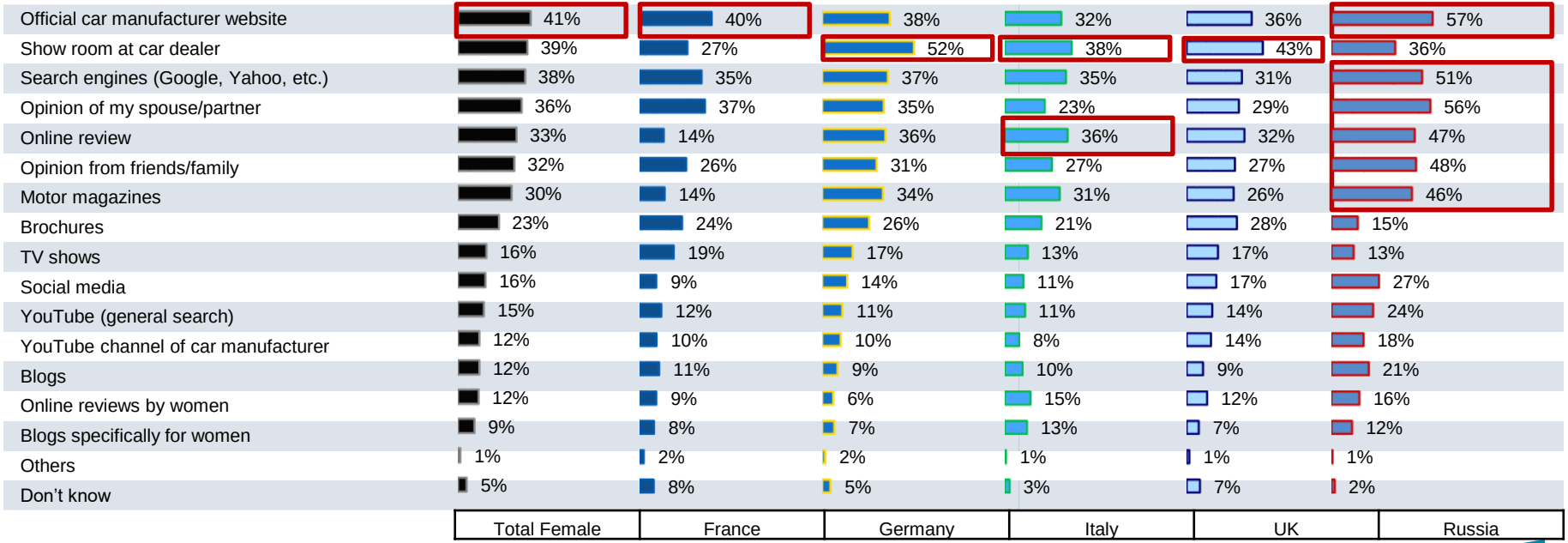
Women as Customers in the Car Industry: Vehicle Features Optimization, Europe, 2015

	 FEMININE VEHICLE SEEKER	 PERSONALIZATION SEEKER	 REGULAR VEHICLE SEEKER
General Strategy	Highlight standard features provided especially for women	Highlight both standard and optional features that women value more than men	Focus on features related to reliability and cost efficiency without emphasizing feminine features
Universal Minimum Assurance	Reliability and cost-efficiency features		
Other Themes to Highlight	• Selected style and power features • Refilling convenience	• Selected style and power features • Refilling convenience	• Reliability and cost-efficiency • Refilling convenience
Some Specific Features to Highlight	• Pilot parking • Multicolor vehicle • Personalized exterior color • Automatic vehicle access • Interior lighting remote • Personal storage • Exterior water fluid filling • Easy fueling • Shoe heel friendly pedal • Female staff at dealership • Customizable perfume	• Cabin materials • Better interior lighting • Interior light remote • Personal storage • Interior personalization • Mood lighting • Anti-UV glass • Powertrain • Ride • 360 visibility	• Price • Fuel economy • Seat-steering adjustment • Comfort • Exterior water fluid filling • Easy fueling
Other Features Sought by Women with Children	• Child proximity • Parent-child interaction • Parent mirrors • Child entertainment	• Parent mirrors • Parent-child interaction • Child entertainment	• Parent mirrors

Source: Frost & Sullivan

OEM websites and showroom/car dealers are the two main sources of information about cars for women customers

Women as Customers in the Car Industry: Main Sources of Information, Europe, 2015



Attitude Towards Cars and Decision-making Process

Main Sources of Information/Opinion About Cars

Source: Frost & Sullivan

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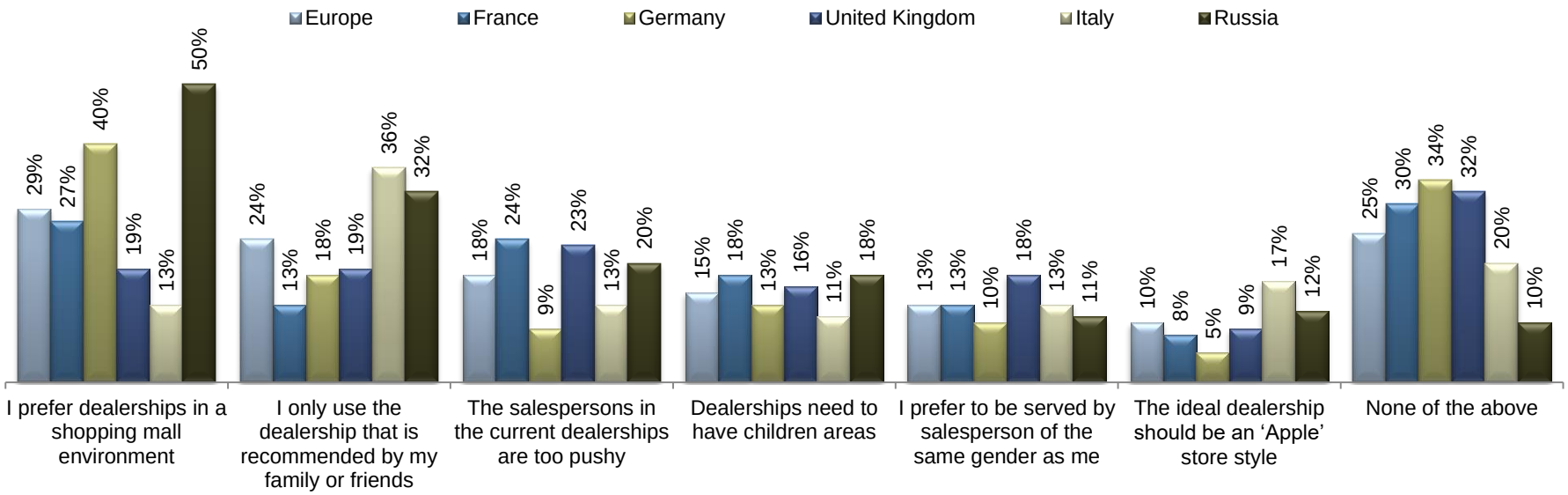
Women customers across Europe believe that the sales people in dealerships are generally too “pushy” and would like this to change

Women as Customers in the Car Industry: Attitudes About Car Dealerships, Europe, 2015



Source: Frost & Sullivan

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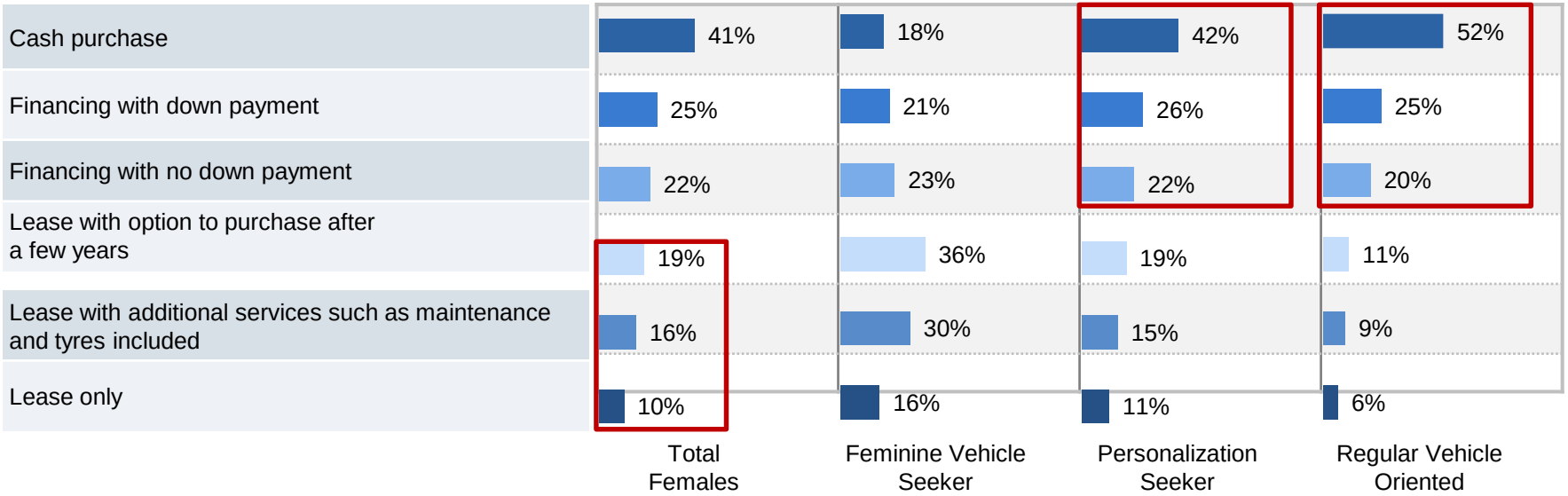
From a financing perspective, cash purchases are the preferred option but lease options are gaining in importance

Women as Customers in the Car Industry: Lease vs. Other Options, Europe, 2015



Profiles of Women in Car

Financing Option Preferences

Source: Frost & Sullivan

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OEMs are adapting their products and retail experience to take into account the decision making processes of women customers

Women as Customers in the Car Industry: Findings, Europe, 2015





Rise of the SUVs and CUVs

Desire for personalization and customization

Social connections leading to sales conversions

Digital journey, an integral element of the sales process

Space, technology and ease of use drive purchase.

PRODUCT

- Model range should be optimized.
- Personalization options drive preference.
- Area of differentiation is usability (not safety).

Lease and warranty are key

RETAIL

- Increased spending on digital retailing
- Marketing through social media to convert a lead into sales
- Lease option and longer period of warranty

Source: Frost & Sullivan

WEARABLES IN CARS

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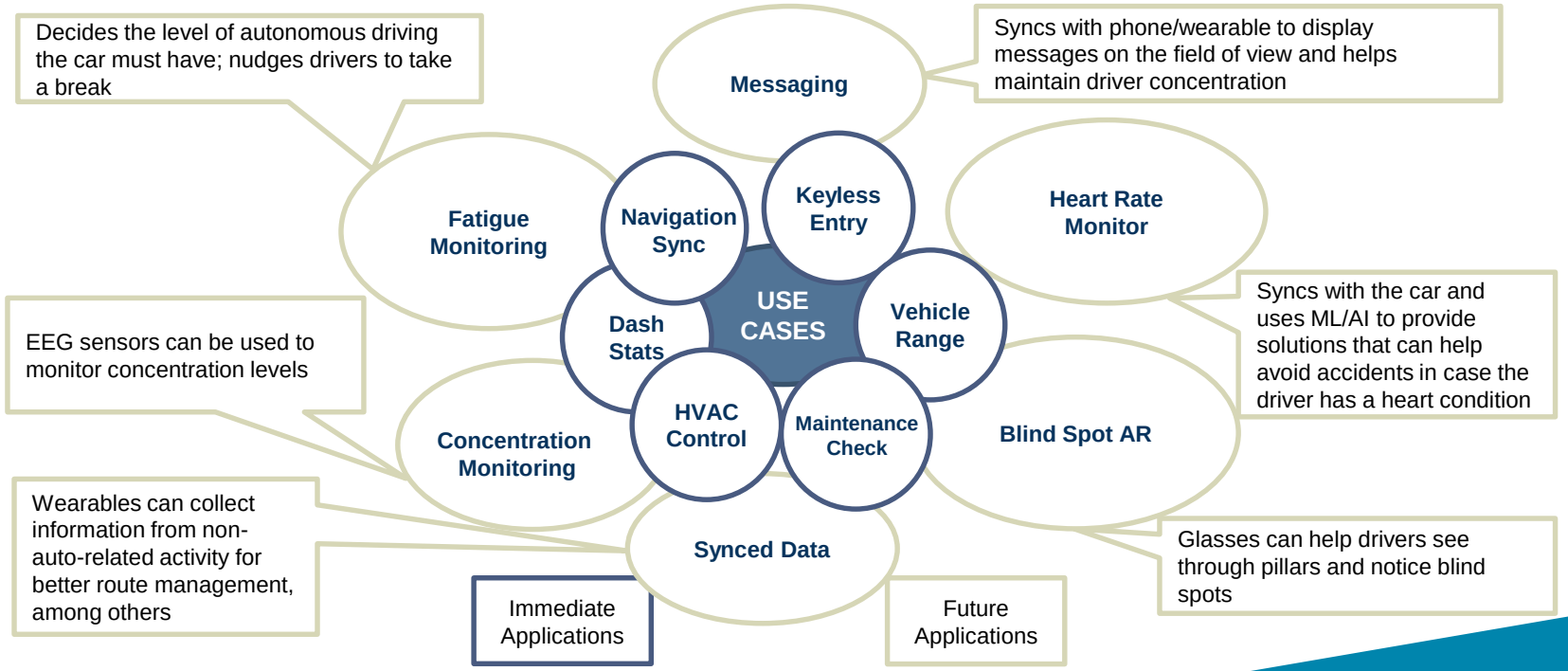
The emergence of many practical use cases and competitive pricing will be key to the adoption of wearables associated with vehicles



Source: Frost & Sullivan

It is also important that functional and social utility match

Value Add

Does the cost of the wearable justify its use case?

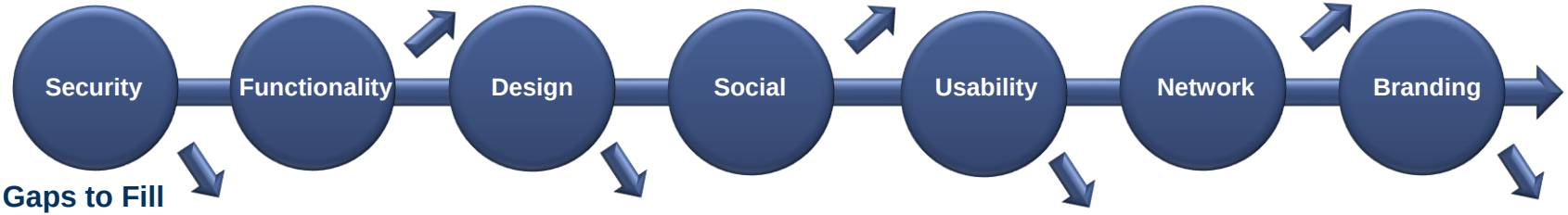
- It will be important to identify the subsidy required for adoption, especially if automotive OEMs want to play a leadership role

Is the usage of wearables associated with automobiles good for society?

- Currently, a limited amount of data is collected; however, with increased adoption, it can be used to gain insights

Does it make other devices more useful?

- With wearables and cars being linked, IOT will become more useful



Gaps to Fill

Does the cost of the wearable justify its use case?

- Companies have to educate customers about the security and the technology in place

Does the cost of the wearable justify its use case?

- Improvements are required in terms of the ruggedness and durability for many of these products so they can be adopted easily

What are the non-financial costs of owning wearables?

- Longer battery life and innovative ways of charging will help increase adoption

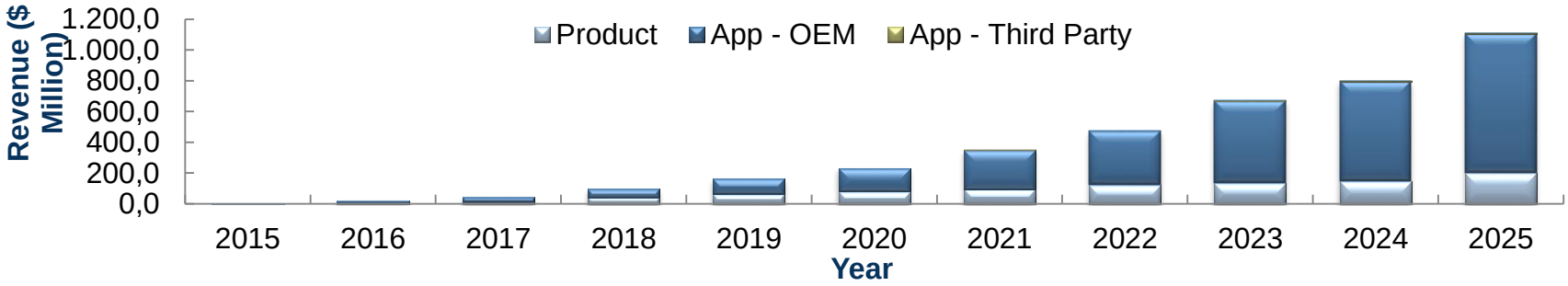
Can wearables satisfy the social and branding needs of consumers?

- Certain customers may not accept a Ford or Samsung watch, especially if they use wearables for non-functional aspects. Targeted branding and ties may be required

Source: Frost & Sullivan

The automotive wearables will grow rapidly over the next decade, reaching $1.1 billion in 2025 which corresponds to 77.4% CAGR

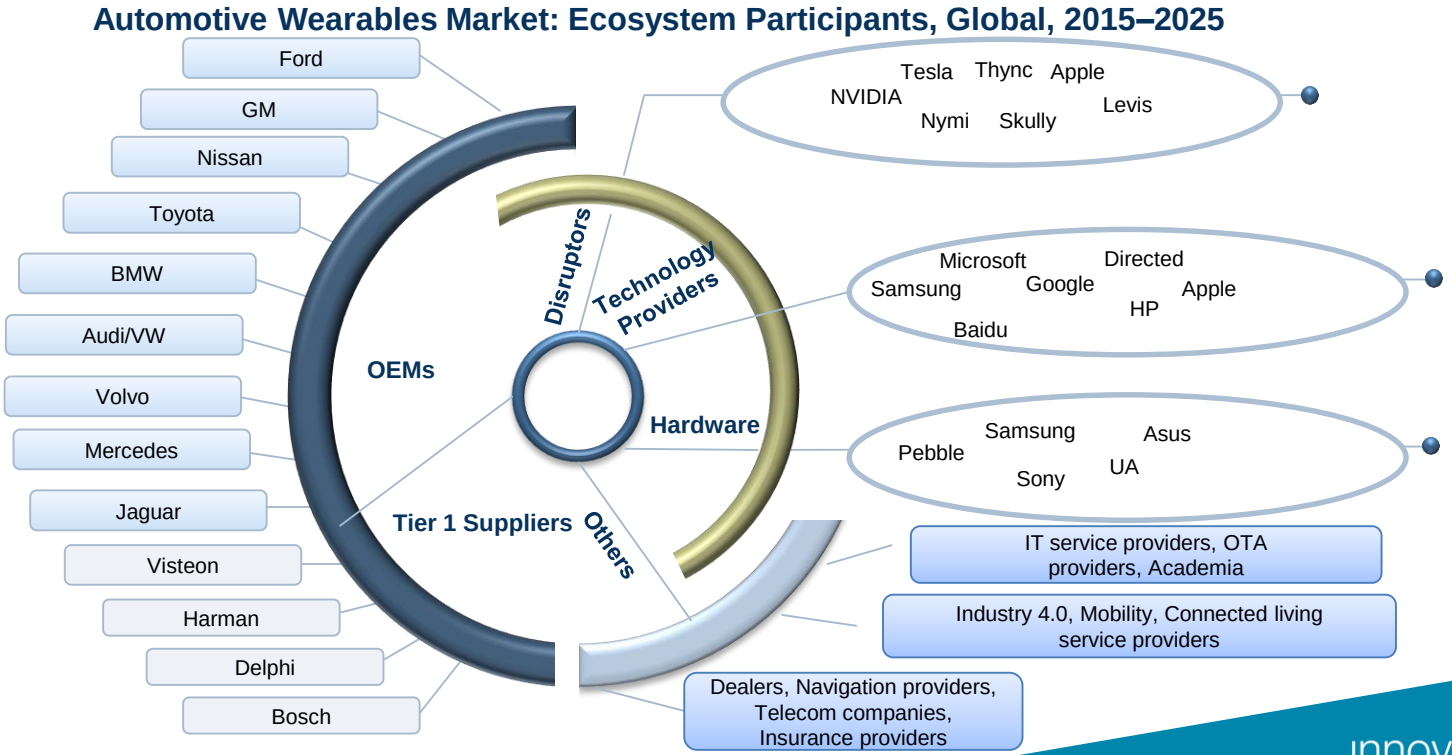
Automotive Wearables Market: Revenue Forecast by Product, Global, 2015–2025



- Most wearable-related automotive applications will be distributed by OEMs.
- Third-party providers will have a limited presence in the application space.
- By 2050, more than 50% of all vehicles are expected to have wearable apps.
- Most product offerings will be in the form of wearable apps; some OEMs can be expected to distribute wearable hardware along with their products.

Source: Frost & Sullivan

Automotive digitalisation involves a complex network of partners across the car manufacturing, technology, telecom and IT industries



Indicative list of participants providing various services
Source: Frost & Sullivan

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The top OEMs have functional-level applications using wearables in their systems, with the focus on electric vehicles

OEM	KEY FEATURES	CAPABILITY LEVEL	NOTES
TESLA	Remote feature, charging stats, intermodal routing, HVAC control	Low — High; 1 2 3 4 5	Tesla has an open platform (relative) and has invited various third-party software providers
MERCEDES–BENZ	Dash stats, locate car, intermodal routing and walking, messaging and communication	Low — High; 1 2 3 4 5	Tied up with Pebble for smart watch application; has apps across all major platforms
AUDI/VW	HVAC, park position, remote key	Low — High; 1 2 3 4 5	Entered several partnerships, including with SONY to create the Scania watch
BMW	Charging and range, intermodal routing, universal remote, driving optimisation	Low — High; 1 2 3 4 5	A leader in this space; developed eyewear prototype
JAGUAR LAND ROVER	Windows check, routing, range, HVAC control	Low — High; 1 2 3 4 5	Has a tie up with Altran to develop software platforms
FORD	Charge status, cabin temperature, remote key	Low — High; 1 2 3 4 5	Has invested heavily in developing wearable solutions

Source: Frost & Sullivan

Third-party companies have started to develop apps that link cars to watches such as the Remote S solution offered by Apple and Tesla

This slide depicts a model S app that controls the vehicle

Monitor Car Location and Speed

View Charge Info

Vehicle Range and Dash Stats

Headlight Flash

Remote Honking

Panoramic Roof Control

Open/Close Boot

Charge Port Opening

HVAC Control

Find Car; GPS Tracker

Use Watch as Car Key- Entry and Start/Stop

Charge Control, Limit Start/Stop

Source: Frost & Sullivan

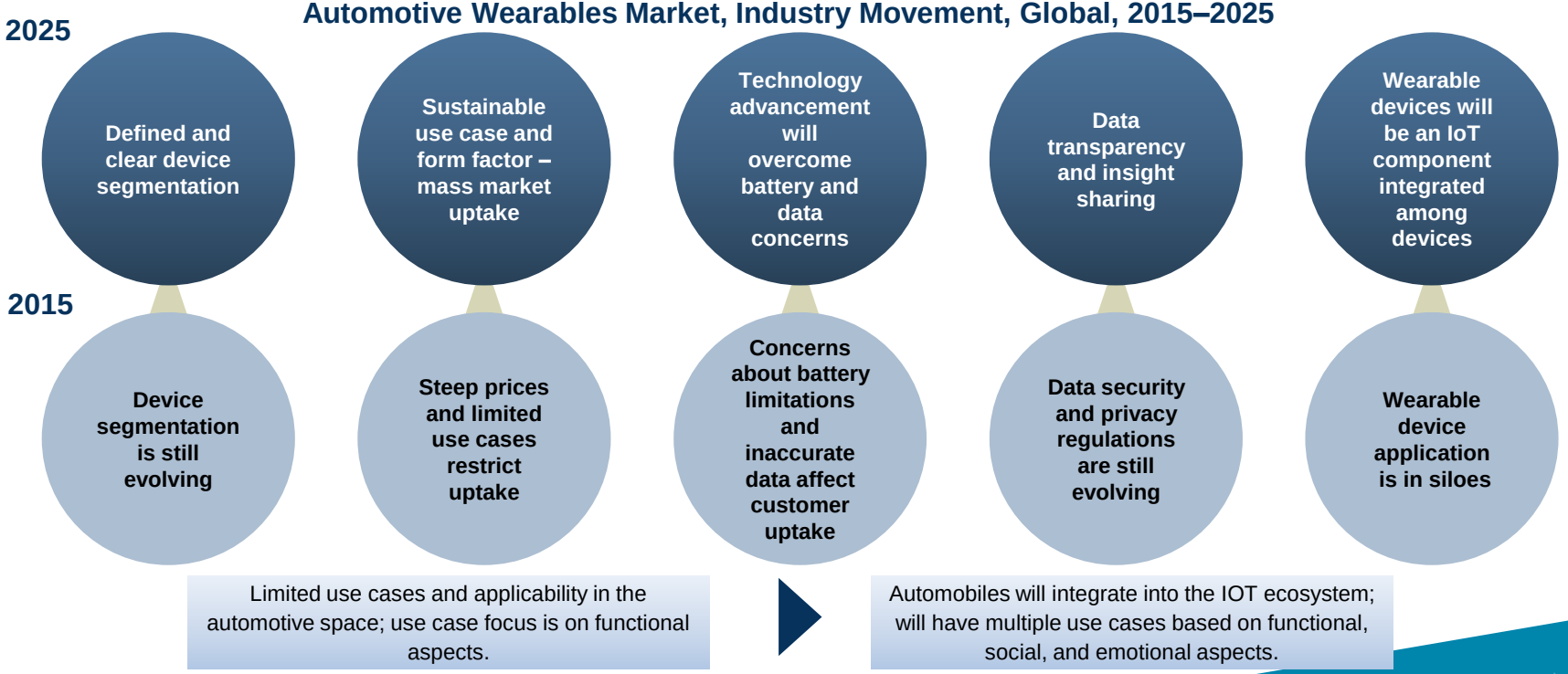
With their significant technical expertise, automotive tier 1 suppliers will also play a major role in developing use cases for wearables

BOSCH	Bosch is a leading automotive component manufacturer and a major in sensors technology, including a wide range of sensors applicable in wearables. The company plays a key role in providing components to various wearables and has a crucial role in establishing standards related to wearables in the automotive industry. The cross-application of sensors, such as the ones used for navigation, will help Bosch become one of the key integrators of the aforementioned 2 industries.
HARMAN	Harman is one of the leaders in terms of providing automotive IT. The company is investing resources in sensors and wearables to provide products related to connectivity and safety. It already has technologies like pupil detection that can be used to identify cognitive load and interact with the vehicle to activate the necessary safety features. Technologies such as the above hold tremendous potential as a form of wearables.
VISTEON	With a strong focus on improving the in-car experience, Visteon has been investing in technologies like gesture recognition, facial identification, and curved OLED to change the way drivers interact with the car, thereby making the ride safer, secure, and more enjoyable. Visteon believes users would like a seamless experience across wearables, phones, and the car; hence, it is looking to give users the ability to sync content in a seamless way between wearables and the car, while also allowing them to personalise the car like they currently can do on a smartphone.
DELPHI	Delphi has invested heavily in autonomous driving. The company is linking its technology with wearables to let users command the car through the device and receive information through the wearable. With autonomous driving, the vehicle can send alerts to the passenger. Besides, the navigation system is in sync with the wearable and can prompt a driver with recommendations, such as ‘we are near a Starbucks, do you want me to place an order?”, based on user routine, time to location, and speed of the car.

Source: Frost & Sullivan

By 2025, with autonomous driving and connected cars, the way in which people interact with their vehicles will see a paradigm shift

Automotive Wearables Market, Industry Movement, Global, 2015–2025



Source: Frost & Sullivan

E-HAILING

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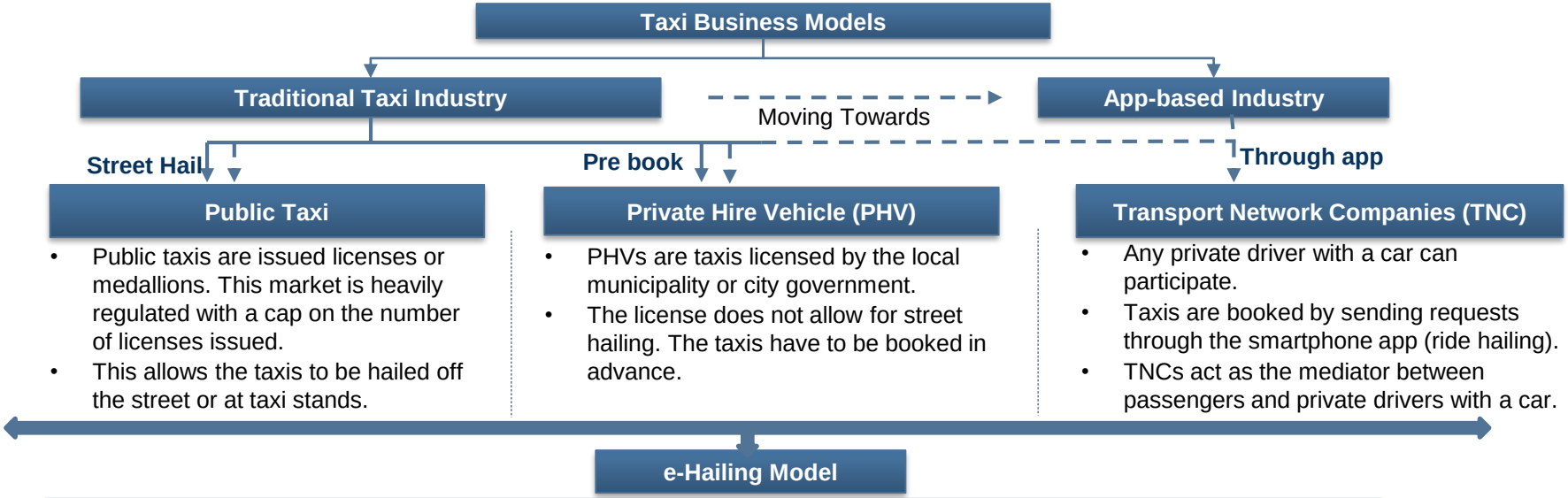
The traditional taxi market is rapidly evolving and moving towards a smartphone and app-enabled model which facilitates e-Hailing

Taxi Business Model Classification, Global, 2015



The e-Hailing model is dependent on a smartphone app that allows the user to view the available taxis and ride hailing vehicles in the vicinity and instantaneously make a booking. A number of apps also allow for dynamic tracking and mobile payment. There are specific apps for public taxis, PHVs, and ride hailing vehicles.

Source: Frost & Sullivan

Greater convenience for customers and increased revenue opportunities for taxi drivers will support continued adoption and uptake

e-Hailing Market: Key Drivers, Global, 2016–2025

Drivers	1–2 Years	3–4 Years	5–10 Years
Convenience and safety for customers: Features like hailing cabs using phones, rather than hailing them off the street, have significantly reduced wait time. Cashless payments ensure that no cash exchanges hands, and features like number masking and driver rating systems ensure passenger safety	H	H	H
Increase in penetration of smartphones: The mobile industry continues to mature rapidly. It is expected to reach 1.2 billion mobile phone users by 2020 in Europe and around 200 million mobile phone users in North America	H	H	H
Rise in revenue for drivers: Drivers attached to these service earn more as they are easily able to get rides; they also avail a number of cash-based incentives and bonuses. Drivers can attach themselves to multiple operators, giving them the freedom to leverage the best operator's service conditions	H	M	M
Creation of a free market by breaking traditional taxi monopoly: Traditional taxi industries are heavily monopolised business, with rates set by the local governments. The introduction of taxi hailing apps breaks the monopoly and brings in a wider range of choice and flexibility for stakeholders	M	H	H

Impact Ratings: H = High, M = Medium, L = Low

Source: Frost & Sullivan

Regulatory concerns and price competition will be among the challenges that e-Hailing market participants will need to overcome

e-Hailing Market: Key Restraints, Global, 2016–2025

Drivers	1–2 Years	3–4 Years	5–10 Years
Protests from the traditional taxi industry: Licensed public and PHV taxi drivers have vehemently protested ride hailing as it meant losing business and customers. Licensed drivers must comply with strict licensing standards and pay a huge sum for the license or to rent the license, whereas ride hailing drivers do not have to undertake any such investments	H	H	H
Fierce price wars leading to consolidation: Aggressive price wars, driver incentives, and subsidies by leading companies, such as Uber, to increase their respective market shares, has made it unsustainable for small local participants, leading them to quit the market. This has also led to a decrease in driver earnings	H	H	H
Legal issues with regard to ride hailing: Regulations are critical to create a conducive environment for the taxi app market. TNCs like Uber continue to be involved in lot of disputes with government authorities across the globe	H	H	M
Drivers simultaneously logging on to different platforms: This has been a major trend among the drivers affiliated to e-Hailing platforms. While this increases earning possibilities for the drivers, the companies lose out on market share and earn lower revenue	H	H	M

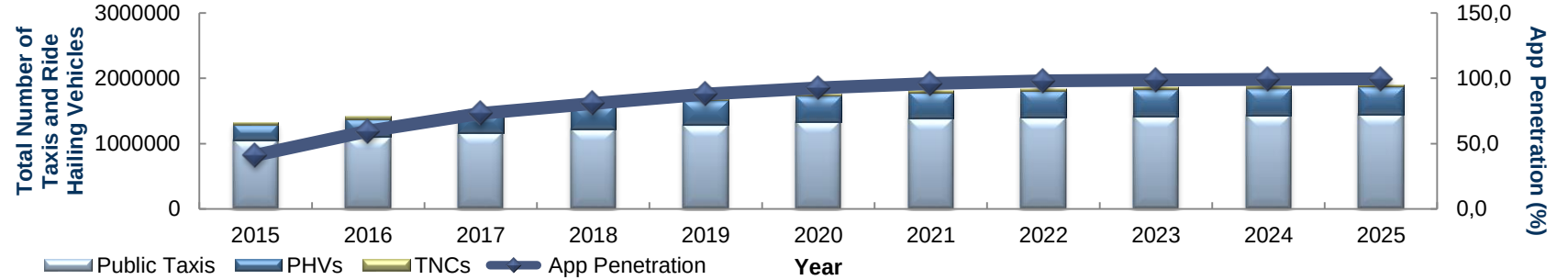
Impact Ratings: H = High, M = Medium, L = Low

Source: Frost & Sullivan

Growth in Europe of 17.7% CAGR (2015-25) in revenue terms will be driven by consolidation among third-party application providers

e-Hailing Market: Total Number of Taxis and Ride Hailing Vehicles and App Penetration, Europe, 2015–2025

Revenue (2015): $23.00 billion | **Revenue (2025): $117.44 billion** | **CAGR (2015-25): 17.7%**



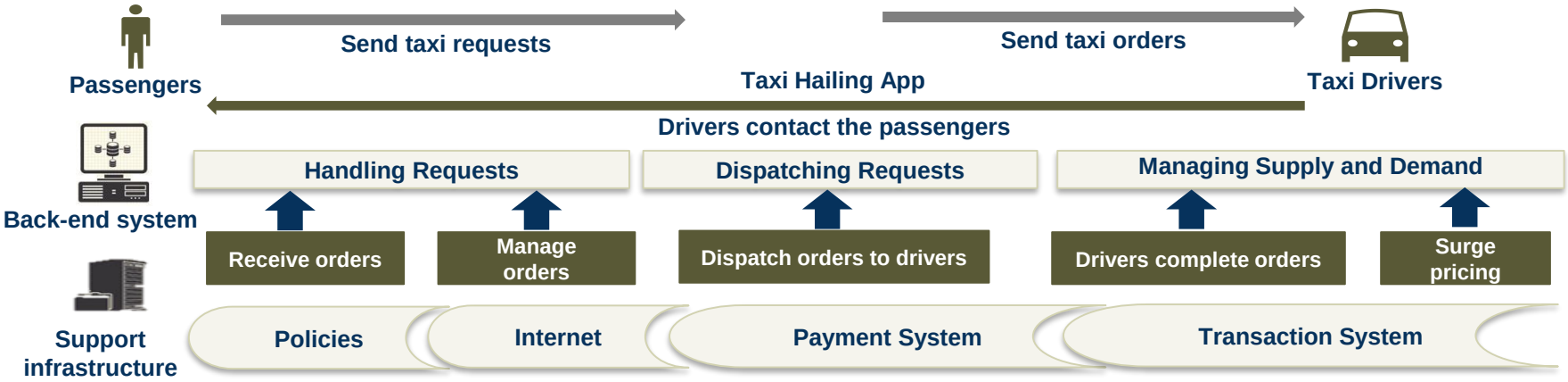
- Being a highly regulated market, ride hailing and TNC operations are likely to decrease significantly over the forecast period, with most of the current ride hailing services merging with the PHV or the public taxi segments.
- The proportion of PHVs is expected to increase steadily, reaching 22.3% by 2025.
- App penetration among users is currently low due to the inherent nature of the taxi industry; however, it is expected to grow rapidly by 2020.
- The European taxi industry has one of the highest percentages of electric taxis; investments in autonomous taxis will transform the structure of the industry in the long term, post 2025.

Source: Frost & Sullivan

App-based taxi booking services have made the taxi hailing process simpler, safer, and more efficient by reducing waiting times

e-Hailing Market: Technology Solutions, Global, 2015

e-Hailing refers to booking a cab electronically by using a smartphone. To book a ride, the person must log-in to the app and furnish the current location either by typing the address manually or providing a current GPS location. The name and the telephone number of the cab driver is sent to the passenger.



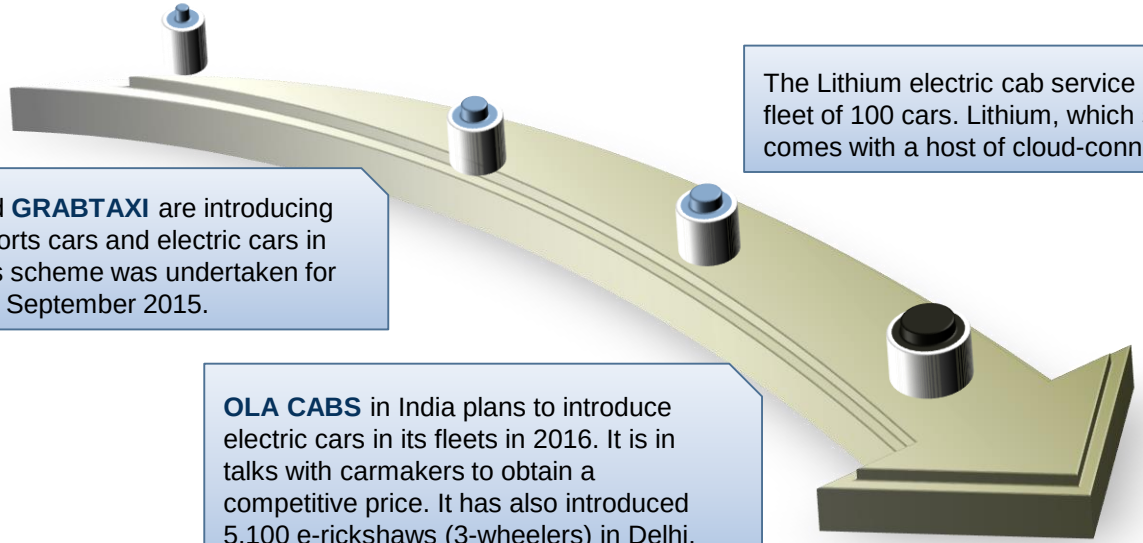
Source: Frost & Sullivan

A number of companies (Uber, GrabTaxi, Ola) have either included EVs in their fleets or plan to introduce them in the near future

e-Hailing Market: Examples of Taxi Apps, Global, 2015

UBER has signed a deal with Chinese automaker BYD Co Ltd to test a fleet of electric cars in Chicago. Currently, 25 BYD e6s are used in fleets; this number is expected to increase substantially by 2016.

European taxi companies have been rapidly adopting EVs. **Nissan** has more than 550 electric taxis across Europe.



The Lithium electric cab service started in Bengaluru, India, with a fleet of 100 cars. Lithium, which services corporate companies, comes with a host of cloud-connected safety features.

GRABCAR and **GRABTAXI** are introducing BMW hybrid sports cars and electric cars in their fleets. This scheme was undertaken for a brief period in September 2015.

OLA CABS in India plans to introduce electric cars in its fleets in 2016. It is in talks with carmakers to obtain a competitive price. It has also introduced 5,100 e-rickshaws (3-wheelers) in Delhi.

Source: Frost & Sullivan

In Europe, acquisitions, partnerships and geographical expansion characterise the growth strategies of the five largest app providers

e-Hailing Market: Top Companies, Europe and Africa, 2015

Company	Business Model	Vehicles/ Drivers	Funding (Billion)	Markets (Europe)
Hailo	Public taxi; Third party	60,000 drivers	$0.1	3 countries
Gett	Public taxi; Third party	50,000 taxis	$0.52	3 countries
Taxi.eu	Public taxi; Third party	62,000 taxis	NA	13 countries
My Taxi	Public taxi; Third party	45,000 taxis	Acquired by Daimler	6 countries
Taxify	Taxi and P2P; Third party	10,000 drivers	$0.002	8 countries

Company	Business Model	Vehicles/ Drivers	Funding (Billion)	Markets (Europe)
Snappcab	Public taxi; Third party	300 taxis	NA	Johannesburg
Ryda	Public taxi; Third party	60 drivers	NA	Johannesburg
Sasa Cabs	Public taxi; Third party	300 taxis	NA	Nairobi
Pewin Cabs	Public taxi; Third party	140 taxis	NA	Nairobi
Mara moja	P2P; Third party	700 drivers	NA	Nairobi

Hailo merged with Mytaxi in early 2017
Source: Frost & Sullivan

Using Frost & Sullivan forecasts for the e-Hailing market, 10.41 million vehicles per year could be eliminated from the roads by 2025

Global	2015	2020	2025
Reduced kms from the Road, Billion	37.59	102.21	122.34
Reduced Tons of CO2 Usage Million	6.92	15.47	14.91
Monetary Savings from ROD off Reduced Mileage ($) Billion	15.47	46.27	60.92
% GDP Savings	0.02	0.05	0.05
Cars Removed from the Road Million	3.2	8.7	10.41

This will result in a reduction of 122 billion kms on the road and $60 billion in savings for users. Significant emission reductions to the tune of 15 million tons of CO_2 can also be attained from reduced vehicle use.

Source: Frost & Sullivan

AUTONOMOUS DRIVING

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Society of Automotive Engineers (SAE) Definitions and OEM Positioning

Engagement of the driver is the key differentiator between various levels of semi automation and minimizing driver engagement is currently the top priority.

Autonomous Driving Market: Definitions for Levels of Automation, Global, 2016–2030

Level	1	2	3	4	5
SAE Definition	The driving mode-specific execution by a Driver Assisted System (DAS) of either steering or acceleration/deceleration with the expectation that the human driver will perform all remaining aspects of the dynamic driving task	The driving mode-specific execution by one or more DAS of both steering and acceleration/ deceleration with the expectation that the human driver will perform all the remaining aspects of the dynamic driving task	The driving mode-specific performance by an automated driving system of all aspects of the dynamic driving task with the expectation that the human driver will respond appropriately to a request to intervene	The driving mode-specific performance by an automated driving system of all aspects of the dynamic driving task, even if a human driver does not respond appropriately to a request to intervene	The full-time performance by an automated driving system of all aspects of the dynamic driving task under all roadway and environmental conditions that can be managed by a human driver
F&S Definition	One of the core functionalities of the vehicle's operation is performed by the system while being monitored by driver	Two (or more) core functionalities are performed by the system while being monitored by the driver	Under specific operating conditions, the system controls the vehicle; driver needs to intervene when requested	System can bring vehicle to safety while in automated mode even if driver does not intervene when requested	The driver is out of the loop; under all operating conditions, the system can control the vehicle appropriately
Capability	• Adaptive cruise control • Emergency braking	• Tesla Autopilot • Traffic Jam Assist • Lane keeping assist	• City/highway pilot with minimal driver intervention—Audi Autopilot	• City and highway pilot, with minimal driver involvement • Fully auto parking	• Fully autonomous vehicles
	2016	2018	2025	2030	

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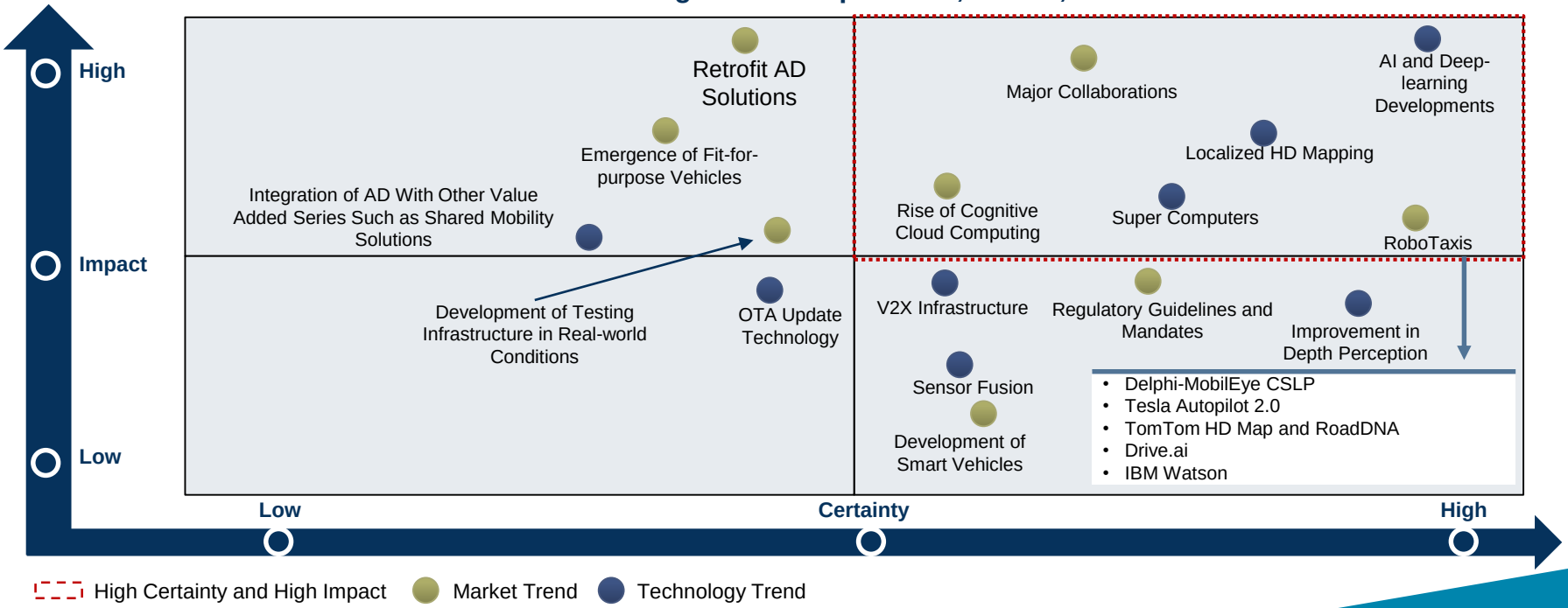
Partnerships, driven by vertical integration of cross-compatible capabilities, are pushing the uptake of autonomous driving technology

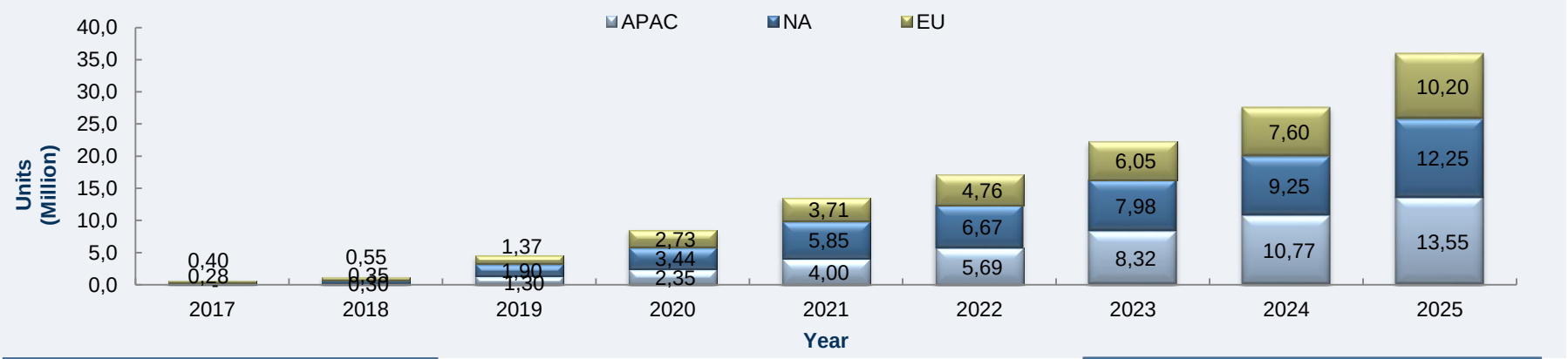
Autonomous Driving Market: Top Trends, Global, 2017



Source: Frost & Sullivan

The market for autonomous vehicles will grow at a CAGR of 64.4% and represent 30.0 million units of largely level 3 and 4 cars by 2025

Autonomous Driving Market: Region-wise YoY Progression, Global, 2017–2025



Short Term

By 2020, level 2 automation is expected to get commoditized with 4 major volume OEMs aiming at introducing the technology to their top spec models; However, take rates will be minimal due to the optional packaging of these solutions.

Mid Term

In the EU and NA markets, introduction of L3 automation as early as 2017-18, driven by OTA updates from Tesla, will influence the take rates for the technology initially, followed by piloted driving offerings from Audi, BMW, and Mercedes-Benz that will drive the product into the premium market.

Long Term

Owing to the introduction of automated driving taxis to support shared mobility business models, the commercial entry of level 4 vehicles is expected by as early as 2020, although mainly for the regulatory benefits in developed markets.

Source: Frost & Sullivan

In Europe, regulation and standardisation are the principal challenges to further adoption although Germany is making good progress

Autonomous Driving Market: Overview, Europe, 2016–2025

5 Categories defined

- Automated parking up to 12km/h
- Automated steering initiated by driver
- System performs lane change when initiated by the driver
- Systems would consist of a function that can indicate and execute it only after the driver's confirmation
- Functions initiated or activated by the driver and can continuously determine maneuvers (e.g., lane change) and complete them for extended periods without additional intervention from the driver

Noteworthy Mention

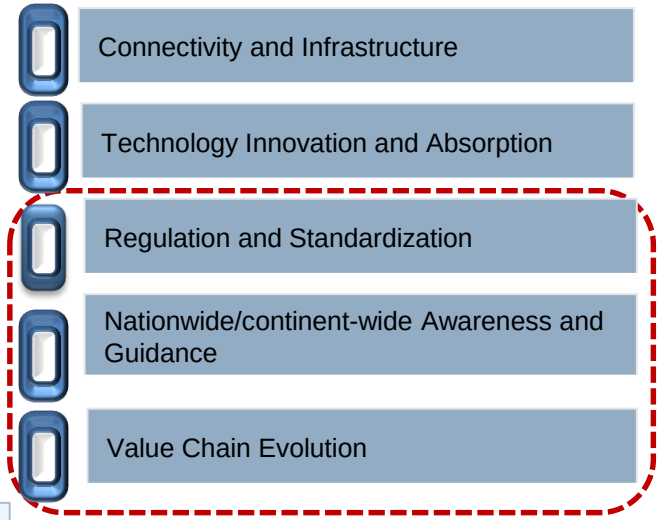
GERMANY: Newly proposed legislation in 2017 to provide legal equality for computers and human motorists, which means the car could take over driving under certain defined circumstances.

KEY OEMS	Volvo, Audi, BMW, Mercedes Benz, Renault
KEY VENDORS	Bosch, Continental, Here, TomTom

Market Trends

- A revision of the outdated EU and UN car regulations involving steering systems is expected in 2017. This will pave the way for clearer regulations for highly and fully automated vehicles.
- Sweden, one of the major promoters of automated vehicle technologies in Europe, is working toward regimenting 100mbps Internet connections throughout the country for the necessary digital infrastructure.
- The automated driving domain will be dominated by suppliers that have exceptional capabilities in chassis-ADAS-safety integration.

Missing Link



Source: Frost & Sullivan

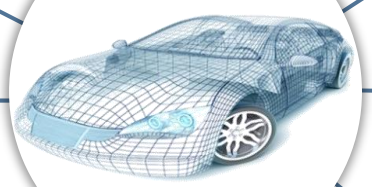
The major traditional OEMs all have autonomous driving strategies and initiatives and are joined by new entrants such as Lucid and Tesla

Autonomous Driving Market: Major OEM Outlook, Global, 2016–2017

	AUDI	BMW	MERCEDES BENZ	TOYOTA	FORD	VOLVO	Lucid Motors (New Entrant-Disruptive OEM)	TESLA (Global First-mover OEM)
Where they are today	Level 3 (2017-18)	Level 3 (2017-18)	L2, L3 (2018)	Active Safety	Active Safety, L2 (2019)	L2, L3 (2018)	Newly Founded Tesla competitor	Between L2 and L3
Expectation for L4	Audi Piloted Driving City	Focused primarily on L3, L4 for fleet	Launched City Pilot automated buses and is looking at L4 automation on cars by 2020	L4 Highway Teammate to make its way only by next decade	Expected to launch a fleet of commercial L4 cars for use in ride-hail services	Working with Uber, it plans to put L4 vehicles on Pittsburgh roads by 2019–2020	To enter the market with L4 vehicles by 2020	Toward 2019–2020
Key takeaway	Audi has been teaching its automated vehicles to drive more like humans in an effort to make them safer on roads	To introduce by 2021, a fleet of L4 automated vehicles that will drive on both highways and in urban environments	Its long-term investment has it ahead of the pack and arguably makes its technology a worthy rival of Tesla's Autopilot	Is leading the way in taking a human approach, toward the development of AI for AD	"Self-driving cars as a service" expected to be a revenue generator over the coming years	Banking on its partnership with Autoliv for development of AD software, plans to sell a self-driving vehicle (XC90) to consumers in five years	Focused on automated driving right from inception; initial offering would be limited to L3 and subsequently L4 vehicles (with steering wheel) only	Is shipping cars with requisite sensors for L4 and would activate features through over-the-air updates with favorable market conditions

Source: Frost & Sullivan

OEMs cannot cover all innovations internally so are working closely with start-ups to bring new solutions to market as quickly as possible



Human Machine Interface (HMI)

iNAGO
neonode
ultrahaptics
BNC systems
MaluubA

Cyber Security

ARGUS
VIDDER
irdeto
Karamba Security
VisualThreat

OTA Update

MOVIMENTO
aryaqa
Advanced Telematic SYSTEMS

Artificial Intelligence Software

Preferred Networks
AdasWorks
CLOUD MADE
fusionops

Autonomous Algorithms

Elektrobit
AdasWorks
MOBILEYE
WIND RIVER
ZOOX
nuTonomy

Sensors Hardware

QUANERGY
LeddarTech
INNOVIZ TECHNOLOGIES
Velodyne
TRILUMINA

Autonomous Processing

CEVA
XILINX
Ambarella
ALTERA

High Definition Mapping

GeoDigital
Civil Maps
ANAGOG
ZENRIN

Autonomous Solution

NAUTO
POLYSYNC
nauyo
drive.ai
Preferred Networks

Driver Safety

ZENDRIVE
navdy
Heads up
Sober Steering
WAYRAY

Mobility Integration

nuTonomy
ubeeqo
Getaround
FAXI
MaaS.fi
drivy

Vehicle to Vehicle (V2V)/ Vehicle to Everything (V2X)

KYMETA
SAVARI
Peloton

Source: Frost & Sullivan, requestsforstartups.com

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Google, Tesla, Toyota and HERE will have the largest map database by the next decade with HAD replacing the current navigational systems

Autonomous Driving Market: Highly Automated Driving Maps, Global, 2016–2025

HAD Maps =

Processing Engine
The data is sent to the map-making engine where it is processed.

+

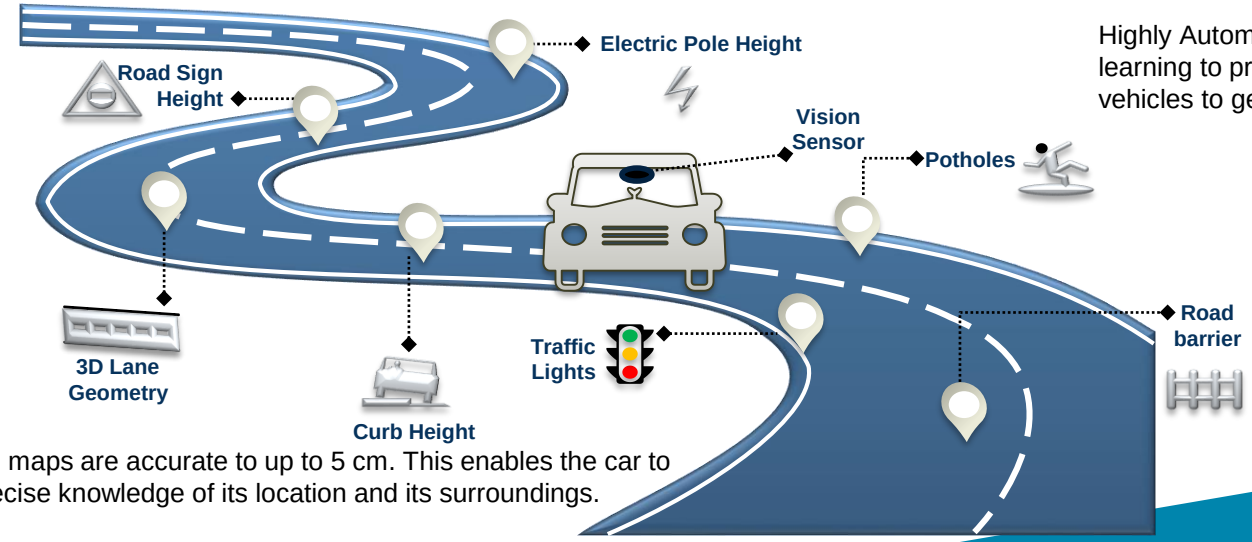
Publish
The data is published in different formats such as NDS, Opendrive, XML, and other proprietary formats.

+

Distribution
The maps are then distributed to OEMs or customers.

+

Update
Maps are regularly updated using probes or other methods such as community feedback.



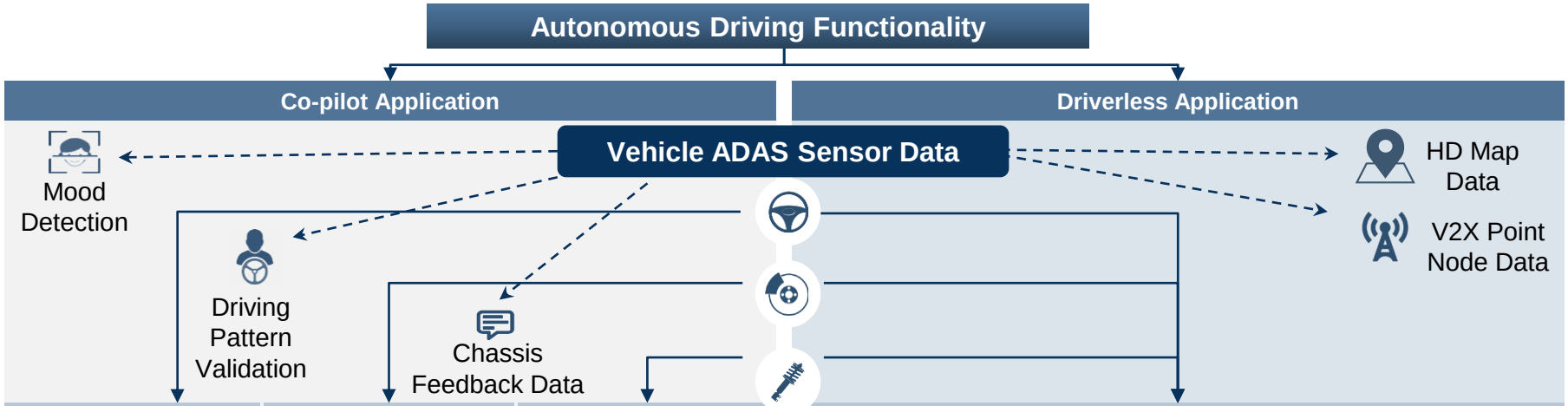
Highly Automated Driving (HAD) Maps use deep learning to process images taken by sensors on vehicles to generate a precise digital map.

The digital maps are accurate to up to 5 cm. This enables the car to have a precise knowledge of its location and its surroundings.

Source: Frost & Sullivan

Moving forwards, guardian-angel type co-pilots will provide a driver in-loop system while still providing benefits of full autonomous driving

Autonomous Driving Market: Future Scenarios of AD Solutions, Global, 2016



Challenges

Co-pilot Application

- Need to assess individual driving pattern and behaviour
- Higher in-car processing functionality
- Application active as long as the vehicle is operational

Driverless Application

- Possible reliability on external sources for data validation
- Need for longer range in depth perception and data processing
- Need for re-engineering of current vehicle architecture

Source: Frost & Sullivan

Circular Economy

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The Circular Economy consist of three concrete business models four of which are represented by automotive trends

Circular Economy Driving New Business Models

Products as a Service	• Pay per service unit • Product renting • Product lease • Product pooling	**Zipcar** provides a car-sharing service that offers customers shared access to a pool of cars located throughout their city.
Reconditioned Products	• Remanufacturing used components • Product transformation with effective design and service	**BMW** sells its remanufactured parts, which provides 50% cost savings to customers compared to new ones, but with the same quality specifications.
Collaborative Consumption	• Social media exchange platforms • Harnessing idle resource capacity • Crowdsourcing	**Netflix** provides collaborative services to its customers by managing a single collection of movies, delivering DVDs through the mail, and providing online streaming media.

Biometrics **Wearables**

Ridesharing **E-hailing**

Source: Frost & Sullivan

Biometrics in cars will usher in a health-as-a-service model in which monitoring systems will come factory-fitted in passenger vehicles

Biometrics in the Automotive Industry: Business Models—Health-as-a-service, Global, 2016–2025

How It Works	Health monitoring features such as pulse trackers, brainwave analysers, and stress detectors will come factory fitted in the car. OEMs will provide connectivity and access to the cloud and apps.
Key Stakeholders	Automotive OEMs and vehicle owners are the key stakeholders.
Data Storage and Technology	Data will be stored and processed on a secure cloud. Meaningful insights will be derived and shared with the user through the vehicle's centre console. Built-in and cloud-enabled technologies will play a key role.
Who Pays for the Service?	Vehicle owners are offered the wearable device for free. The owner will pay a yearly subscription to the automotive OEM for the insights, and the automotive OEM will pay a licensing fee to the wearable company.
Potential Future Participants	Mercedes (Pebble), BMW (Samsung Gear), Hyundai (Google Glass), and Volvo (Microsoft Band) are potential companies that could follow this business model.

Source: Frost & Sullivan

The wearable device-as-a-service model will save development costs for auto OEMs whilst also benefitting drivers

Biometrics in the Automotive Industry: Business Models—Device-as-a-service, Global, 2016–2025

How It Works	Car manufacturers in partnership with wearable companies will offer a free wearable device at the time of purchase. The capability to integrate brought-in devices seamlessly will be available in the vehicle as well.
Key Stakeholders	OEMs, wearable manufacturers, and vehicle users are the key stakeholders.
Data Storage	The wearable company will collect and process the data from the vehicle owner, and insights will be provided on the centre console. Brought-in devices and cloud-enabled technologies will play a key role.
Who Pays for the Service?	Vehicle owners are offered the wearable device for free. The owner will pay a yearly subscription to the automotive OEM for the insights, and the automotive OEM will pay a licensing fee to the wearable company.
Potential Future Participants	Mercedes (Pebble), BMW (Samsung Gear), Hyundai (Google Glass), and Volvo (Microsoft Band) are potential companies that could follow this business model.

Source: Frost & Sullivan

Ridesharing will increasingly be a collaborative component of other modes of transportation such as carsharing and taxi e-hailing

Ridesharing Market: Key Trends, Europe, 2015–2025

Factors Impacting the Evolution of Ridesharing

Current Scenario

- Fixed
- Corporate
- Dynamic
- Pure ridesharing companies
- A number of region-specific, small companies with fewer than 10,000 members

Urbanization
Gen Y
Pollution
Natural Resources
Social Responsibility
Congestion
Connectivity
Globalization
Population Growth
Air Quality

Future Trends

- Market consolidation
- New business models (targeting specific customer segments, duplicating public transport)
- New market participants (OEMs, taxi hail)
- Technology-enabled, multimodal integration
- Autonomous cars merging the self-driven and be-driven business models

Source: Frost & Sullivan

In addition to benefits for users, ridesharing has positive effects on emission rates, traffic congestion, and fuel usage

Ridesharing Market: Benefits of Ridesharing, Europe, 2015

Less Congestion

Ridesharing mitigates traffic congestion and lessens vehicle miles traveled.

Efficient Use of Infrastructure

Congestion on bridges and highways is reduced. HOV and HOT lanes shift cars from other roads.

Short Wait Times

Abundance of rideshare vehicles means an average wait time of less than 4 minutes.

Integrated Urban Mobility

Integration of ridesharing with other transportation modes, such as public transit and carsharing, will economically extend service into low-density areas.

Safe Travel with Social and Economic Advantages

Services ensure stringent driver profile checks and validation. Drivers have an income source and riders travel at a lower cost.

Reduced Cost of Ride

Ridesharing is cheaper than car ownership, taxis, and carsharing.

Source: Frost & Sullivan

Start-ups in the Automotive Industry

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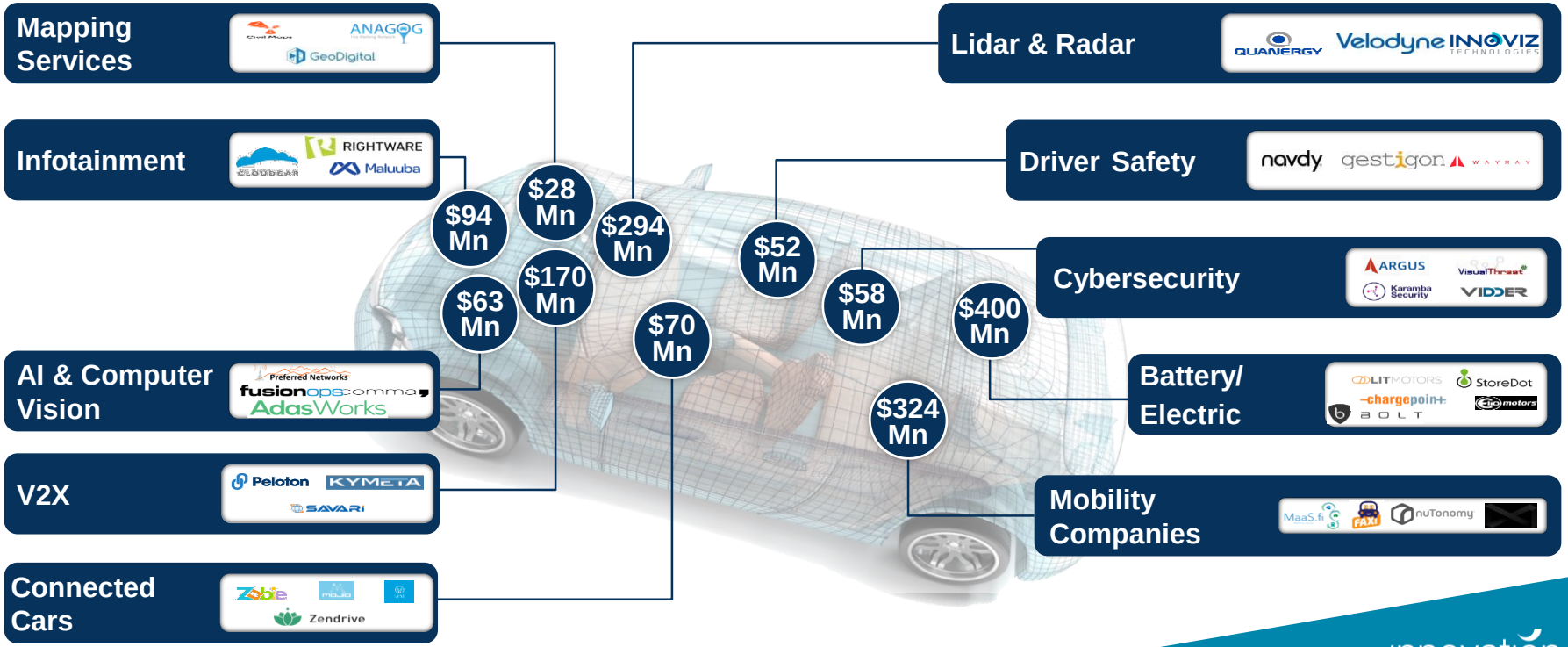
Total global funding for automotive start-ups was $1.55 billion in 2016, with major investment focused on a range of technologies



● **Total funding in technology area**

Source: Frost & Sullivan

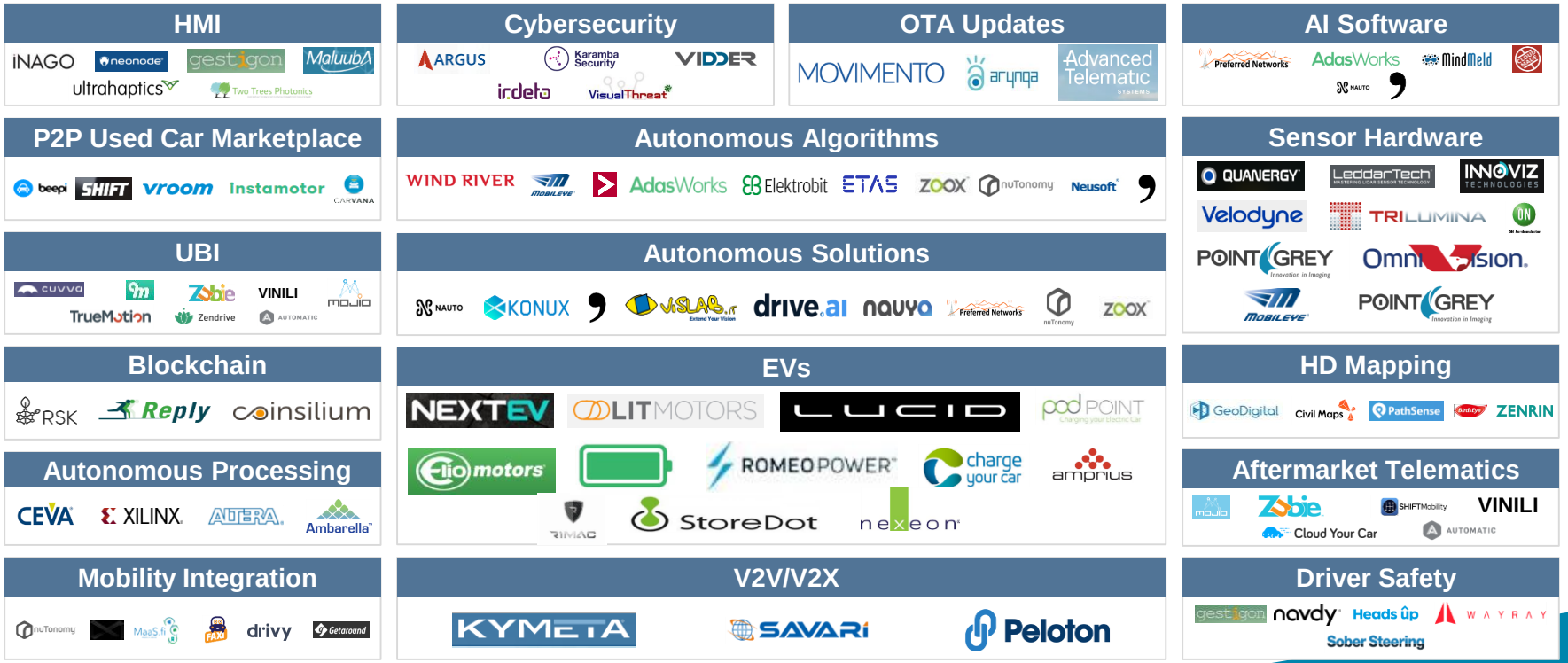
All of the major OEMs are making investments and/or acquisitions with a view to accelerating their presence in growth areas

Start-ups Disrupting the Automotive and Mobility Industry: Snapshot, Global, 2016–2017

Audi Electronics Venture GmbH
SILVERCAR (M)
cubic (C)
moovit (M)
(P)
embark (M)
JustPark (P)
Life360 (Analytics)
chargepoint (EV)
MobileROI
REVER (M)
ZIRX (M)
scoop (M)
RideCell (MaaS)
Zendrive (Analytics)
cargomatic
i-TECH
RidePal (M)
PELOTON (C)
Lytx
STEELWRIST (T)
Z6omcar
chariot (M)
Civil Maps (Mapping)
Pivotal (Software)
Velodyne (Sensor)
Livio
Preferred Networks (A)
UBER (M)
Infinix (M)
evopark
NAVISTAR (T)
EYEMOTIVE (S)
QuantumScape (B)
Gett (M)
autobutler (Aftermarket)
TRAVELCAR (M)
Koolicar (M)
CRUISE (A)
Sidecar (M)
coskata (E)
lyft (M)
SDC materials
SAVAARI (Com)
solid energy (Energy)
Your Mechanic (Aftermarket)
BLACKLANE (M)
BAIC MOTOR
FlightCar (M)
tiramizoo.com
GeoDigital (HAD)
SIRRUS
(M)
SAKTI3 (Battery)
MATTERNET (L)
mytaxi (M)
carpooling.com (M)
Deutsche ACCUmotive (B)
MOTOR COACH INDUSTRIES
atieva (Electric)
NANOSTEEL (Manufacturing)
SUNLOGICS (Solar Power)
Telogis
Going myway (P)
HAIO (M)
ZONAR (M)
globesherpa (Payment)
PROTERRA (Electric Vehicle)
alphabet energy
TURO (M)

Key: C-Connectivity; M-Mobility; P-Parking; EV-Electric Vehicle; A-Autonomous
Source: Frost & Sullivan

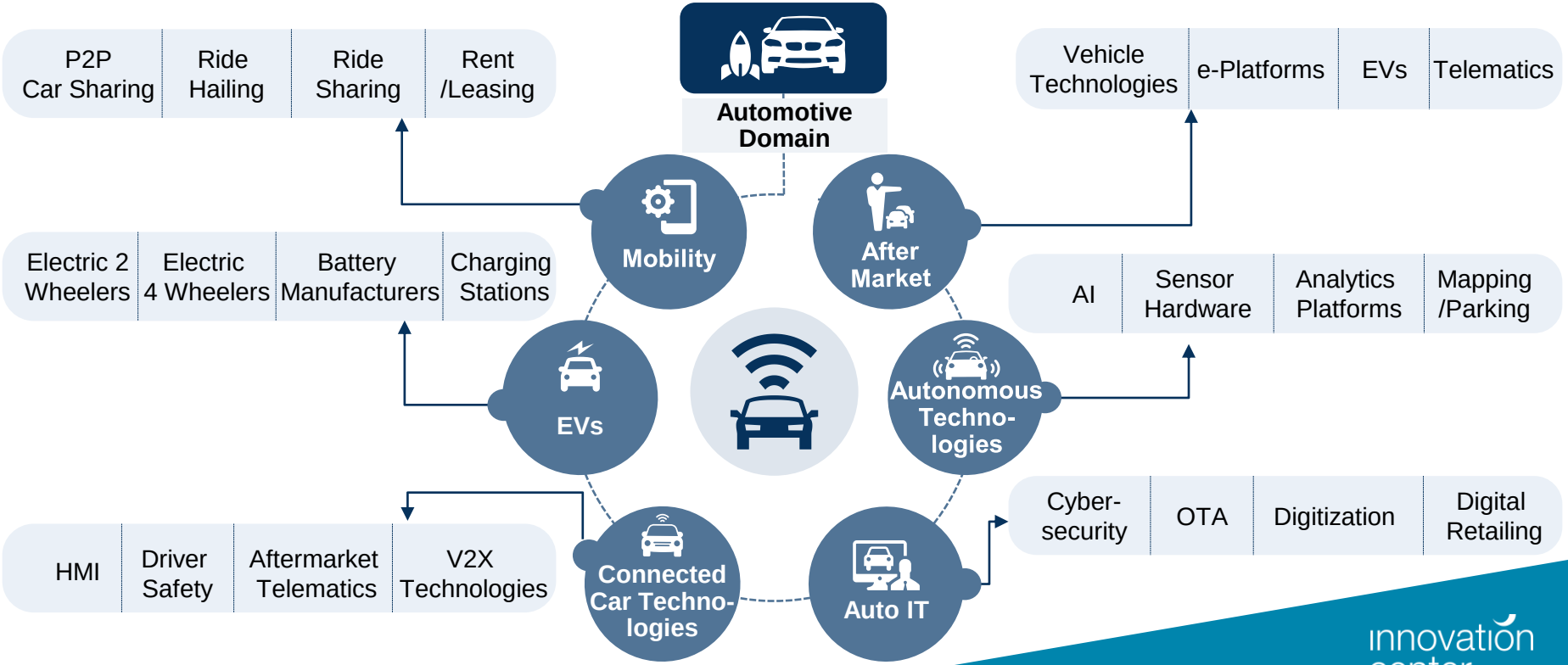
Over 1,700 start-ups are disrupting the automotive supply chain



Selected companies
Source: Frost & Sullivan

Source: Frost & Sullivan

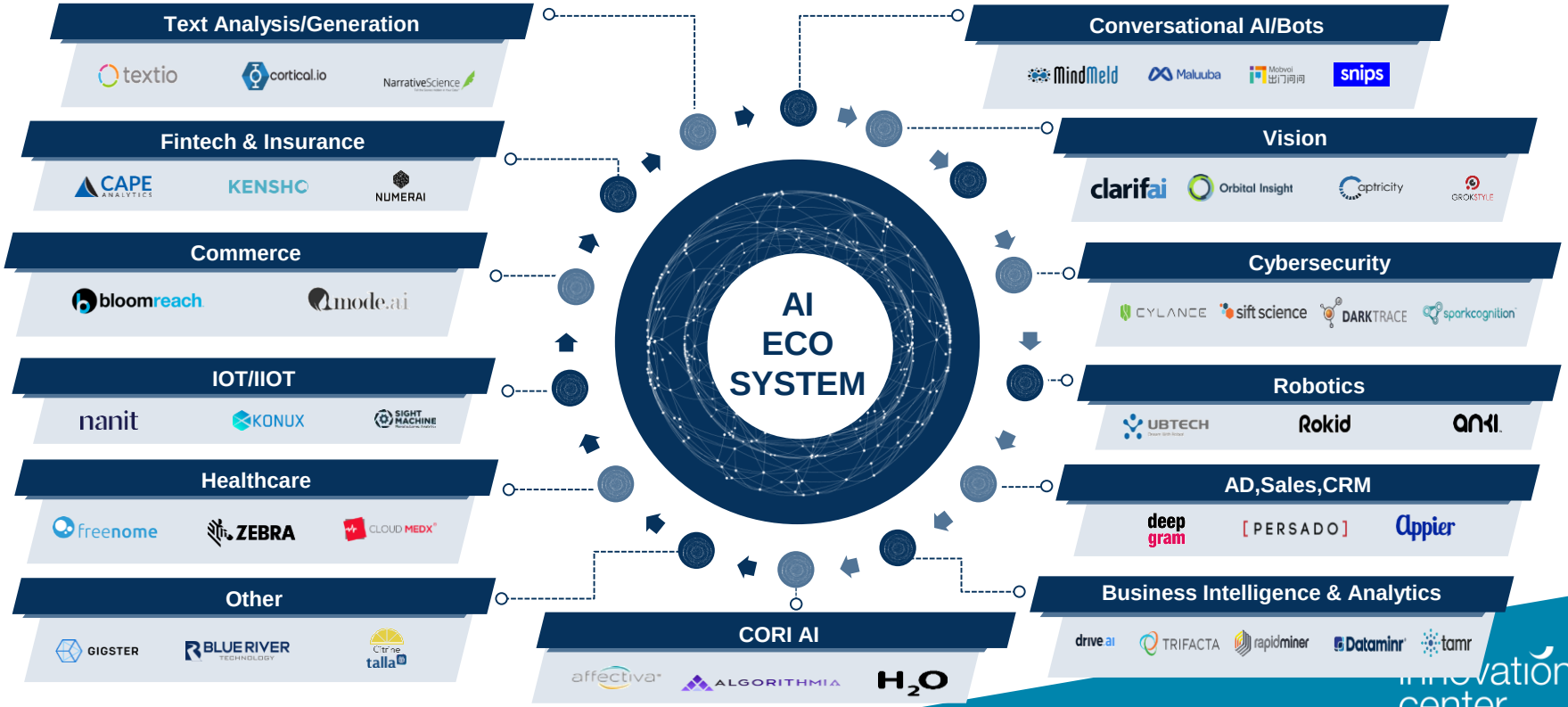
Start-ups can be found in every area of the automotive market



Source: Frost & Sullivan

Source: Frost & Sullivan

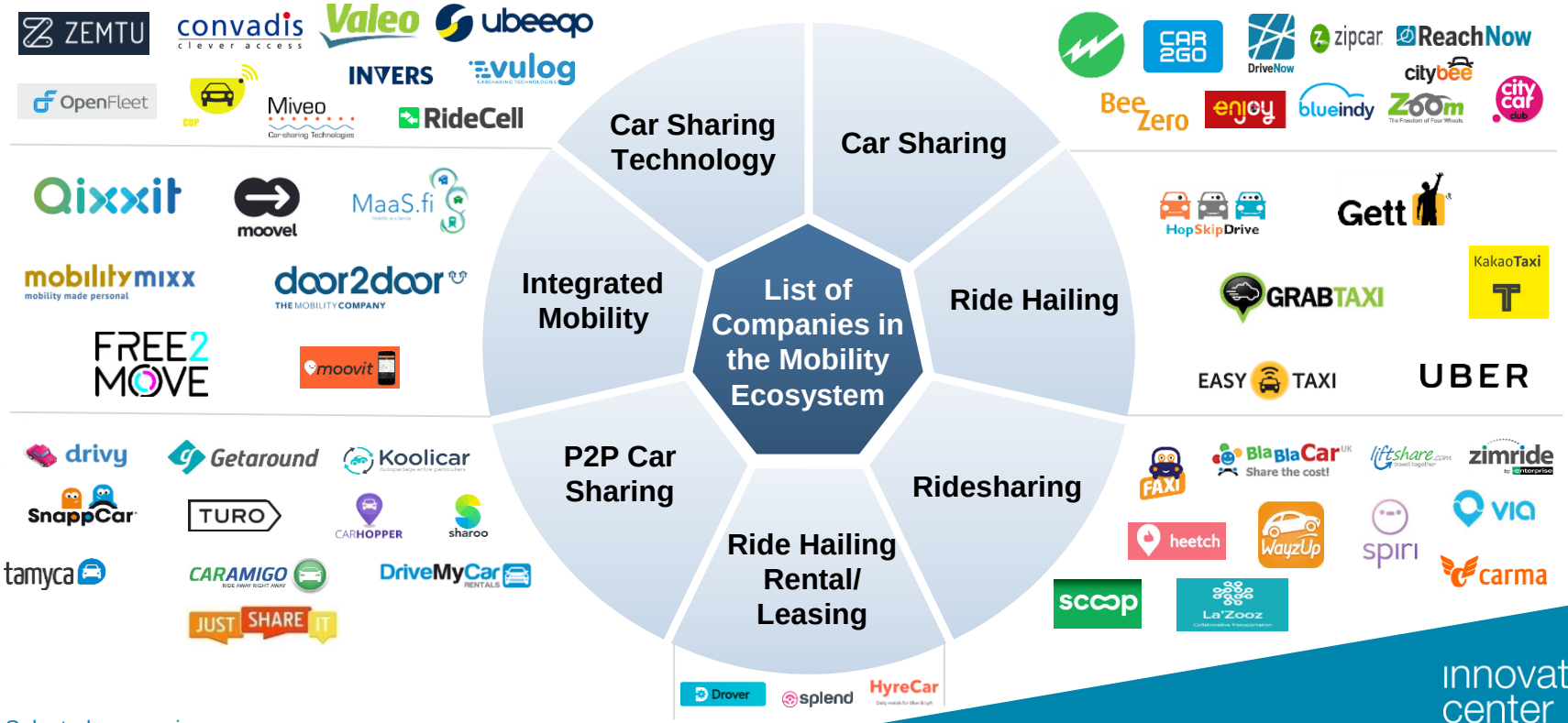
Key start-ups in Artificial Intelligence



Selected companies
Source: Frost & Sullivan

Source: Frost & Sullivan

Key start-ups in Mobility



Selected companies
Source: Frost & Sullivan

Source: Frost & Sullivan

Key start-ups in Electric Vehicles

Selected companies
Source: Frost & Sullivan

Source: Frost & Sullivan

Key start-ups in the Aftermarket

EV

Evatran
ecotricity
EverCharge
Boston Power
POLAR
StoreDot
pod POINT
PlugShare
ZERO
ZAF Energy Systems
chargepoint
amprius
charge your car
GBatteries
nexeon
ROMEO POWER

Vehicle Technologies

WAYRAY
GeoDigital
Mobvoi 出门问问
navdy
CARROBOT
PathSense
Civil Maps
BirdsEye
ZENRIN
Maluuba
MindMeld
snips

Telematics

vinli
nauto
PACE
mojio
Zubie
TankTaler
Cloud Your Car
AUTOMATIC
HUGHES TELEMATICS, INC.

e-Platform

who can fix my car .com
GoTire
SHIFTMobility
openbay
STEERO
tuhu
REPAIR JUNGLE
Auto MD
YourMechanic
servicingstop
ClickMechanic
REPAIR PAL
fair MECHANICS

Selected companies
Source: Frost & Sullivan

Source: Frost & Sullivan

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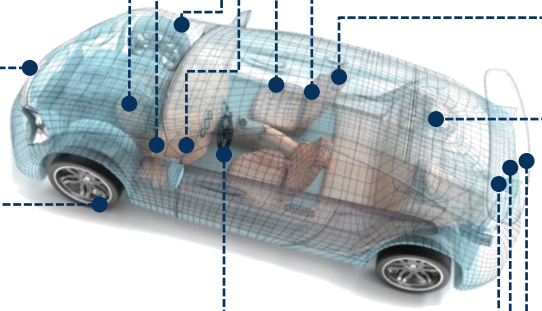
Key start-ups in Connectivity



HMI: INAGO, UDRIVE.COM, BIC, ultrahaptics, Maluuba, neonode

Sensors Hardware: QUANERGY, LeddarTech, INNOVIZ TECHNOLOGIES, Velodyne, TRILUMINA

Aftermarket Telematics: mojio, Zubie, VINILI, Cloud Your Car

Cyber-security: ARGUS, VIDDER, Karamba Security, VisualThreat

AI Software: Preferred Networks, AdasWorks, fusionops

Mapping: GeoDigital, STREETLINE, PARKWHIZ, ANAGOG

UBI: CUVVA, Zendrive

OTA Updates: MOVIMENTO, Advanced Telematic

Analytics Platform: otonomo, SISENSE

V2V/V2X: KYMETA, SAVARI, Peloton

Driver Safety: gestigon, navdy, Heads Up, WAYRAY, Sober Steering

Mobility: nuTonomy, ubeeqo, MaaS.fi, drivy, Getaround

Blockchain: RSK, Reply

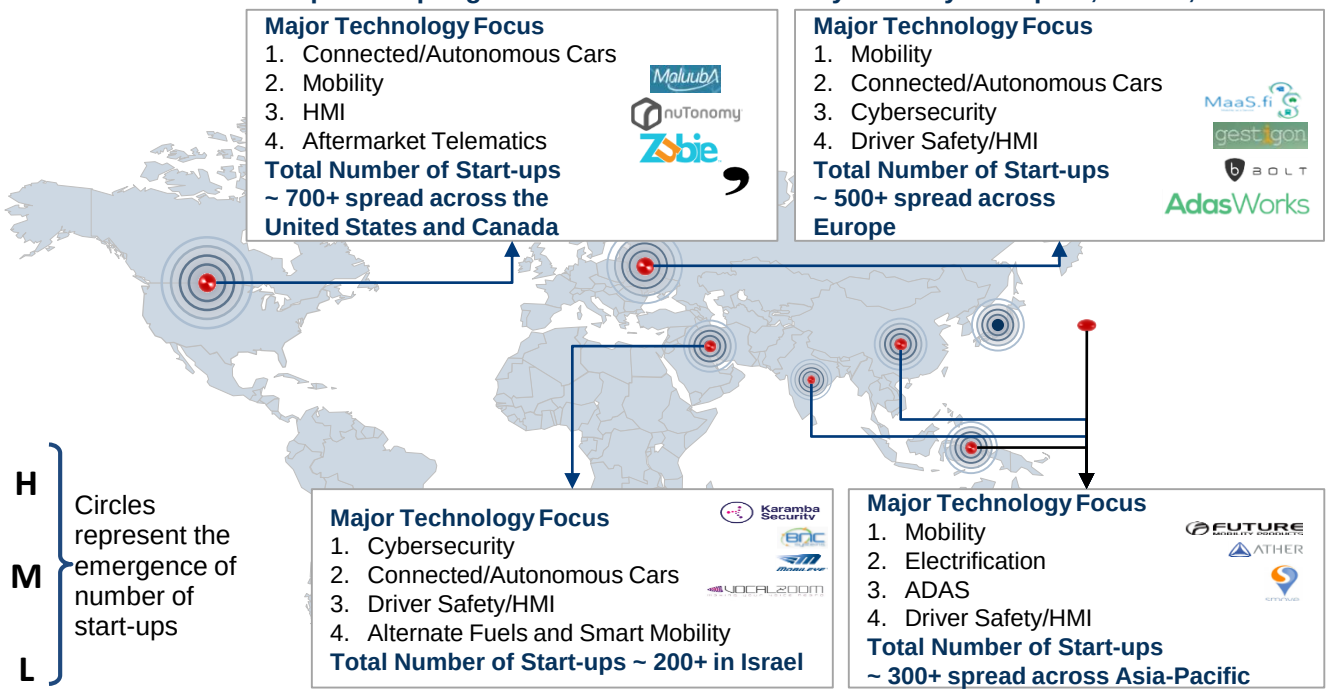
Used Car Marketplace: beepi, SHIFT, vroom, CARVANA, Instamotor

Selected companies
Source: Frost & Sullivan

Source: Frost & Sullivan

The start-up landscape has evolved rapidly over the years with North America and Europe leading growth from just 450 in 2010

Start-ups Disrupting the Automotive and Mobility Industry: Hotspots, Global, 2016–2025



Source: Frost & Sullivan

Source: Frost & Sullivan

Israel is a hotspot with the number of start ups increasing from 50 to more than 300 with a focus on mobility and cybersecurity

HMI

inpris
NovoSpeech
Noveto Systems Ltd
BNC systems
BEYONDVERBAL
VOCAL ZOOM
eyeSight
neomatix
vo wondervoice

Cybersecurity

ARGUS CYBER SECURITY
Arilou
Karamba Security
TOWERSEC
Guard KNOX cyber technologies

Alternate Fuels

DESIGNER ENERGY
ENGINEUITY
Evofuel
GREEN CITY
DOR
kaiima

Sensors Hardware

oryx
vayyar
INNOVIZ TECHNOLOGIES
RFISee
MOBILEYE

Mapping/Parking

Bike & Park
HiGPark
ANAGOG
Cellint
Origin GPS
POINTER ISRAEL
PARKLIFE

Driver Safety

SAVER1
BrightWayVision
Guardian electrical solutions
Ex-Sight.Com
Mishor Drive Like A Pilot
i4drive
INFINITY

EVs

driivz
REDLER Technologies
Elbit Systems
π Energy
TADIRAN BATTERIES
Chakratec
BSI
AutoPower Extra Electrical Power
VOLTANANO
METROBOARD
ETVENERGY
StoreDot Inspired by Nature

V2V/V2X

Autotalks
Gilat Gilat Satellite Networks
Intellicon
siano MOBILE SILICON

Mobility

iRide SHARE
CAR2GO... Anytime, Anywhere
TBUS
SMARTBUS smartbus.co.il
city graph Access Ltd.
Optibus

Vehicle Safety

trackimo always there
engie
TRAXX
TrackTec

Analytics Platform

otonomo
SISENSE

Mobile Apps

nexar
HopOn cutting through lines
ZenCity
BAZZ Safe Messaging on Your way
GreenOn

Selected companies
Source: Frost & Sullivan

Source: Frost & Sullivan

The start-up eco-system in India is also very varied

Connected Truck/ Commercial Vehicles

PT technologies and Electric Vehicles

Learning Motors: Logo yet to be revealed, start up announced by Punit Soni

Fleet and Leasing

Indian Aftermarket Startup Ecosystem

Service Aggregators

eCommerce

Market Place

Safety & Security

Startup Companies within Mobility Market in India

Used Cars

Fintech

Auto Service

Drone-based

3D Printing

Artificial Intelligence

Biometrics

Connected Cars

Startups in the Indian Rail Sector

Search and Prediction

Food on Trains

Social Networking

Official Indian Railways

Most startups in ticketing and food delivery. Indian railways to set up incubators to promote startups for other activities.

Selected companies
Source: Frost & Sullivan

Source: Frost & Sullivan

Increasingly, Africa is developing interesting players

Used Cars

Social Route Planning/Car Pooling

E-hailing

Health Wellness

Parking Solutions

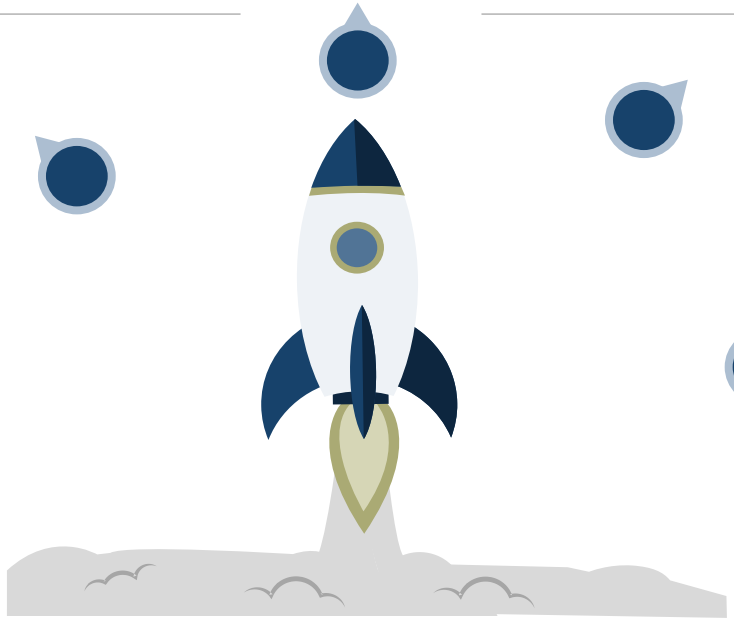
Startup Companies within Mobility Market in Africa

PT technologies and Electric Vehicles

E Commerce

Automotive Manufacturers

Last Mile Delivery and Warehousing



Selected companies
Source: Frost & Sullivan

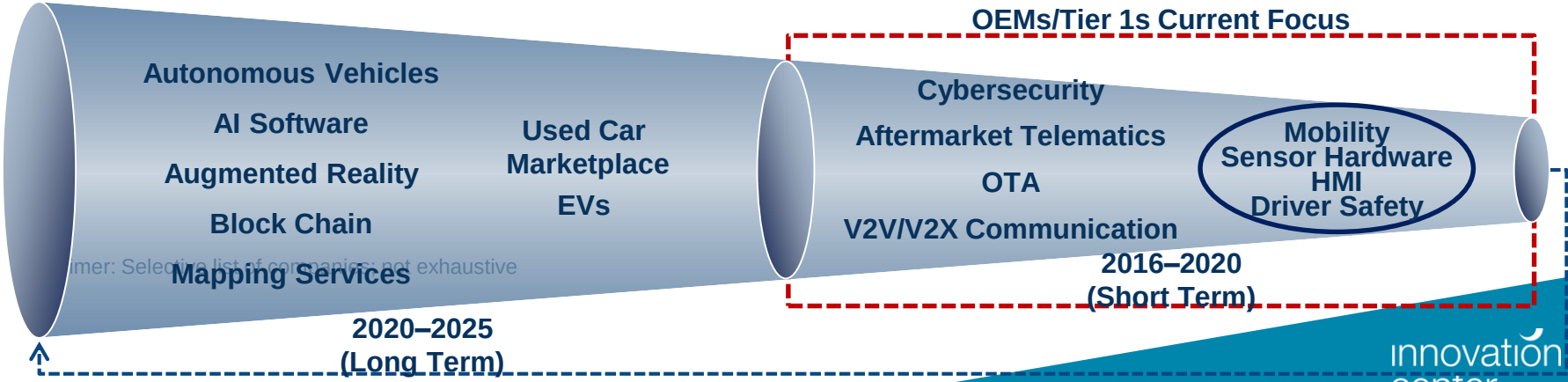
Source: Frost & Sullivan

Moving forwards, OEMs will focus on the digitalisation of their ecosystem so start-ups will focus on retail and blockchain technology

Start-ups Disrupting the Automotive and Mobility Industry: Domain Focus, Global, 2016–2025

Examples of Acquisitions /Investment

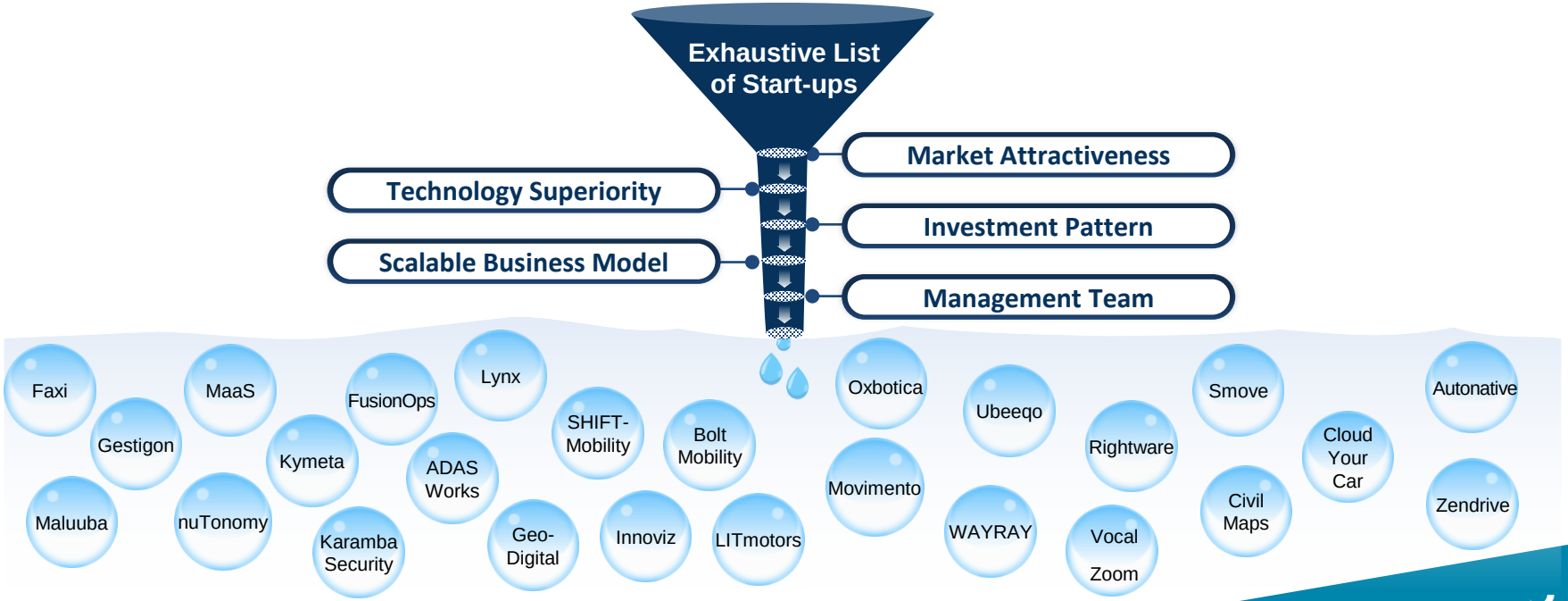
- **HMI:** Daimler collaboration with uSense for gesture recognition
- **OTA:** Windriver acquisition of Arynga
- **Driver Safety:** Renault with Gestigon for driver monitoring
- **Mobility:** PSA Group acquiring Koolicar for car sharing
- **V2V/V2X:** An enabling technology for autonomous vehicles
- **Sensor Hardware:** Delphi investment in Quanergy
- **Cybersecurity:** Harman acquisition of Argus



Selected companies
Source: Frost & Sullivan

A key success factor for an entrepreneur is the ability to provide the passion of a start-up is with the experience of a large company

Start-ups Disrupting the Automotive and Mobility Industry: Key Criteria, Global, 2016–2017



Note: This is the first issue of the featured start-ups; subsequent issues will feature a new set of companies.

Source: Frost & Sullivan

Frost & Sullivan believes that there are a range of start-ups which have a unique perspective and strength of vision, are extremely innovative, and hold the potential to revolutionize the automotive ecosystem (1/2)

Company	Funding Received ($ Million)	Technology Domain	USP
Innoviz	9	Sensor Hardware	LiDAR under $100 to support autonomous cars
ADASWorks	11	AI Software	Autonomous driving AI software, including environment recognition, motion planning, and navigation and control
Kymeta	144	V2V/V2X Communication	Specializes in the development and commercialization of software-enabled satellite terminals
Gestigon	6	Driver Safety	Driver monitoring and recording of events inside the cabin
Maluuba	11	HMI	Voice assistant platform offers ~93% accuracy
nuTonomy	19.6	Mobility (Driverless Taxi)	Commercialization of driverless taxis; fleet expansion will take place by the end of 2017
GeoDigital	17.92	HAD Mapping	Develops HD map data with <10cm absolute accuracy and <5cm relative accuracy
Lit Motors	2.2	EVs	Low-cost electric scooter with the comfort features of a car
WAYRAY	10.6	Driver Safety - HUD	Cost-effective portable holographic HUD that can be used in different cars
Movimento	9.6	OTA Services	Ability to perform SOTA and FOTA
Rightware	5.2	HMI Software	Virtual cockpit to support information sharing
Cloud Your Car	4.5	Aftermarket Telematics	Car beacon plugs into a standard cigarette lighter and requires no set up; can be used in any cars and make and year
Karamba Security	5	Automotive Cybersecurity	Embedded software has zero false positives and requires no malware signature updates; negligible performance impact on the ECUs it hardens
Civil Maps	9.2	HAD Mapping	Technology available for commercialization as a plug-and-drive hardware
Zendrive	20	UBI	UBI with help of a smartphone; technology and solution are more robust and secure when compared to OBD port solutions

Source: Frost & Sullivan

Source: Frost & Sullivan

Frost & Sullivan believes that there are a range of start-ups which have a unique perspective and strength of vision, are extremely innovative, and hold the potential to revolutionize the automotive ecosystem (2/2)

Company	Funding Received ($ Million)	Technology Domain	USP
FusionOps	43.6	AI - Supply Chain	Supply chain platform with embedded AI that can harmonize data from various ERP systems and support the supply chain business
Faxi	9	Mobility	The only SaaS platform that addresses the key objections that prevent employers from connecting co-workers to enable shared commuting
Lynx	11	In-vehicle Infotainment	Manufactures, develops, and sell s proprietary hardware and software platforms for the automotive industry. It aims to serve tier 1 suppliers and vehicle manufacturers
SHIFTMobility	2	Aftermarket	Brings various aggregators, such as distributors, service centers, and manufacturers, under one mobile platform
MaaS	2.46	Mobility	Integrated mobility platform that brings every type of transportation together under an intuitive single platform in a mobile app
Autonative	Not Available	Aftermarket Digital Platform	Online e-Commerce platform that helps OEMs sell their parts for B2C and B2B
Bolt Mobility	1	Mobility	Electric 2 wheeler with advanced 4G connectivity and a 7” touchscreen
Ubeeqo	4	Mobility	Public car sharing in major European cities and a revolutionary mobility app
Oxbotica	2.2	EVs	Autonomous control system is a vehicle-agnostic operating system that can work on anything - from forklifts to cargo pods and vehicles
Smove	10.6	Mobility	Innovative car sharing solution with EVs in Singapore
Future Mobility	10.6	Mobility	First car is likely to have a price tag of about $43,700 (RMB300,000)
VocalZoom	10.6	HMI	Advanced microphone for voice recognition, with optical laser technology

Source: Frost & Sullivan

Source: Frost & Sullivan

APPENDIX

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Principal abbreviations

ADAS	*Advanced Driver Assistance System*	**IOT**	*Internet Of Things*
AI	*Artificial Intelligence*	**JLR**	*Jaguar Land Rover*
AM	*Aftermarket*	**K**	*Thousand*
APAC	*Asia Pacific*	**KM**	*Kilometre*
B	*Billion*	**MIT**	*Massachusetts Institute of Technology*
B2B	*Business To Business*	**MPV**	*Multi-Purpose Vehicle*
B2C	*Business To Consumer*	**NA**	*North America*
CAGR	*Compound Annual Growth Rate*	**O2O**	*Online-to-Offline*
CO2	*Carbon Dioxide*	**OEM**	*Original Equipment Manufacturer*
DAS	*Driver Assisted System*	**OLED**	*Organic Light-Emitting Diode*
DIFM	*Do It For Me*	**OS**	*Operating System*
DIY	*Do It Yourself*	**OTA**	*Over The Air*
ECG	*Electrocardiogram*	**PHV**	*Private Hire Vehicle*
EU	*European Union*	**SUV**	*Sports Utility Vehicle*
GDP	*Gross Domestic Product*	**TNC**	*Transport Network Companies*
GPS	*Global Positioning System*	**UK**	*United Kingdom*
HAD	*Highly Automated Driving*	**US**	*United States*
HVAC	*Heating, Ventilation and Air Conditioning*	**V2V**	*Vehicle To Vehicle*
HWW	*Health, Wellness & Wellbeing*	**V2X**	*Vehicle To Everything*

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