

D R A U P
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Autonomous Vehicle: *Future of Automotive industry*

Zinnov Point of View

July, 2018



\$2.2 Trillion

Potential savings in the areas of fuel efficiency, cost of life and productivity gains enabled through AV based business models in US by 2020

\$87 Billion

Estimated worth of Autonomous Vehicle Industry by 2020

1 Million

Potential Job loss in US by 2020

12%

Expected AV market share as percentage of total worth of Auto industry, in 2020

2,000

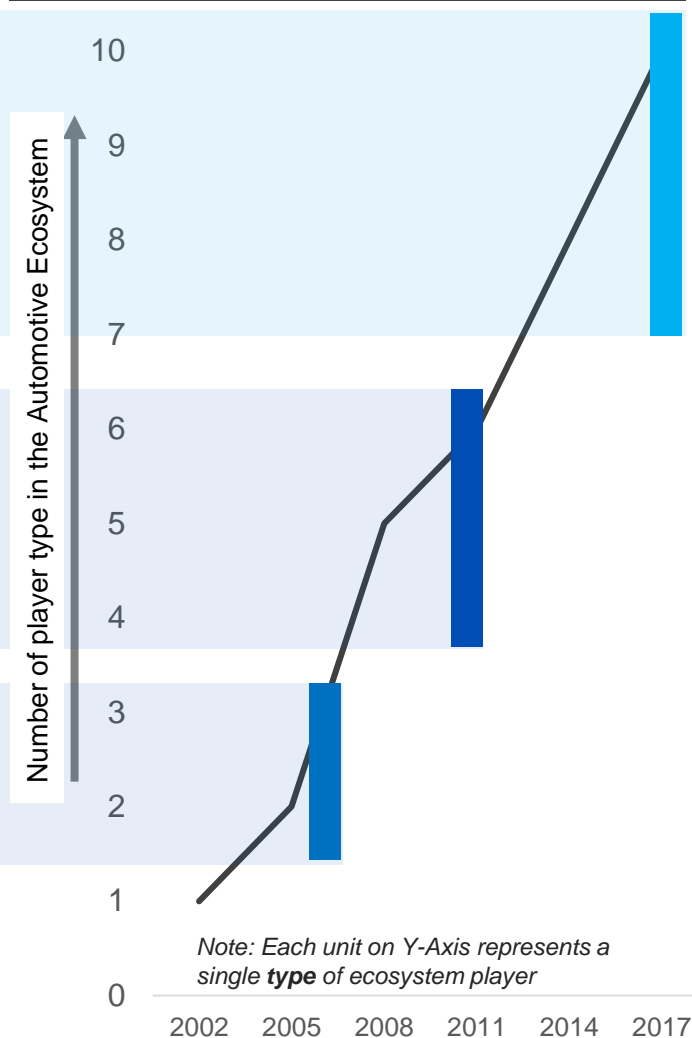
Number of global AV start-ups in 2020, a five-fold increase from present day

The traditional automotive industry is getting disrupted due to technology providers across diverse industry segments

Automotive Ecosystem has been disrupted through digital mega innovations

Smart Mobility	Telecom: 5G Infrastructure	verizon
	Insurance Providers: Usage based Insurance	IMS
	Cloud Platforms: Data Management & Security	Microsoft
	New Age Suppliers: ADAS Systems & Components	Mobileye, Velodyne LIDAR
Internet Age	Data Services: Connected Car	HARMAN
	Mobility Services: Alternative Ownership	Go
	Tech Mafia: Car OS, HMI	Google, Apple
Silicon Evolution	Consumer Electronics: Infotainment OS	Qualcomm, Microsoft
	Semiconductor Giants: SoC Processors	Intel
Automotive 1.0	Traditional Suppliers: Telematics equipment	TOMTOM

Ecosystem maturity trend during last 15 years

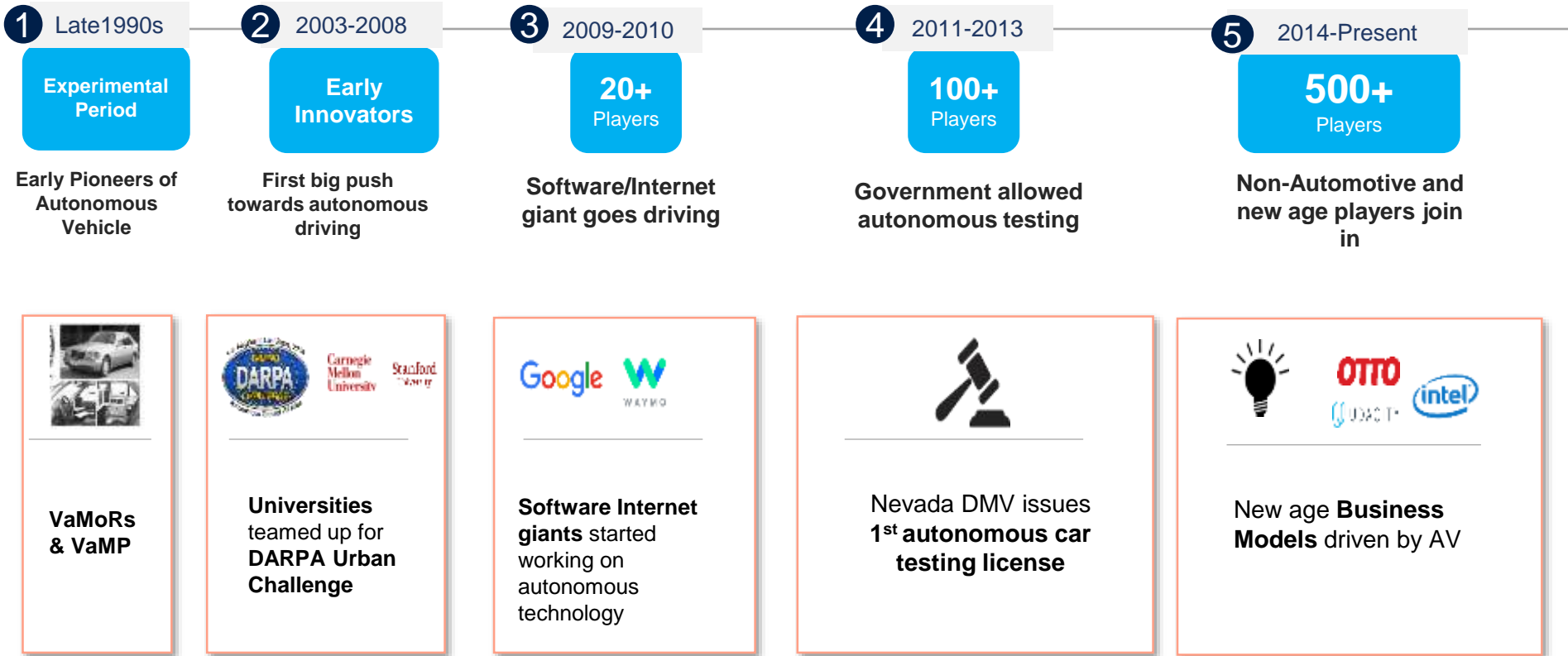


- **Traditional suppliers** such as Bosch and TomTom have enabled advanced vehicle navigation and monitoring through specialised telematics equipment
- **Semiconductor** giants such as Intel and Nvidia have developed **specialised SoCs** for processing and computing large amount of vehicle datasets
- **Tech Mafia** have transformed the vehicle into a **software computing system** with capabilities to take autonomous decisions
- New age suppliers have built capability into **Advanced vehicle control using deep learning, sensor systems and connectivity services**
- The current **Autonomous Vehicle** ecosystem has been rapidly growing through a rich infrastructure of network, cloud & insurance providers enabling **new age business models**

Note: The timeline above is illustrative of landmark events in the autonomous vehicle ecosystem during the last 15 years. The list above is non exhaustive

DRAUP Engineering Module: The platform tracks real time insights and developments in the Autonomous Vehicle Ecosystem such as global engineering footprint, product launch, Leadership Announcements, M&A, among other essential insights

Early autonomous vehicle prototypes were limited to experiments, but today more than 500 organizations are disrupting this space

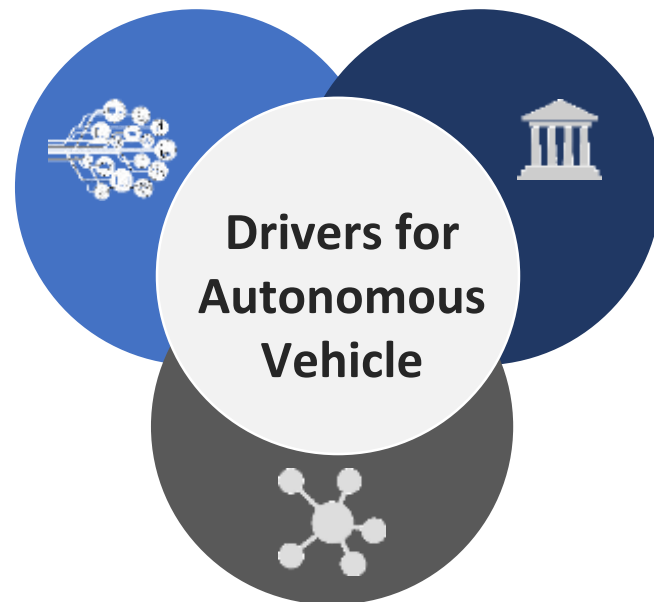


- 1 **German Pioneer Ernst Dickmanns** at Bundeswehr University Munich introduced vehicles with basic sensors and microprocessors
- 2 **Universities** teamed up with OEMs such as GM and VW to **test early prototypes** such as LiDAR & navigation systems during the first **DARPA Challenge**
- 3 **Google's Self Drive Project** (Now **Waymo**) launched a fleet of 7 Toyota Prius hybrid in 2010 and tested for more than 140,000 miles on public roads
- 4 **Currently 41 states in US** have considered legislations for autonomous vehicle testing. Germany, Japan and Israel have also allowed AV testing
- 5 New age disruptors such as **Otto** launched autonomous truck delivery, **Udacity** open sourced self-driving vehicle data. **Semiconductor Giants** started acquiring mature AV providers through acquisitions and partnerships
 - The current AV ecosystem consists of **500+ players** including Automotive, Semiconductor, Software/Internet and new age disrupters

Note: Timeline above illustrates landmark events in the autonomous vehicle ecosystem during the last 20 years. The list above is non exhaustive

DRAUP Engineering Module: Consists of around 180 engineering organisations and nearly 100,000 start-ups working across Automotive, Software/ Internet and other Hi-Tech verticals

Technology Advancements	Government Regulations	Open Ecosystem
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1

Technology advancement



Decline in **cost of computing** and advancement in **processing power** have enabled processing large volume and variety of data such as image, voice, text etc.



Advances in machine learning have allowed **computer vision** to compute unstructured data and distinguish objects on the road and build **3-D maps** of the surrounding area



Deep learning and **artificial intelligence** have led to better algorithms for pedestrian detection, traffic control and other automation features.

2

Political, legal and social drivers



State **legislations** related to autonomous vehicles have gradually liberalised . In 2017, **33 states** have introduced legislation related to autonomous vehicles in USA, allowing testing of autonomous fleets under certain specified conditions



Extensive government investment in key countries- US and UK governments plan to invest \$4Bn and £38Mn over the next 5 years, on driverless cars technology



Projected 20% overall reduction in road accidents- Elimination of drivers is expected to reduce driving accidents caused by human error.

3

Open Ecosystem



Collaborative and open innovation- Top player Tesla open-sourced its patents while Baidu and Lyft have open software platforms



Competitive landscape- Entrance of technology mafias which are building a competitive environment in AV through their strong capability in software platforms



R&D partnerships between universities and automakers- Toyota partnered with University of Michigan for autonomous innovation.

US states and several other nations are relieving the regulations around Autonomous Vehicle testing on public roads

Autonomous Vehicles regulations by State and Central government organisations

Regulations Passed	Legal for testing prototype with driver	Legal for testing prototype on public roads with driver	Legal for testing prototype without driver	Legal for testing prototype on public roads without driver	Semi autonomous fleet services allowed
Michigan	✓	✓	✓	✓	✓
Florida	✓	✓	✓	✓	
California	✓	✓	✓	✓	
Singapore	✓	✓	✓	✓	
Netherlands	✓	✓	✓	✓	
China	✓	✓			
Germany	✓	✓			
Japan	✓	✓			
UK	✓	✓			✓
Israel	✓	✓			

AV* Adoption Index **LOW** **HIGH**

AV*: Autonomous Vehicle

Technology Enablers **Government Regulations** Open Ecosystem

- Michigan being a traditional automotive engineering hub became the **first state** to approve the latest autonomous technology allowing automakers to test their autonomous prototypes on **public roads even without a driver**.
- Governments of UK, Japan and Germany are **cautious about the safety** of current autonomous technology. Thus they have taken proactive regulatory measures by **allowing testing only in the presence of a driver**.
- Governments in geographies such as Germany, UK and other European countries are not able to develop a **concrete regulatory framework** for testing and assessing autonomous driving because they face challenges in defining ethical laws relating to **responsibility in accidents** caused by fully autonomous vehicles.
- The Netherlands' Council of Ministers recently updated its bill to allow tests without a driver. Shanghai issued its first self-driving license, allowing automakers to test their AVs on public roads.

Open-source Ecosystem created by Technology Mafia's and new age players have created a collaborative and co-innovative environment

Technology
Enablers

Government
Regulations

Open
Ecosystem

Open-sourced Ecosystem

Open-source driving data and frameworks



OTA, Security,
Data Platform,
Simulation

Udacity

Open-sourced driving data

Github

Various open-source autonomous projects

PolySync Autonomous Kit

Open-source car control project detailing conversion of a vehicle into an autonomous driving vehicle.

Robot Operating System

Enables automakers to quickly develop and prototype autonomous vehicles and sensor-rich vehicles using predefined ROS packages.

Open-source Autonomous Car Platforms

Baidu's Apollo Project

Provides hardware platform, software platform, vehicle platform and cloud data services

OSVehicle - EDIT

Open-source self-driving car platform by OSVehicle

Lyft Open Platform Initiative

Early partners include Waymo, nuTonomy, Jaguar, Land Rover, GM

Patents and other supporting infrastructure open to 3rd parties



Patents

Tesla Motors

Open-sourced all patents on AV development



Supporting
Infrastructure

Comma.AI

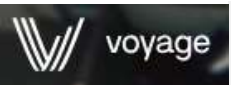
Comma Neo: Open-source robotics platform

Wind River Rocket

Open-source embedded operating system

Uptane

Open-source Cybersecurity framework

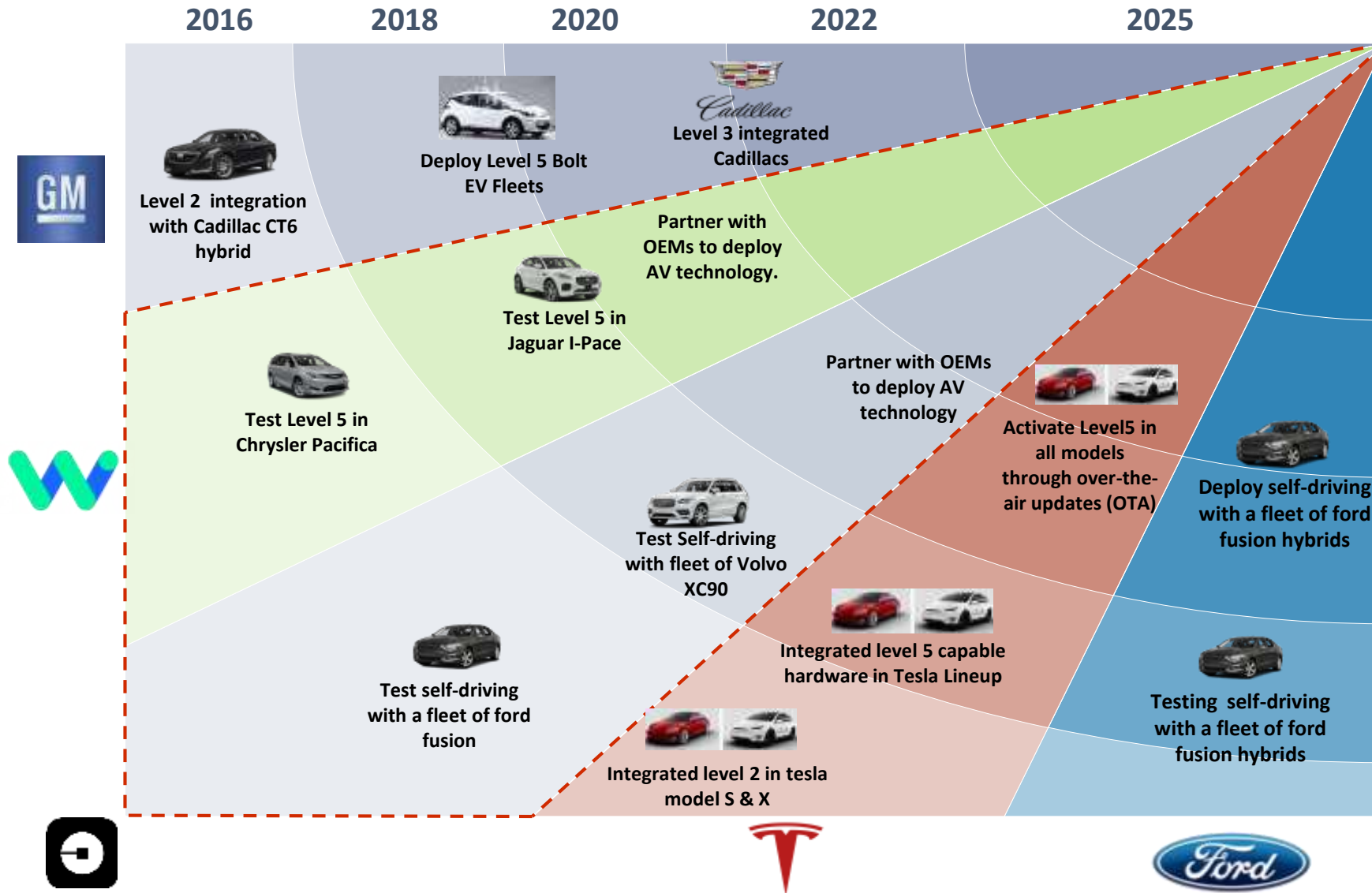


Voyage, the self-driving car spin-out from Udacity, has open-sourced its approach under an Open Autonomous Safety initiative. It has also deployed 5 Level-4 autonomous vehicles in retirement communities in California and Florida.



StreetDrone is another UK based start-up developing open source self driving software and automotive car models on the Renault Twizy.

Electric Autonomous Cars such as Hybrid, Plug-ins and Plug-in hybrids autonomous cars to cover the urban transportation landscape by the next decade



- **58% of autonomous light-duty vehicle models are currently built over an electric powertrain while a further 21% utilize a hybrid powertrain**, according to a testimony submitted at the House Energy & Commerce Committee.
- Top drivers for Electric Autonomous Vehicle adoption :
 - **Regulatory restrictions** relating to gas-mileage requirements.
 - Electric cars are easier for computers to drive due to **fewer moving parts and low maintenance.**
 - **Wireless charging integrates** seamlessly with autonomy
- Self driving cars to populate urban areas first due to better availability of charging stations. The US Department of Energy lists around 36,000 such charging stations across America.

Note: The infographic above shows analysis done on specific companies. There are several other companies working towards the automation of electric vehicles. The above analysis is based on the DRAUP's proprietary engineering database and insights from industry stakeholders, updated as on Feb, 2018

China leapfrogging in EV sales and production (up 53% over 2016) is a key hotspot for Electric –Autonomous vehicles as more and more Chinese start-ups are focussing on developing EV-AV integrated vehicles

Key Chinese EV start-ups with Autonomous Focus

	 NIO	 Weltmeister	 X P E N G	 车和家 CHJ-AUTOMOTIVE	 BYTON
Year Founded	2014	2015	2015	2015	2016
Capital Raised	\$2.1 Billion	\$2 Billion	\$840 Million	\$700 Million	\$240 Million
Production Model Launch	2017	Q3 2018 (expected)	Q3 2018 (expected)	2019 (expected)	2019 (expected)
Self-driving Car Partners					AURORA
California/China Test Permit	Yes/Yes	No/No	No/No	No/No	No/No

China Ecosystem Insights

- With the Chinese government’s motive to make EVs account for 12% of overall cars sales by 2020, EV makers sold **777,000 vehicles in China in 2017** (2.7% of total car sales) vs **200,000 cars in the US** (1.2% of the total car sales)
- This leap in Electric Vehicles sales and production coupled with the fact that Electric cars have fewer moving parts and less maintenance overheads, has pushed Chinese Autonomous Vehicle and Electric Vehicle makers to conceptualise Autonomous Electric Vehicles.
- Chinese government has set up **Autonomous car demonstration zones in Shanghai, Hangzhou, Chongqing and Wuhan** and has allowed open road testing in Beijing. With this easing of regulations, Chinese Autonomous start-ups headquartered in Silicon Valley, such as **Pony.ai and JingChi have shifted their HQs back to China.**
- Chinese Internet firm LeEco also announced an autonomous EV concept project, called LeSee, backed by \$1 billion in capital investments from Lenovo

Note: The above analysis is based on the Office of Beijing Municipal Public Security Bureau and DRAUP’s proprietary engineering database and insights from industry stakeholders, updated as on Feb, 2018

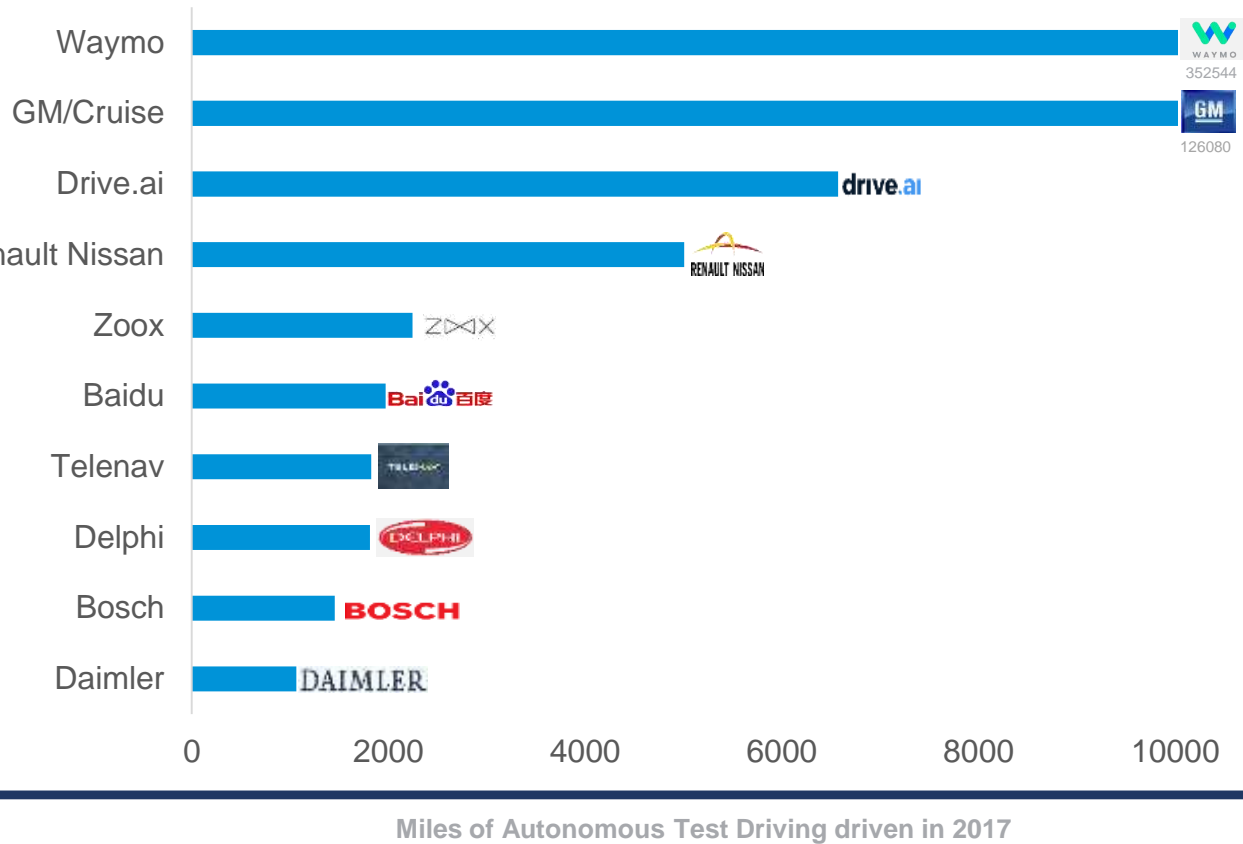
New Business Models such as shared service model and fleet owned taxis for self-driving cars would replace the traditional car ownership model

Service and public utilization based models to dominate while traditional ownership model to diminish

	Business Model	Description	Examples
Emerging Models	Individual Owned Shared Service Models	Privately owned vehicles provide ride hailing/sharing service when owner is not currently using it.	Uber, Lyft
	Fleet Owned Taxis	Service company operates fleet of autonomous vehicles to provide mobility services	Waymo, NuTonomy, Lyft
Potential Models	Vehicle Licensing	Consumers pay owner for the use of vehicle in the	Customizable rental programs
	AV-enabled software packages	Services and software that unlock full autonomous capabilities	Productive software suites
	Retrofit	Package of Hardware and Software to retrofit fully autonomous capabilities on selected vehicles	Comma One

Level 5 Autonomous Vehicles have Millions of Test Miles to complete before they can be Consumer Ready; Companies are investing in Simulation platforms

Autonomous Test Miles Driven In California (2017)¹



Miles to Go

Industry Standard
11 Billion Miles
(to reach required safety levels as per industry consensus)

Waymo
7 Million of Autonomous Test Miles since 2009

Uber
3 Million Autonomous Test Miles driven since 2016

AV Simulation Testing Providers



- **Waymo** and **GM** seem to be way ahead of the competition when it comes to real world tests but are way behind the Industry Standard
- On-Road testing is a very lengthy process which could take years to complete. Hence companies are shifting their focus towards **simulated testing** which can simulate all aspects of the autonomous drive without posing any risk to pedestrians or other motorists
- **OEMs** are still figuring out the right balance of testing AVs in real world scenarios and **simulated environments**.
- Companies like **Tesla, Apple** and **BMW** rely mostly on simulated testing of AVs
- Companies like **NVIDIA, Electrobit, Cognata** currently provide Simulation solutions for AV testing
- Testing through simulations also gives the ability to test countless variations in road conditions, scale and cost.
- Research done by RAND Corporation suggests that autonomous vehicles need to drive **11 billion miles** in testing before being ready for consumers while the company with the highest autonomous miles, Waymo has only completed 7 million miles in 10 years.

Note: 1-The data retrieved from the website of California DMV. The data reflects the number of test miles covered by AVs in the state of California from December 2016 to December 2017.

The current Autonomous Vehicle Technology Stack comprises of diverse technology providers across components, platforms and full stack autonomous solutions

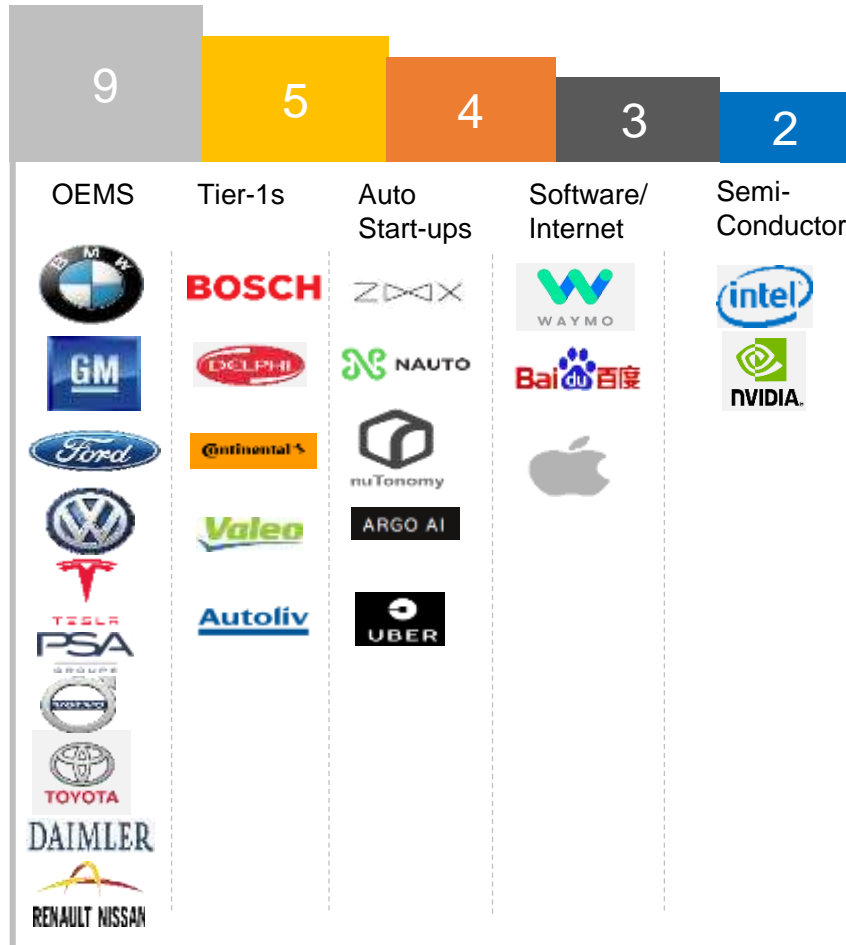


Note: The illustrated list of companies is not exhaustive;

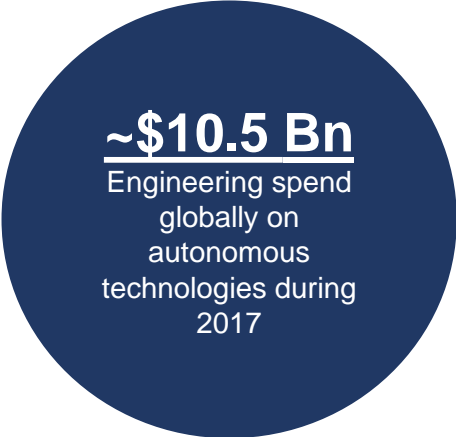
The above analysis is based on the DRAUP's proprietary engineering database and insights from industry stakeholders, updated as on Feb, 2018

25 players

Cumulative investment in Autonomous Vehicle by top 25 players



Autonomous Vehicle In-house¹ technology spend



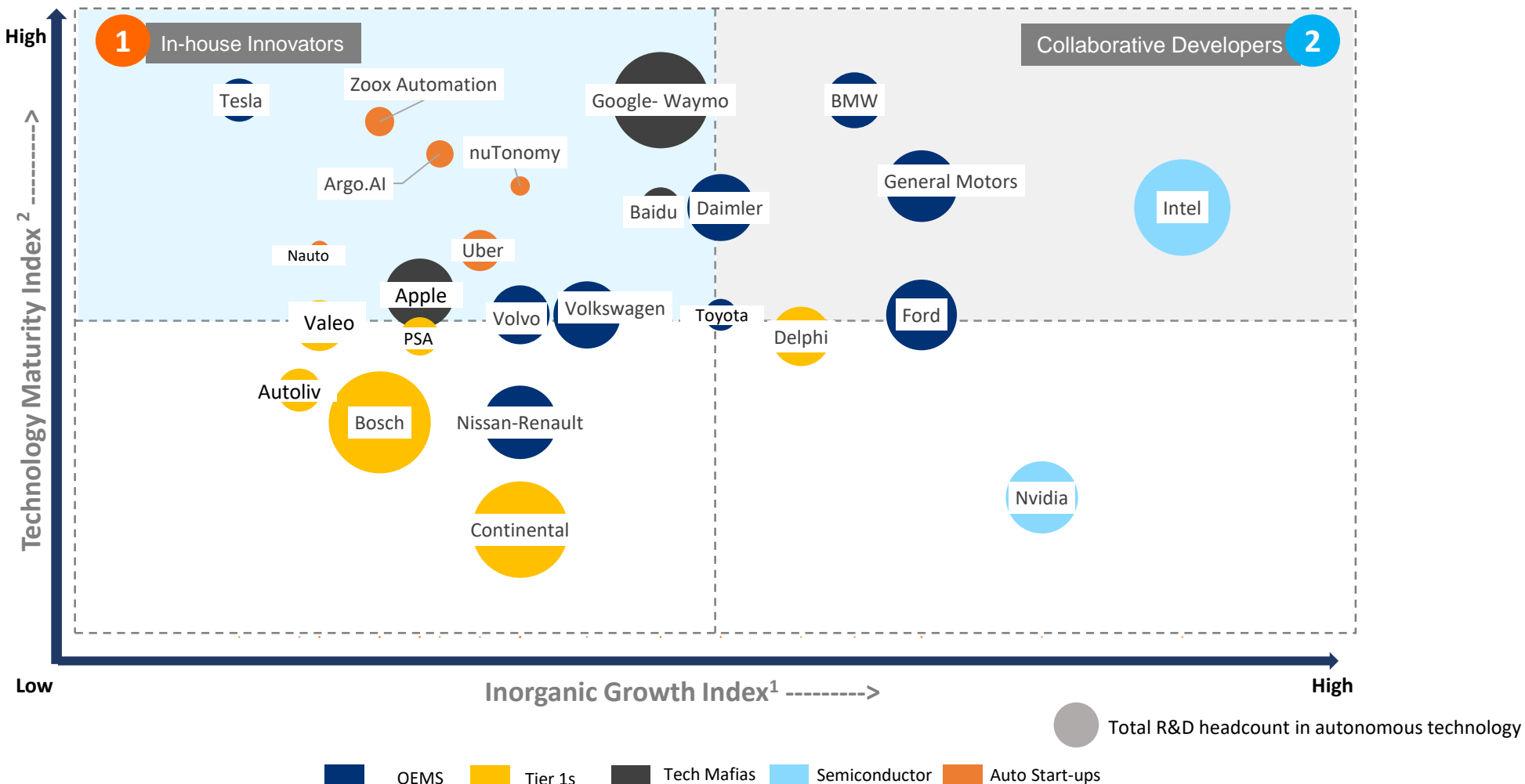
Autonomous Vehicle External² technology spend



Note: 1-AV In-house Technology spend: includes salaries and compensation along with spend on software, platforms and hardware tools required to develop In-house capability;
2-External Technology Spend: Consists of investment in Autonomous Vehicle and related technology areas through Acquisitions, Partnerships and Corporate Venture Arms;
The above analysis is based on the DRAUP's proprietary engineering database and insights from industry stakeholders, updated as on Feb, 2018

Two type of organisations are accelerating Autonomous Vehicle Ecosystem: In-house Innovators vs Collaborative Developers

Autonomous Vehicle Capability & Investment Analysis



1 In-house Innovators

- **Start-ups** and **Tech Mafias** have been investing in Autonomous Vehicle platforms and Vehicle Operating Systems, leveraging their strong software capability
- Key technology focus areas of these companies are **Deep learning** for vehicle control and **Computer Vision** for environment perception and sensing

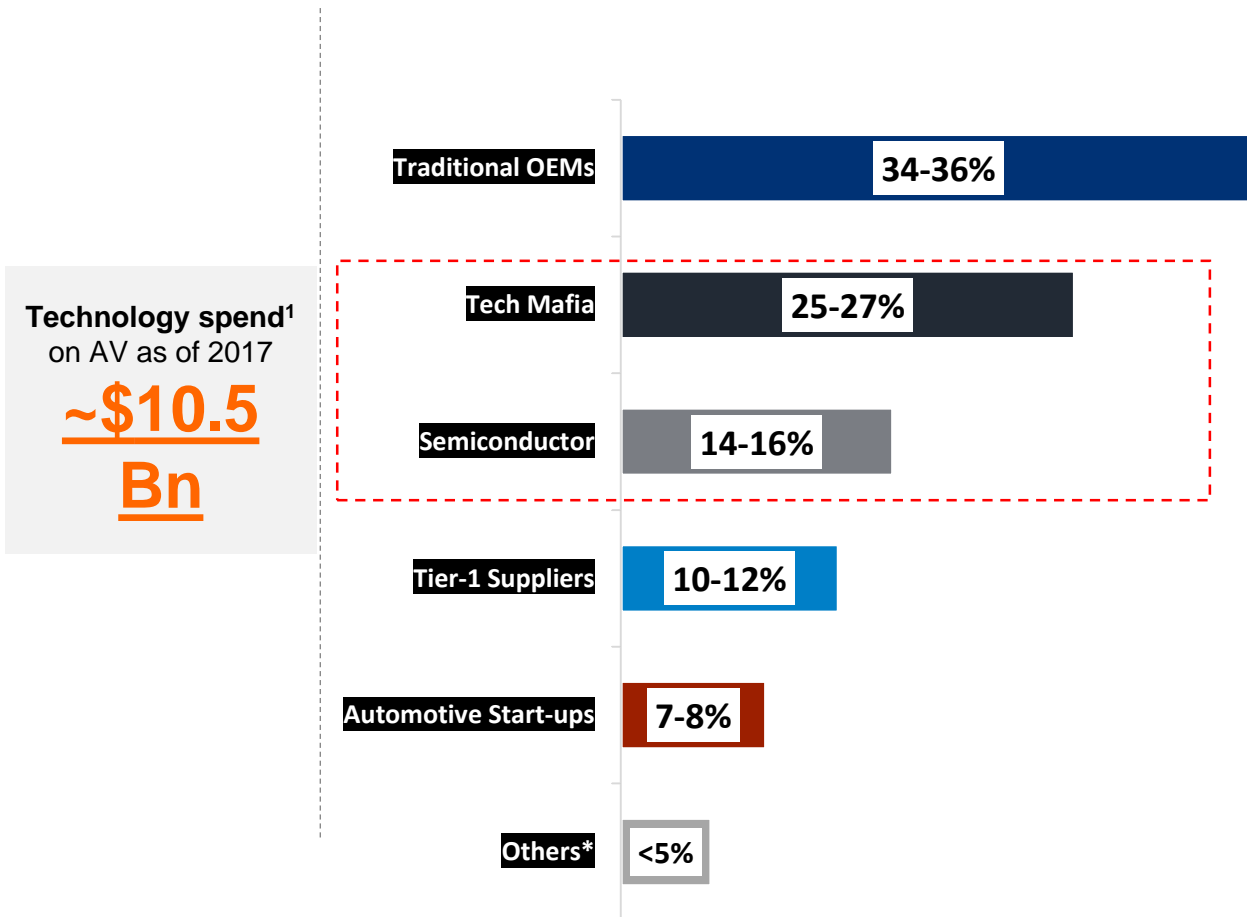
2 Collaborative Developers

- **Semiconductor** giants such as Intel and **OEMs** such as BMW, Toyota and GM have established strong consortium to co-innovate
- These players have also acquired many companies which offer **full stack Autonomous Vehicle** solutions. Some of the significant acquisitions being **Mobileye (by Intel)** and **Cruise (by GM)**

Tech Mafia and the Semiconductor giants are spending heavily alongside Automakers to develop strong Autonomous Vehicle capability

In-house Innovators

AV Spend by Industry Verticals



Note: The numbers above are rounded-off, so they might not add up to 100%

Others* include Telecom, Data Services, Insurance and other AV related infrastructure providers

- **OEMs** have strategic focus on developing critical **safety and driving systems** in-house. OEMs such as Daimler, BMW and Ford are establishing partnerships with technology providers to collaboratively develop software capability for vision and perception systems
- **Semiconductor** giants such as Intel and Nvidia have developed **specialised Autonomous Vehicle SoCs** for processing and computing using ML algorithms
- **Tech Mafia** giants are differentiating through strong AI capability leveraging **deep learning algorithms required to make advanced driving systems safe and predictable**
- **Tier-1 suppliers** such as Bosch, Delphi and Continental are major players providing **Sensor Systems such as Lidar, Radar and Ultrasonic sensors**
- Autonomous Vehicle **start-ups** have received nearly **~\$ 3.5 Bn+** in VC funding as of Feb, 2018. **Full stack ADAS providers** is the most funded segment. **Nauto, Argo AI and Drive.ai** are the top players investing in full stack- Autonomous Vehicle solutions

In-house R&D is focussed on developing core software capabilities, leveraging deep learning for computing, vehicle control and vision-based perception

In-house Innovators

Total In-house Technology Spend¹

USD \$ 10.5 Bn

Technology Segments

3D mapping/ Localization

11 %

Vision based perception

24 %

HMI/ UI-UX

10 %

Computing & Vehicle Control

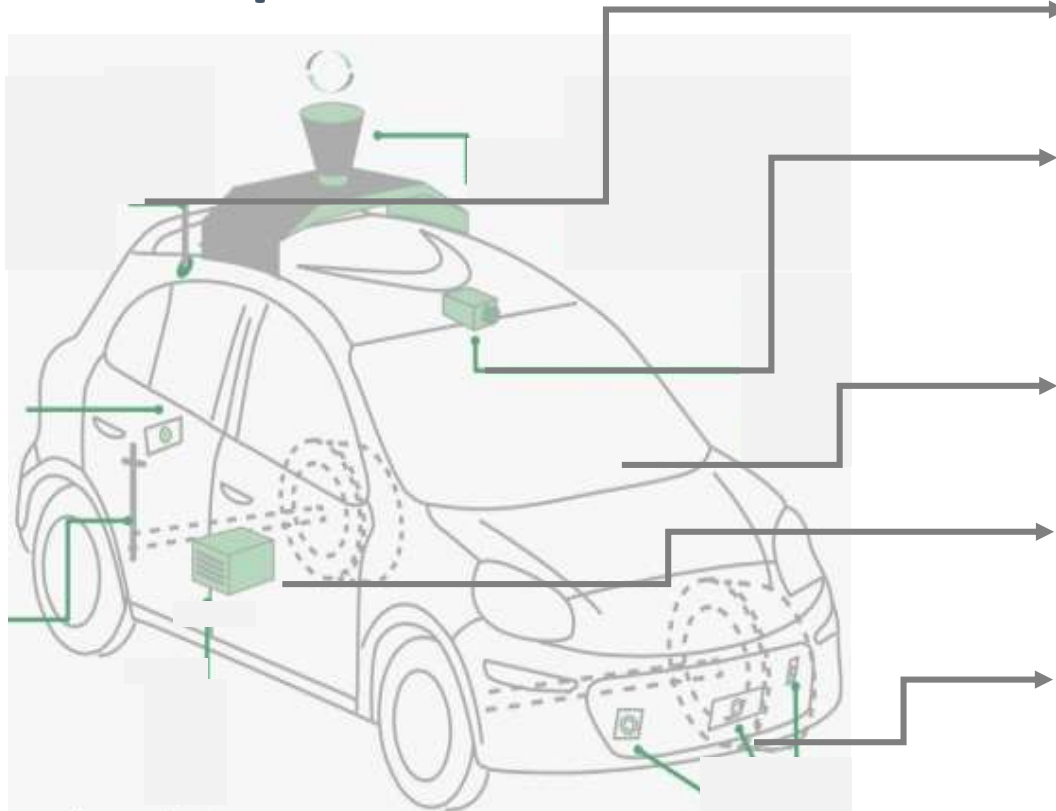
30 %

Sensors

20 %

Network, Connectivity & Security

5 %



Note: The numbers above are rounded-off, so they might not add up to 100%

INSIGHTS

High resolution HD Maps enable precise lateral and longitudinal positioning for vehicle localization

Computer Vision systems use advanced **deep learning to aggregate, classify and identify critical environment data** such as obstacles, pedestrians, traffic signs etc.

HMI is crucial to optimally support the driver in the **monitoring and remotely control autonomous cars** and to give access to live sensor data and useful data about the car state, such as current speed, engine and gear state

Using Neural Networks, **the vehicle brain** analyses all sensor input and operates steering, accelerator and brakes for critical driving decisions such as **collision warning, cruise control and advanced safety**

Lidar, Radar, Odometry and Ultrasonic sensor systems for lane centering, path planning and V2V communications

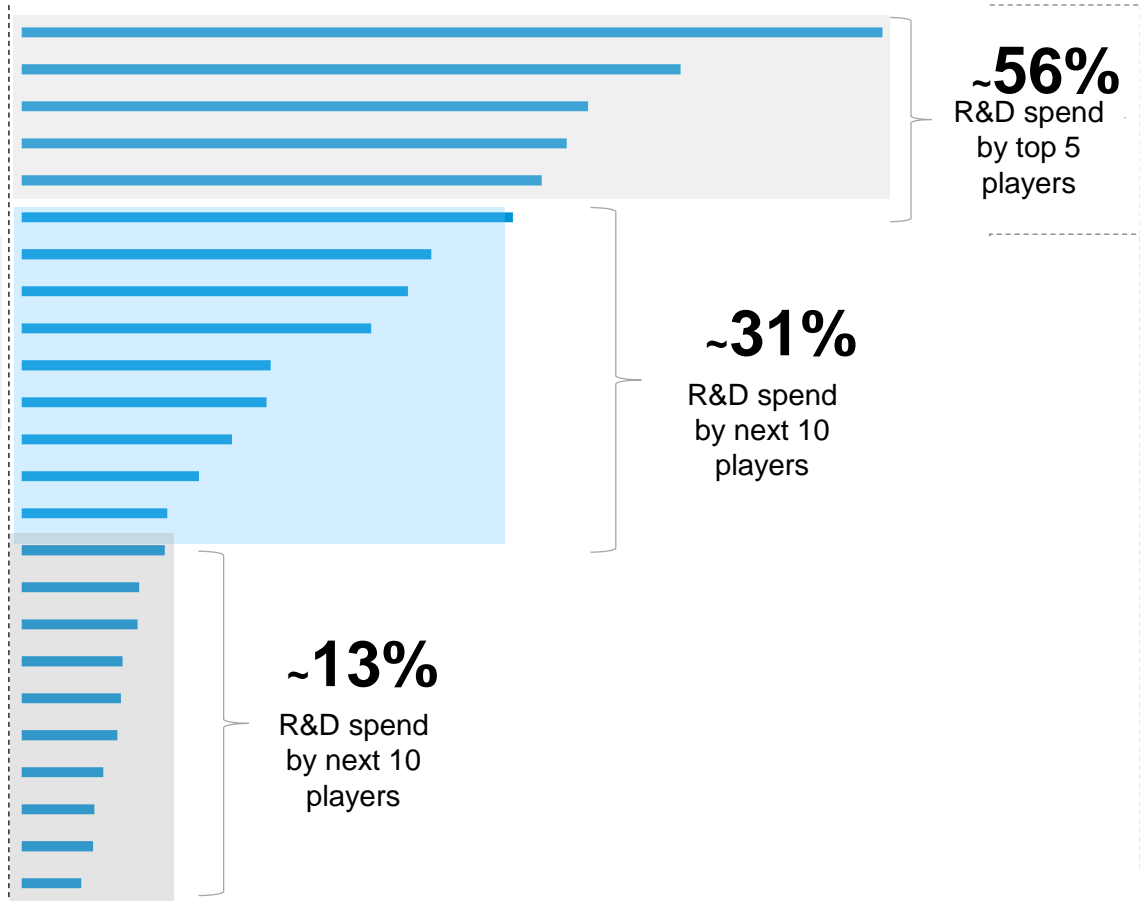
Advanced vehicle connectivity infrastructure to enable communication between vehicles and environment (V2V, V2X)

Technology spend by the top 5 players is largely focused on developing full stack solutions, robust sensor systems and advanced computing platforms for vehicle control

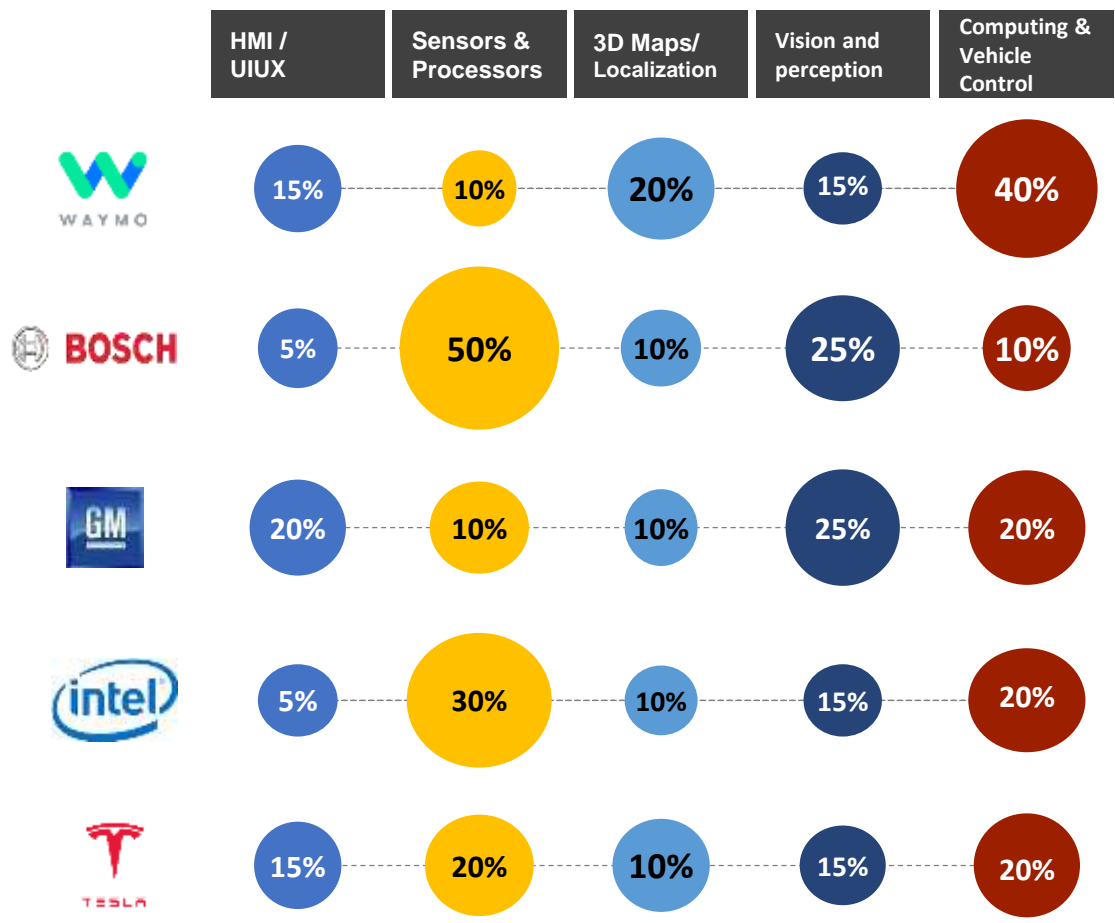
In-house Innovators

Autonomous Vehicle in-house technology spending analysis

\$10.5 Bn
In-house
R&D Spend



Focus Areas of top 5 Players



Note: The numbers above are rounded-off, so they might not add up to 100%

Note: 1-Technology spend includes employee compensation and related expenses along with spend on software, platforms and hardware tools required to develop In-house capability; The above analysis is based on the DRAUP's proprietary engineering database and insights from industry stakeholders, updated as on Feb, 2018

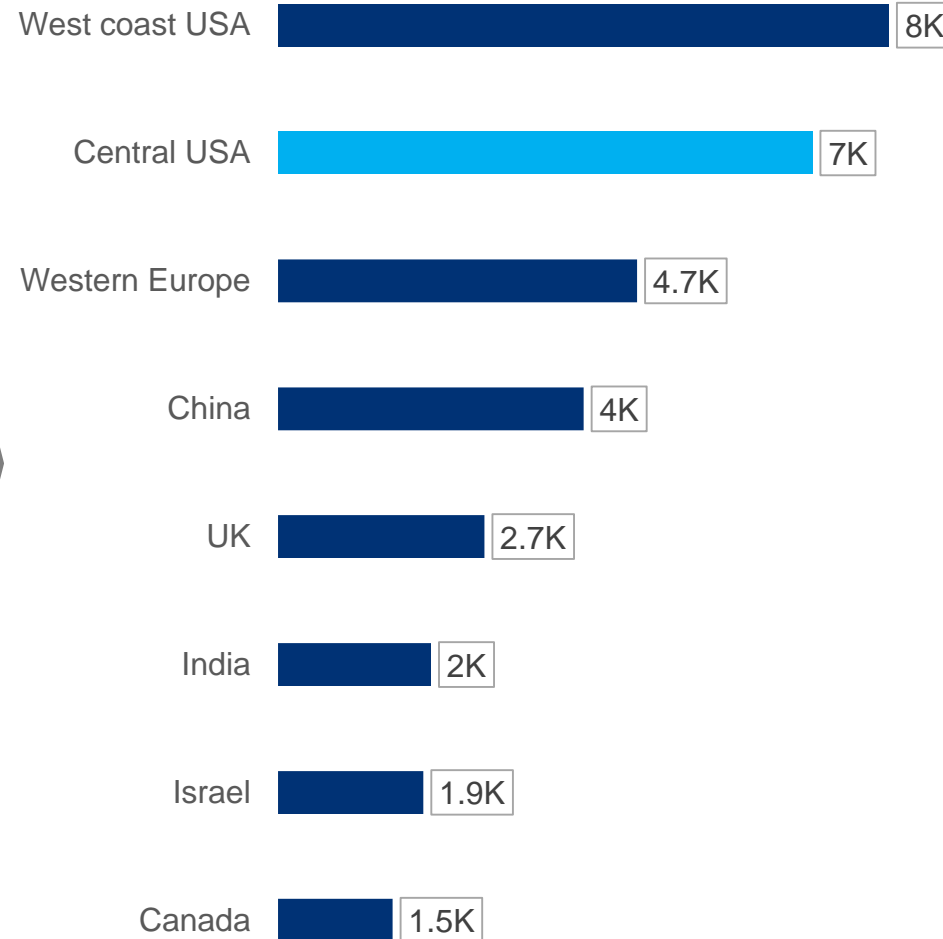
While the AV talent footprint is distributed across global locations, US and Europe are the hotspots with nearly 50% of talent consolidated between these two regions

In-house Innovators

Geographical split

Global Autonomous Vehicle
Engineering Headcount

38,000 – 43,000



- **USA- Bay Area** is a technology hub for engineering talent in **Machine learning, Computer vision and AI**
- **Global automakers** such as GM, VW, Toyota have opened **R&D facilities in Bay area** in the last 2 years to leverage these new age engineering skills and lead the autonomous revolution.
- **Western Europe** is a hotspot for traditional automakers. Bosch has built a \$1.1 Bn R&D facility in Dreden, Germany for developing hardware components required for autonomous vehicles.
- **UK and Israel** are mature autonomous start-up hotbeds for autonomous innovation, with top **start-ups** such as **FiveAI, Oxbotica, Mobileye and HERE maps. Daimler** recently opened a R&D centre in Tel Aviv and **Jaguar Land Rover** opened a new UK R&D center highly focused on autonomous R&D.
- **China – Baidu** is a leading player in the Chinese landscape. It has more than 50 partners for its **open source Apollo Project**, which has created a collaborative ecosystem for autonomous technology development
- **India-** Top tier 1 player **Bosch** has its 2nd largest R&D centre in India focused on sensor system and computer vision

Note: The numbers above are estimated R&D headcounts in respective locations updated as of 1st quarter of financial year 2018

Note: Geographical split indicates only the prime Autonomous Vehicle R&D locations. Primary locations in West Coast include California, Washington and Seattle and Central US include Michigan and Ohio; The above analysis is based on the DRAUP's proprietary engineering database and insights from industry stakeholders, updated as on Feb, 2018

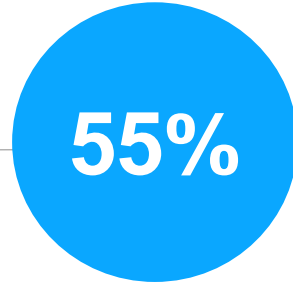
In Bay Area, Automakers have established AV innovation labs to collaborate with Tech Mafias and disrupters, and explore new AV enabled mobility solutions

In-house Innovators

~5,200
Bay Area

Autonomous Vehicle Engineering
Headcount in Bay Area

Innovators



Google's **Core R&D team of ~1,000 engineers**, located in the Bay Area, is largely focused on developing deep learning software capability for advanced vehicle control and automation



Tesla is building **critical ADAS systems in-house** and leveraging partner network with Nvidia and Bosch for autonomous hardware capabilities.



Invested **\$14 Mn on the new expanded R&D facility in California** and plans to add 1,100 workers to it's new acquisition team at Cruise Automation

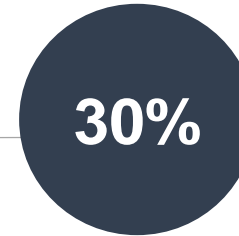


Opened a new **Automated Driving Group in Silicon Valley** and plans to invest \$250 Mn on self-driving tech via its Intel Capital investment arm. Intel also has 3 other autonomous R&D labs in Arizona, Germany and Oregon.



Uber poached around 50 researchers and engineers from Carnegie Mellon University's Robotics Institute to build its autonomous capability

Followers



To invest **\$1 Bn in San Francisco** over next five years in AI and self-driving cars R&D



Invested **\$1 Billion** in AI startup Argo AI; Developed aDRIVE gaming environment for autonomous test driving



VW works in partnership with **Stanford University** for autonomous driving. Its research lab -**Volkswagen Automotive Innovation Lab** is located within the Stanford University campus

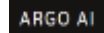
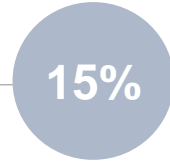


Acquired **HERE maps** for 3D mapping technology



Bosch has an autonomous driving solutions center in Palo Alto. It partnered with Daimler to launch automated valet parking system

Emerging Players



Collaborative Developers

Total investment spend to acquire AV capability

~\$ 22 Bn

SEMICONDUCTOR

OEM

TECH MAFIA

~\$18 Bn

~\$3 Bn

~\$1 Bn

Top Acquisitions



→ Corporate VC Spend → Acquisition

2

...acquiring highly mature solutions to develop AV capability in emerging areas

DRAUP
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Collaborative Developers

\$\$ Represents investments
- Represents acquisitions

AV acquisitions by technology focus areas

1 3D Maps/HMI

2 Sensors, GPS & other / Vision & Perception

3 AI Platforms for Vehicle Control / Full Stack AV solutions

High

Acquisitions Maturity¹

Low

2013 2014 2015 2016 2017

Year of Acquisition

Google--Waze

Nvidia \$\$ Almotive

Bosch \$\$ Almotive

Delphi--Ottomatika

GM--Cruise Automation

GM+BWM+Audi--HERE

Continental--Elektrobit

Continental--Advanced Scientific concepts

BMW, Toyota \$\$ Nauto

Intel--Itseez

Uber--Otto

Ford--SAIPS

Ford \$\$ Civil Maps

Ford \$\$ Velodyne Lidar

Baidu \$\$ Velodyne Lidar

Intel--Mobileye

Ford \$\$ Argo AI

Uber--Geometric Intelligence

Baidu--xPerception, KIIT, Raven Tech

1 Early Movers

Google made the inception into Autonomous Vehicle space through acquisition of mapping technology company Waze to incorporate real-time traffic data into its existing self-driving project

2 Aggressive AcquirersOEMs and Tier 1 suppliers being digitally naïve companies started acquiring mature autonomous capabilities through their **Venture arms** and **strategic acquisitions**. Some of the mature acquisitions include Cruise Automation by GM and HERE Maps co-investment by GM, BMW and Audi**3 Recent Movers****Semiconductor** giant **Intel** recently made **the biggest acquisition in the AV ecosystem**, investing **\$16 Bn** to acquire core AV capabilities from **Mobileye**. It has also leveraged its partnership network to position itself as a full stack AV provider

1- Analysed Acquisition maturity with respect to the acquired technology maturity across the stack of Components, sub-systems and full stack autonomous systems

● OEM	● Tier 1	● Tech Mafia	● Semiconductor
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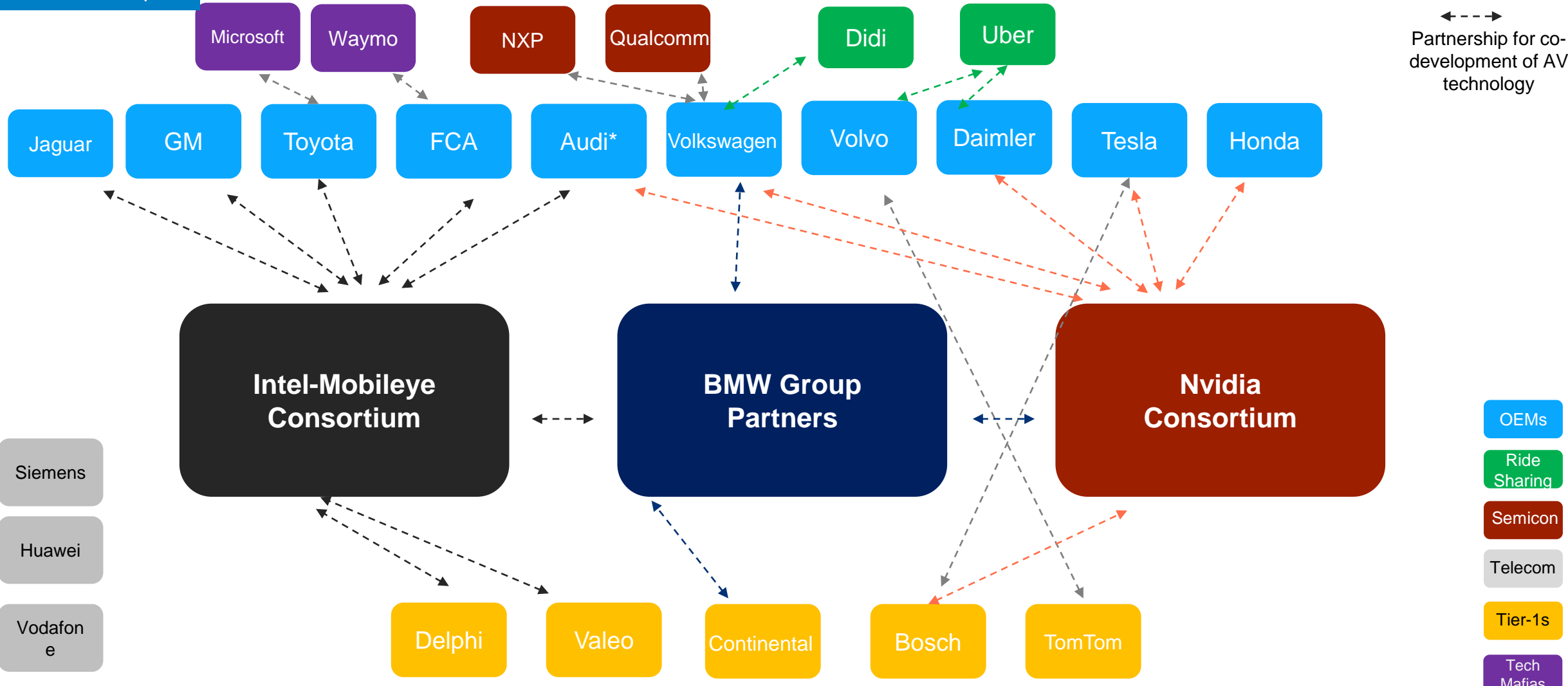
Note: List above is non-exhaustive

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Source : DRAUP 21

Incumbents have also established consortiums to co-innovate; Intel, BMW and Nvidia have the most robust partnership networks among their peers

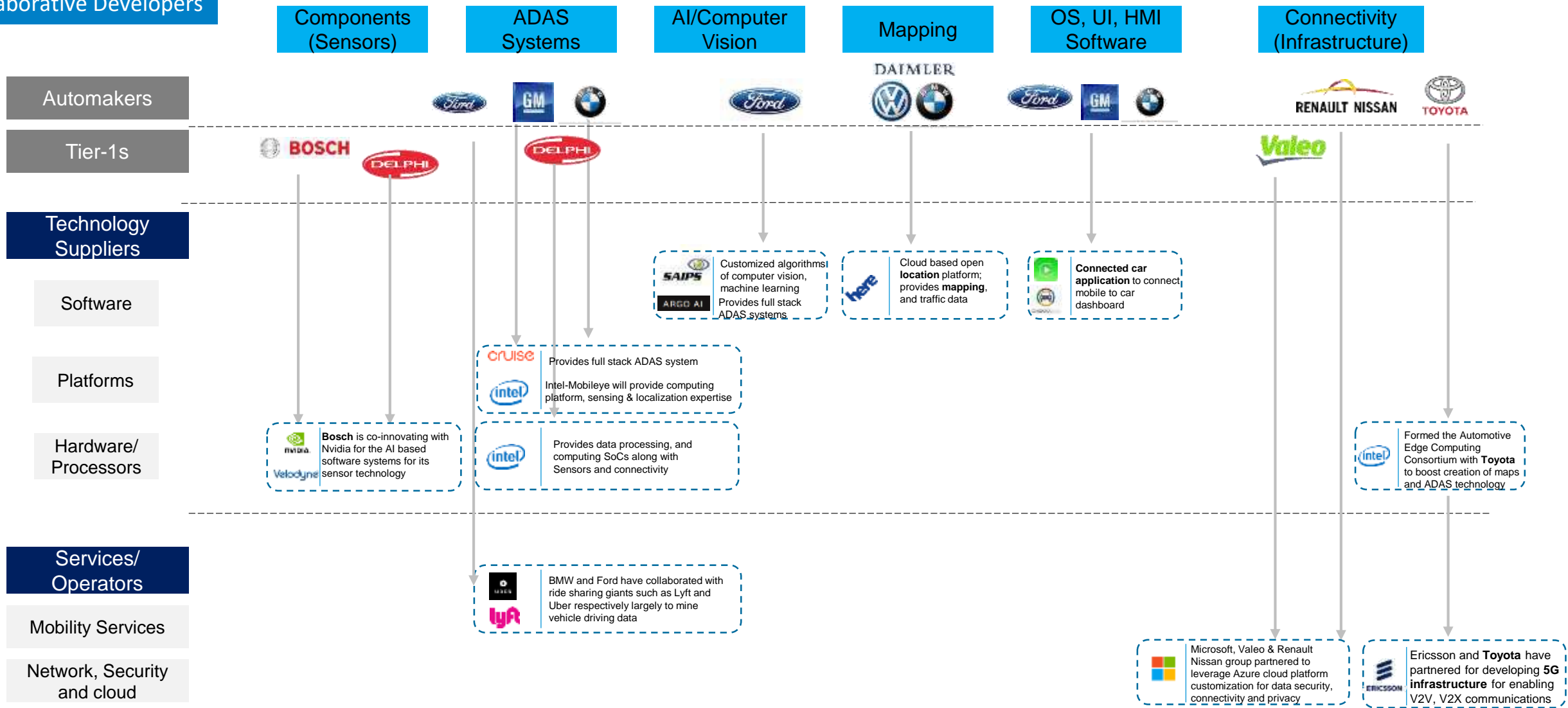
Collaborative Developers



* Part of Volkswagen Group

Automakers are thinking ahead and collaborating with Technology providers and disruptors to move beyond their traditional business segments

Collaborative Developers



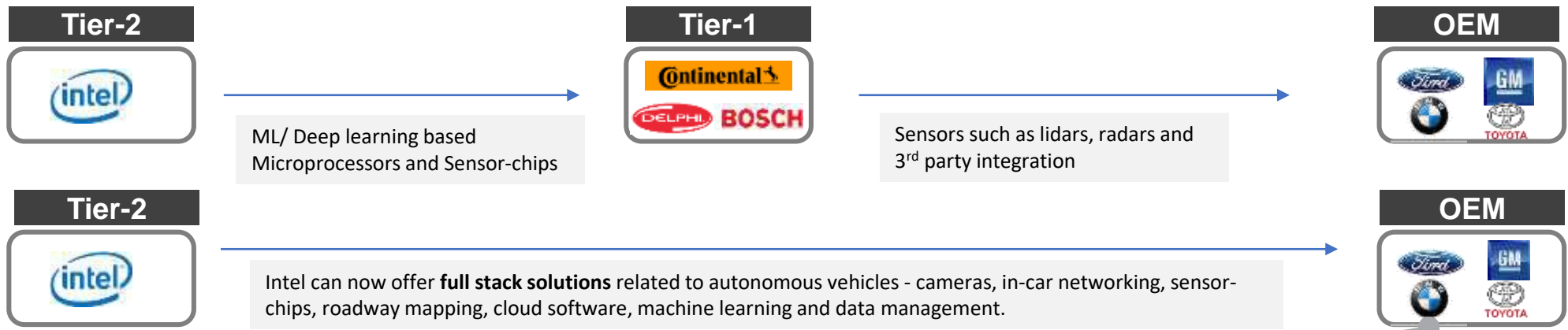
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Tier-2 suppliers are disrupting the traditional supplier relationship model to position themselves as a direct Full-stack supplier of AV solutions; **CASE STUDY-Intel**

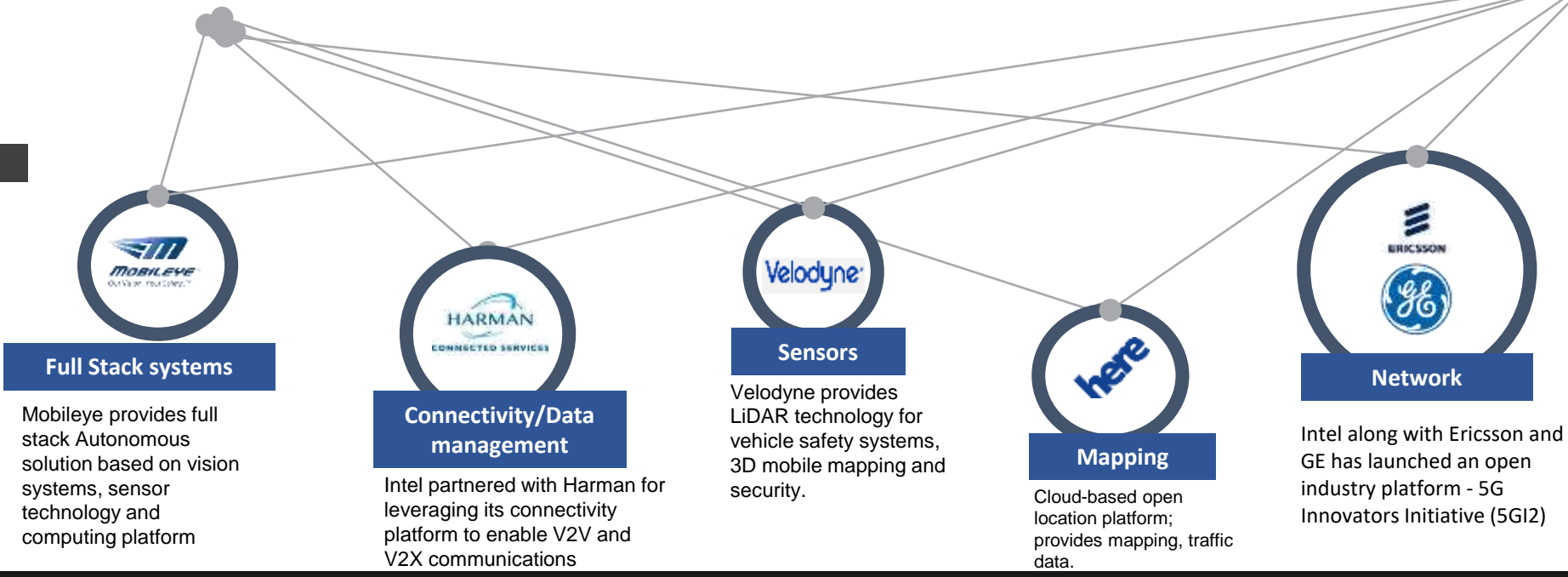
Collaborative Developers

Traditional Industry Structure

New Age Industry Structure

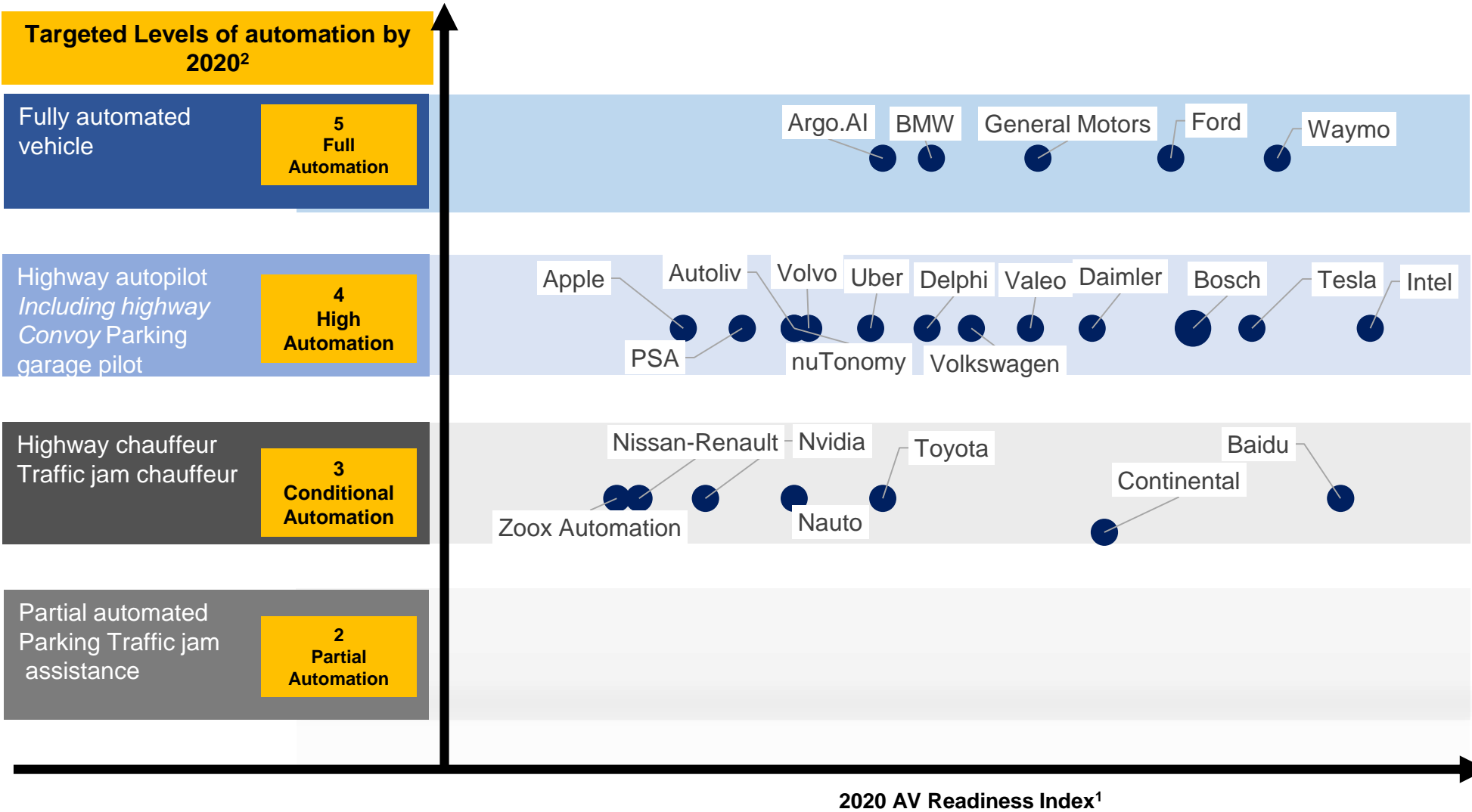


Tier-n



Bubble Size indicates size of the partner companies

Going ahead, we believe companies are committed to drive future growth in the autonomous space



- The overall Ecosystem looks populated, but through our structured research and deep dive analysis of the current capability and investment of the 25 players, we have arrived **at the league of 5** for 2020 Autonomous Vehicle launch
- **The league of 5** are well positioned and future-ready, basis their current R&D investment or via virtue of their acquisitions and/or partnerships
- **Ford** and **Waymo** have committed to attain **Level 5** automation capabilities whereas **Intel**, **Tesla** and **Bosch** have envisioned **Level 4** automation by **2020**
- These players have been exploring a diverse set of GTM strategies such as partnerships with mobility providers, fleet management and personal ownership model to launch their first commercial Autonomous Vehicles by 2020

Note : **1-2020 AV Readiness Index:** Function of % R&D Talent in Autonomous Vehicle technology, External Acquisitions and Investment, patents and partnerships;
2- Function of current leadership Outlook and commitments for autonomous vehicle launch in 2020. Automation Levels as outlined by SAE updated as of 2018;
 The above analysis is based on the DRAUP's proprietary engineering database and insights from industry stakeholders, updated as on Feb, 2018



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