P3 **A**UTONOMOUS **D**RIVING
MARKET INSIGHTS

We analyze global autonomous driving ecosystems in Mobility-as-a-Service, Ownership and Freight Transport.

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DISCLAIMER

P3 autonomous mobility

P3 advises leading international OEMs, suppliers, technology and insurance companies in the field of autonomous driving and autonomous mobility.

AUTONOMOUS MOBILITY

>8	years of international experience in autonomous driving consulting
>100	customers worldwide and more than 200 successful AD projects
>50	employees around the globe in the autonomous driving space
75%	of the employees are engineers and software developers

We approach autonomous driving from many different perspectives. We understand the markets, know the players, but also have the technological know-how and the necessary software expertise.

Market & Strategy

- Go-to-market strategy
- Global market and competitive analysis for AD MaaS, TaaS & ownership
- MaaS & TaaS business model development incl. business case & TCO
- Competence analysis, assessment of “best-fit” partners
- (SDS) partnerships models and joint venture agreements
- AD shuttle / robotaxi and ADAS in-field testing & benchmarking

Technology & Regulation

- End-to-end architecture assessment and customization
- Cybersecurity, Functional Safety & SOTIF
- Regulation Implementation (AD SMS, SUMS & CSMS for SAE L3 & L4)
- Test Strategies & Management & Tool Confidence
- Sensor set evaluation and platform fortification strategies
- Support for Homologation (Type approval ODD and operation area)

Operation & Scaling

- AD Program Management incl. strategic setup, operations strategy, organizational build-up, project conduction & benchmarking
- Scaled Pilots: setup and management of runup schemes for AD pilot projects
- AD Product Lifecycle Management AD Logistics Concepts - Conceptualization of market-ready TaaS products

BUSINESS CASE, TCO & COSTS

COMPUTING HW ANALYSEN

DRIVE BY WIRE

MAAS/TAAS PILOT FLEETS

STRATEGY & DUE DILIGENCE

SENSOR ROADMAPS

E/E ARCHITECTURE

AD /SDS SW STACK

PILOT/ FUNDING PROJECTS

TECHNOLOGY SCOUTNG

V2X & OPEN API

FUSA CYBER SECURITY

PROJECT MANAGEMENT [AGIL]

REGULATION & STANDARDS

DATA & SIMULATION

TESTING & APPROVAL STRATEGY

HOMOLOGATION

P3 autonomous mobility

Market & Strategy

Overview | Our market, strategy, and technology intelligence portfolio

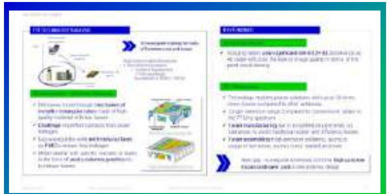
SDS-Performance/ UX Benchmark

AD Market Models EU/CN/US

Tech Stack & AD Readiness Analysis

Go-to-Market Strategy

ADAS Benchmark



Autonomous Mobility Tech Insights

AD Regulation Radar EU/CN/US

TCO Calculations for MaaS Services

Value Chain and Positioning Strategy

P3 AD market, strategy, and technology intelligence portfolio

Working closely with our Technology & Regulation and Operations & Scaling teams, we provide holistic market, competitor, and technology intelligence for your specific needs

We help our customers to master challenges and complexity and enter new or expand existing markets - with a clear guideline for a successful Go-to-market or market development strategy

Go-to-Market
Strategy & Playbook

Countries, Cities & Customers

Suggesting initial target countries and cities through a P3 city selection process, considering factors such as openness to innovation, consumer behavior, competitors, regulatory landscape, and market size.

Entry Strategy & Partnerships

Guidance on general market entry, including partnering with local companies, acquisitions, or establishing a local presence, with assessment and recommendations for potential partners.

Vehicle & Operations Requirements

Analysis of both city/government (e.g., inclusion) and fleet operator requirements (e.g., hub/service infrastructure, vehicle type), and passenger preferences (e.g., convenience vs. accessibility).

Economic Perspective

Elaboration of unit economics to ensure financial sustainability and profitability of L4 service, including reasonable revenue per ride, expected costs for fleet operations, fixed and variable costs

Data Protection & Safety

Guideline how to align data practices (e.g., with GDPR) and establish a clear framework for data sharing emphasizing privacy and compliance with local regulations

Local Authority Collaboration

Outlining of collaboration strategies with local authorities and communities, e.g., proactive engagement with relevant government bodies, PTA, and city officials

Regulatory Landscape

Analysis of EU regulations, including type or operating area approval requirements and draft for a governance and process landscape model

Go-to-Market Timeline

Definition of a go-to-market timeline, considering lead times, for example for lobbying with local authorities, city tendering and city development process

Our AV Fleet Simulation Tool enables companies to select the most promising G2M cities and understand business related KPIs by simulate future AV fleets in targeted cities and regions

INPUT PARAMETERS

City & Mobility Demand
- General mobility demand
- Personal demand (trip number & length)
- Modal split
- Demographics
- Population density
- …

ODD & boundary conditions
- Local climate conditions & extremes (heat, cold)
- Topography
- Weather phenomenon
- Infrastructure & traffic
- …

Vehicle parameter
- Technology availability (% of city area)
- Energy consumption
- Battery size
- Passenger capacity
- Component durability
- …

Operation strategy
- Charging strategy & deployment planning
- Hub / service network
- Fleet size & uptime
- Forecast bookings
- Service network/ route length
- …

AV FLEET SIMULATION

OUTPUT implications

Vehicle manufacturers / OEMs
- Understand necessary fleet size and attractiveness of the city
- Consulting tool to emphasize the performance of the product
- …

Cities
- Understand necessary fleet size and mobility gaps within city
- Evaluation of offers and vehicle requirements
- …

Fleet Provider
- Evaluation of competitor products (vehicle types & fleet management)
- Identification of locations for hubs or maintenance facilities
- …

Tech Provider
- Understand product usage to negotiate revenue sharing
- Understanding necessary service life of SDS or related components
- …

From a holistic demand analysis to your individual tailor-made strategy: we are the right partner for your market entry and expansion.

360° Demand Analysis

In a first step, we **jointly analyze and define your status quo, pain points and needs** and sketch your **future positioning and target picture** in the AV ecosystem or specific market.

+

P3 AD Market & Strategy Portfolio

You have the needs; we have the solutions. We **draw on our unique Market, Competitor, Customer, and Tech Intelligence portfolio** as well as **innovative software-solutions**.

Overview | Our market, strategy, and technology intelligence portfolio

P3

P3 AD market, strategy, and technology intelligence portfolio

Working closely with our Technology & Regulation and Operations & Scaling teams, we provide holistic market, competitor, and technology intelligence for your specific needs

=

Tailor-made Strategy

We **jointly develop** your tailor-made **go-to-market or market development** strategy based on your capabilities and competencies and our long-term AV expertise.

P3 AD Market Insights

Let's start: P3 AD Market Insights Introduction

41

Companies focusing on autonomous **MaaS**

35

Companies focusing on **privately owned vehicles**

34

Companies focusing on **goods transport** and **TaaS**

We **analyze** global Autonomous Driving **value creation networks and ecosystems** using **Layer Models** and **provide overviews** of **MaaS, ownership & goods transport use cases**

Based on their respective **core business**, we identify **(strategic) partnerships, investments** or **acquisitions** of **specific market players** and place them in the layer model. We focus on **North America, Asia** (China, Japan and Korea) and **Europe**

All **insights are based on publicly available sources**. Project knowledge or other **non-publicly available information is not considered**.
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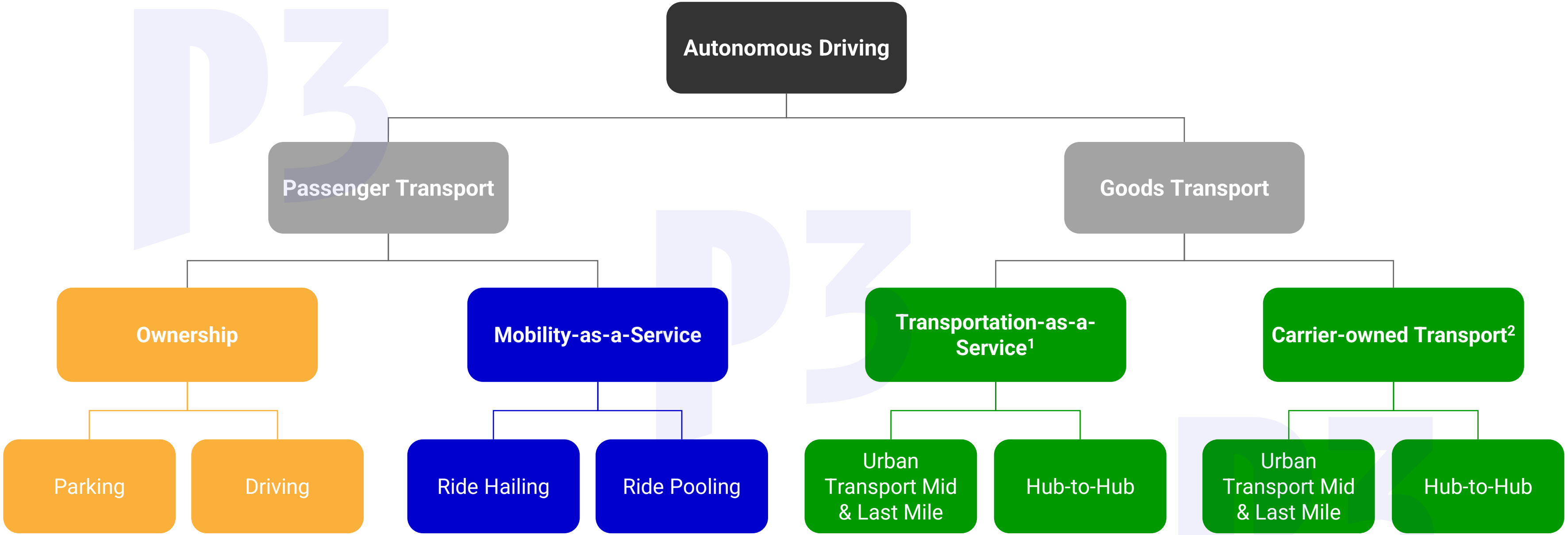
Autonomous Driving Use Cases



Autonomous Driving

- **Passenger Transport**
  - **Ownership**
    - Parking
    - Driving
  - **Mobility-as-a-Service**
    - Ride Hailing
    - Ride Pooling
- **Goods Transport**
  - **Transportation-as-a-Service**[1]
    - Urban Transport Mid & Last Mile
    - Hub-to-Hub
  - **Carrier-owned Transport**[2]
    - Urban Transport Mid & Last Mile
    - Hub-to-Hub

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[1] Self-driving truck provider owns and operates the truck and offers transport / capacity on demand

[2] Customer / carrier owns and operates trucks and pays a per-mile fee to the SDS / truck provider

CLICK THE TILE FOR DIRECT ACCESS TO THE RESPECTIVE SECTION

What you’ll find in this Report

Mobility-as-a-Service

Ownership

Goods Transport

TOP 3 Updates per Use Case

Mobility-as-a-Service

- Asia: DeepRoute partners with Tencent Map
- Asia: PIX Moving and 42dot added to the P3 AD Market Insights
- EU: P3 Mobility and Schaeffler added to the P3 AD Market Insights

Ownership

- Asia/US: Mobileye partners with Mahindra and HiRain
- Asia: Nullmax, Haomo.ai and IM Motor added to the Market Insights
- Asia: Chery chooses Mobileye and WBTL for cloud-enhanced ADAS

Goods Transport

- US: Torc teams up with Aeva and Uber Freight
- US: Kodiak and Ryder Aurora team up for on-site fleet maintenance
- US: Nuro partners with Foretellix and arm on safe and scalable AVs

Mobility-as-a-Service

01

MaaS

Use Cases, Market Insights & Layer Description

01 MaaS

				Private Ground	**Highway**	**Urban**	**Suburban**	**Rural**
				Airport, factory yards, fields, etc.	Highways, 2+ lane roads	City center, designated streets	Federal highway, residential areas	Rural roads, gravel road
Owner-ship	Parking			home yard parking (L4)	-	self parking pilot car park (L4), urban self parking (L5)	self parking pilot parking place (L4) [e.g., supermarket] , self parking (L5)	
	Driving			-	pilot (L2+), pilot (L3), chauffeur (L4)	urban highway / ring roads pilot (L3) , city chauffeur (L4/5)	commuter pilot (L3/L4) , chauffeur (L5)	
MaaS	Ride Hailing	**M**		-	-	robotaxi	robotaxi	robotaxi
	Low Speed	**ML**		low speed AD shuttle (<25km/h)	-	low speed AD shuttle (<25km/h)		-
	Ride Pooling	**M**		private robo shuttle	-	robo shuttle	robo shuttle	robo shuttle
		L		private robo shuttle	hub-to-hub robo shuttle	robo shuttle	robo shuttle	robo shuttle
		XL		private robobus	hub-to-hub robobus	robobus	robobus	robobus

01 MaaS Layer Description

LAYER 1		LAYER 2	LAYER 3	LAYER 4	LAYER 5	LAYER 6
Sensor Set / SoC / Computing HW	SW-Stack / Virtual Driver	Self-Driving Ready Vehicle	Fleet Operations	Mobility & Platform Provider	Rider Experience / Content Provider	Infrastructure

Self-Driving System (SDS) is the sum of all necessary systems to realize self driving level 4 (SAE).
Key functionalities are sensor data fusion, object detection, localization, prediction, environment interpretation, trajectory planning and actuator control.

The HW stack includes sensors, SoC and computing platforms, for example, while the SW stack covers the virtual driver, among others.

Self-Driving Vehicles are considered L4 ready vehicles with an integrated and homologated SDS (sensors, computing hardware and software), which operate in a specific ODD (Operational Design Domain).

Fleet Operators potentially own, operate and maintain a fleet of self-driving vehicles. It may be necessary that a fleet operator is responsible for fleet intelligence functions and technical supervision. Therefore, Layer 3 covers both physical and digital fleet operations.

The **Mobility Provider** owns the user frontend. It is point of sale and provider of the primary communication and interaction channel with the user. Thus, it is responsible for pricing, ride planning, ride execution and important for the overall brand experience.

The **Content Provider** for **Rider Experience** owns a software platform that acts as middleware to service partners. Digital content (e.g., media), digital products (e.g., productivity tools) and digital services are part of this platform.

The service area and its **infrastructure** are core elements to enable an AD service. Infrastructure includes the vehicles' IT infrastructure (especially cloud services and backend), V2X technology and takes into account human behavior prediction in that specific scenery.

01 MaaS Layer Description

EXEMPLARY TASKS PER LAYER

LAYER 1

Sensor Set / SoC / Computing HW

- HW development
- HW production
- Sensor integration
- Automotive approval
- Sensor testing & approval
- Sensor fusion
- ⋮

SW-Stack / Virtual Driver

- SW development
- Simulation
- Prediction
- SDS licensing
- SW testing & approval
- HD mapping
- Verification & validation
- ⋮

LAYER 2

Self-Driving Ready Vehicle

- Design & development
- Redundant chassis
- SDS integration
- SDV testing
- After sales
- Production
- Logistics
- Sales channel
- Homologation
- Pricing
- ⋮

LAYER 3

Fleet Operations

- Fleet financing
- Insurance
- Concessions
- Charging
- Maintenance & cleaning
- Backend (Layer 1-4)
- Hub operations
- Fleet Control Center (fleet steering and monitoring)
- Driver sideline activities
- Remote assistance
- Fleet intelligence (e.g., fleet & ride optimization)
- ⋮

LAYER 4

Mobility & Platform Provider

- Customer app
- API (Layer 1-4)
- Rider authentication
- Pricing
- Booking
- Dynamic routing
- Payment
- Ticketing
- Marketing & Sales
- Customer support
- Multimodal connectivity
- ⋮

LAYER 5

Rider Experience / Content Provider

- In-vehicle advertisement
- Shopping
- Education
- Working
- Multimodal connectivity
- Gaming
- ⋮

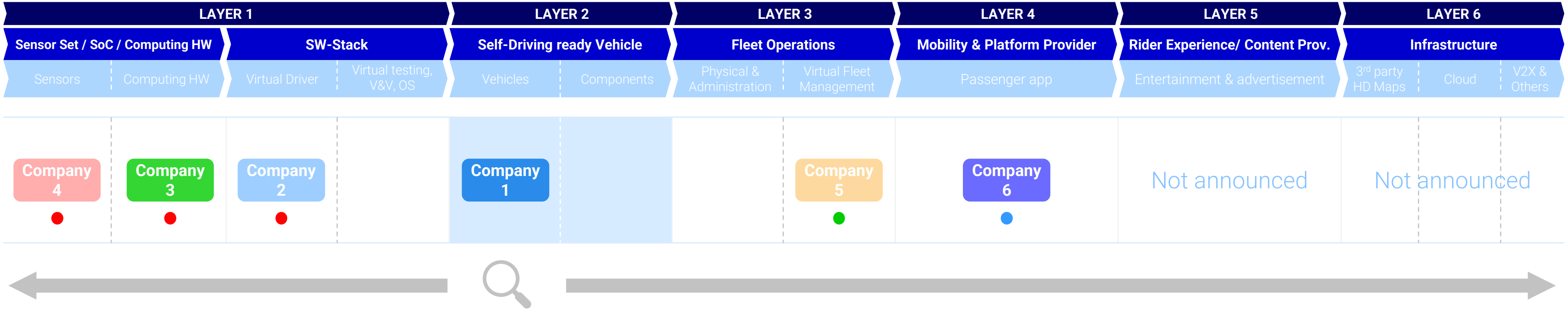
LAYER 6

Infrastructure

- Localization
- 3rd party HD maps
- V2X
- Data communication
- Cloud infrastructure
- Service area
- ⋮

Exemplary

How to **read** the ecosystem **model**



LAYER 1 | LAYER 2 | LAYER 3 | LAYER 4 | LAYER 5 | LAYER 6

Sensor Set / SoC / Computing HW | SW-Stack | Self-Driving ready Vehicle | Fleet Operations | Mobility & Platform Provider | Rider Experience/ Content Prov. | Infrastructure

Sensors | Computing HW | Virtual Driver | Virtual testing, V&V, OS | Vehicles | Components | Physical & Administration | Virtual Fleet Management | Passenger app | Entertainment & advertisement | 3rd party HD Maps | Cloud | V2X & Others

Company 4 ●

Company 3 ●

Company 2 ●

Company 1

Company 5 ●

Company 6 ●

Not announced

Not announced

One row shows the **ecosystem of one player**.

In this example, Layer 2 (L4 ready vehicles) is the core business of the market player. The external and internal partnerships, acquisitions or investments are shown in the other layers on the left and right.

Core Business 🟥 **Partnership** or supplier deal 🟩 **Investment** ● **Acquisition** ● **Parent / Subsidiary**

02

MaaS | NAR

Partnering & Value Chain, Level 4 Target & P3 Assessment

Source: Waymo

PARTNERING & VALUE CHAIN

02 MaaS | NAR 🇺🇸

LAYER 1				LAYER 2		LAYER 3		LAYER 4	LAYER 5	LAYER 6		
Sensors / SoC / Computing HW		SW-Stack		Self-Driving ready Vehicle		Fleet Operations		Mobility & Platform Provider	Rider Experience/ Content Prov.	Infrastructure		
Sensors	Computing HW, SoC	Virtual Driver	Virtual testing, V&V, OS	Vehicles	Components	Physical & Administration	Virtual Fleet Management	Passenger app	Entertainment & advertisement	3rd party HD Maps	Cloud	V2X & Others
WAYMO 🟦	SAMSUNG 🔴 intel 🔴	WAYMO	LATENT LOGIC 🔵	STELLANTIS 🔴 JAGUAR 🔴 VOLVO 🔴 GEELY 🔴 RENAULT NISSAN MITSUBISHI 🔴		AVIS 🔴 AutoNation 🔴 Swiss Re 🔴 transdev 🔴	WAYMO 🟦	WAYMO 🟦 lyft 🔴 Google Maps 🟦 Uber 🔴	TUNE IN 🔴 Spotify 🔴 YouTube Music 🔴 npr 🔴 Audacy 🔴 iHeart RADIO 🔴 deezer 🔴 ((sxm)) 🔴 pandora 🔴		Not announced	
STROBE 🔵 ASTYX 🔵 OUSTER 🔴	Qualcomm 🔴 NVIDIA 🔴	voyage 🔵 cruise		gm 🟦 HONDA 🔴			cruise 🟦	cruise 🟦 lyft 🔴	Not announced		Microsoft 🟢🔴	
LUMINAR 🔴 mobileye 🟦 ZF 🔴	mobileye 🟦	mobileye		NIO 🔴 HOLON 🔴 SCHAEFFLER 🔴 Lohr 🔴 VW Commercial Vehicles 🔴 MAN 🔴		Marubeni 🔴	holo 🔴 moovit 🔵 beep 🔴 WILLER 🔴 transdev 🔴 RATP 🔴 SIXT 🔴	moovit 🔵 Ruter# 🔴 WILLER 🔴 transdev 🔴 RATP 🔴 SIXT 🔴 ioki 🔴	moovit 🔵		Not announced	

🟦 **Core Business** 🔴 **Partnership** or supplier deal 🟢 **Investment** 🔵 **Acquisition** 🟦 **Parent / Subsidiary** ❗ **Update**

02 MaaS | NAR 🇺🇸

LAYER 1				LAYER 2		LAYER 3		LAYER 4	LAYER 5	LAYER 6		
Sensors / SoC / Computing HW		SW-Stack		Self-Driving ready Vehicle		Fleet Operations		Mobility & Platform Provider	Rider Experience/ Content Prov.	Infrastructure		
Sensors	Computing HW, SoC	Virtual Driver	Virtual testing, V&V, OS	Vehicles	Components	Physical & Administration	Virtual Fleet Management	Passenger app	Entertainment & advertisement	3rd party HD Maps	Cloud	V2X & Others
Aurora 🟦 blackmore 🔵 OURS 🔵 DENSO 🔴 HESAI 🔴	NVIDIA 🔴	Uber ATG 🔵 **Aurora**		TOYOTA 🔴 HYUNDAI MOTOR GROUP 🟢		TOYOTA 🔴		Uber 🔴	Not announced		aws 🔴	
APTIV 🔴🟢 OUSTER 🔴	Ambarella 🔴 APTIV 🔴🟢	**Motional**	Applied Intuition 🔴	HYUNDAI MOTOR GROUP KIA 🟢	APTIV 🔴🟢	PIVET 🔴	ottopia 🔴	lyft 🔴 via 🔴 Uber 🔴	Not announced			APTIV 🔴🟢 EVERSOURCE 🔴 DERQ 🔴 BlackBerry 🔴
HESAI 🔴 OUSTER 🔴	NVIDIA 🔴	Strio.AI 🔵 **ZOOX**		ZOOX 🟦		Not announced		ZOOX 🟦 amazon 🟦	Not announced			

Core Business 🔴 **Partnership** or supplier deal 🟢 **Investment** 🔵 **Acquisition** 🟦 **Parent / Subsidiary** ❗ **Update**

02 MaaS | NAR

LAYER 1				LAYER 2		LAYER 3		LAYER 4	LAYER 5	LAYER 6		
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Sensors	Computing HW, SoC	Virtual Driver	Virtual testing & validation	Vehicles	Components	Physical & Administration	Virtual Fleet Management	Passenger app	Entertainment & advertisement	3rd party HD Maps	Cloud	V2X & Others
AEVA 🔴 OUSTER 🔴		**May Mobility**	Applied Intuition 🔴	May Mobility 🔵 TOYOTA 🔴🟢 LEXUS 🔴 BMW 🟢	GENTEX CORPORATION 🔴 BraunAbility 🔴	BRIDGESTONE 🔴🟢 Stantec 🔴 MOTER TECHNOLOGIES 🔴 ❗	ottopia 🔴 Liftango 🔴	via 🔴 moovit 🔴 spare 🔴 Liftango 🔴	Not announced	Not announced		
SICK 🔴 OUSTER 🔴 DENSO Crafting the Core 🔴	intel 🔴🟢	**PERRONE ROBOTICS**	WIND 🔴 aicas 🔴	PERRONE ROBOTICS 🔵 GreenPower MOTOR COMPANY 🔴 rampini 🔴 LIGHTNING MOTORS 🔴 tropos technologies, inc. 🔴		SP SUSTAINABILITY 🔴 Global Finance Group 🔴	First Transit 🔴 guident 🔴	Not announced	Not announced			verizon 🔴
OUSTER 🔴 FLIR 🔴	NVIDIA 🔴	**ADASTEC**		KARSAN 🔴 vmc 🔴		VV 🔴	ottopia 🔴 APPLIED AUTONOMY 🔴	Kolumbus 🔴	Not announced		aws 🔴	AECOM 🔴 ❗

Core Business 🔴 **Partnership** or supplier deal 🟢 **Investment** 🔷 **Acquisition** 🔵 **Parent / Subsidiary** ❗ **Update**

02 MaaS | NAR

LAYER 1				LAYER 2		LAYER 3		LAYER 4	LAYER 5	LAYER 6		
Sensors / SoC / Computing HW		**SW-Stack**		**Self-Driving ready Vehicle**		**Fleet Operations**		**Mobility & Platform Provider**	**Rider Experience/ Content Prov.**	**Infrastructure**		
Sensors	Computing HW, SoC	Virtual Driver	Virtual testing, V&V, OS	Vehicles	Components	Physical & Administration	Virtual Fleet Management	Passenger app	Entertainment & advertisement	3rd party HD Maps	Cloud	V2X & Others
OUSTER 🔴 LeddarTech 🔴	Horizon Robotics 🔴	COAST		COAST 🔵		COAST 🔵		Not announced	Not announced			dg:Cities 🔴

Core Business 🔴 **Partnership** or supplier deal 🟢 **Investment** 🔵 **Acquisition** 🔵 **Parent / Subsidiary** ❗ **Update**

02 MaaS | NAR

	What to expect?	Latest News		Announced L4 target [1]			
			´23	´24	´25	´26	´27
WAYMO	Working **10+ years** towards **autonomous driving**, Waymo's virtual driver is the world's **most experienced one.** The fully driverless I-PACE and Pacifica fleet in Phoenix impresses with a **terrific system performance**. In our view, Waymo is **currently ahead of competition** in the autonomous race.	- Waymo's application to expand California robotaxi operations paused by regulators. *(21.02.2024)* UPDATE READ	L4 target achieved in Phoenix by 2020.				
cruise	Cruise operates a **commercial robotaxi service** in **San Francisco**, which is currently only **available for a selected group at night**. Both **SW and HW Stack are among the most advanced** in the AD market, even if the Chevy Bolt is too small for the use case. However, system performance in SFO is strong.	- Cruise appoints automotive and autonomous vehicle safety leader Steve Kenner as Chief Safety Officer. *(12.02.2024)* UPDATE READ	L4 target achieved in SFO by 2022. Fleet currently grounded due to loss of permit.				
mobileye	Mobileye is already **testing its AV fleet in various locations around the globe**, including complex European traffic. First promising **pilot projects in Norway (Oslo)** and **Germany are at the ready** - these **will show what the system is capable of** and how well it performs compared to competitors.	- Volkswagen launches its first autonomous driving test program in the United States. *(06.07.2023)* READ	Not announced.				
Aurora	While Aurora shifted its **focus primarily** to **self-driving trucks** some time ago, it has been **quiet about its robotaxis**. We believe: the **company needs a working business case**, otherwise it will become a victim of market consolidation. MaaS is therefore probably not part of the business for now.	- Self-driving vehicle company Aurora cuts 3% of its workforce. *(24.01.2024)* UPDATE READ		◆			
Motional	The JV of Hyundai and Aptiv accumulated **>2mn miles on public roads by 2022**. System **performance** in Vegas is **good**, whereas the **complexity of the (small) service area is comparatively low.** In 2023, Motional intends to offer **robotaxi services in major US cities by across** Uber and Lyft. Let's see.	- Autonomous vehicle company Motional is about to lose a key backer. *(31.01.2024)* UPDATE READ		◆			
ZOOX	For a long time, only rumors could be read about Zoox in the media. In 2020, they **unveiled a purpose built SDV**, which could even be relevant for TaaS in the future. In San Francisco, however, **only a large Highlander test fleet is on the road** so far…	- Zoox begins testing robotaxis on public roads in Las Vegas. *(28.06.2023)* READ	Not announced.				
MAY Mobility	May's fleet is already **available to the general public** in different cities. The **SDS is designed for multiple vehicle platforms** and used in the Toyota Sienna Autono-MaaS autonomous vehicles, among others. Although it can't keep up with the big players, it holds its own in the market.	- May Mobility launches first driverless transit service for Early Riders in Arizona, takes next step toward transforming the way riders get around cities and urban environments. *(18.12.2023)* UPDATE READ	Not announced.				

1) Definition L4 target: a robotaxi service that is publicly available in a specific ODD and operated without a safety driver.

LEVEL 4 TARGET & P3 ASSESSMENT

02 MaaS | NAR

	What to expect?	Latest News		Announced L4 target 1)				
				´23	´24	´25	´26	´27
PERRONE ROBOTICS	Perrone been **developing autonomous vehicle solutions since 2003**. Apart from its low-speed shuttles, Perrone claims to have **outfitted over 30 vehicles types with its retrofit kit**. Despite its experience, we don't believe Perrone will become a leading market player.	- Driverless shuttle van on the road at Newark Airport. *(14.09.2023)*	READ	Not announced.				
ADASTEC	Unlike most MaaS providers, ADASTEC is not focusing on robotaxis but is developing the **SDS for transit buses**. Thus, they **currently have an USP** - whether the SDS is performant enough remains to be proven. By June 2022 ADASTEC deployed busses in five locations (EU and US).	- Karsan's Autonomous e-ATAK has become the first self-driving public transport bus in Europe to operate through tunnels.. *(09.02.2024)* UPDATE	READ	Not announced.				
COAST	The company provides MaaS solutions for cities, theme parks, campuses, airports, rail yards, and other private sites. In the meantime, **COAST seems to be focusing primarily on use cases other than passenger transport** (e.g., harvesting, ports).	- COAST Autonomous announces collaboration with the city of Winter Haven, Florida to explore deployment of autonomous transportation solutions. *(30.03.2022)*	READ	Not announced.				

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1) Definition L4 target: a robotaxi service that is publicly available in a specific ODD and operated without a safety driver.

03

MaaS | Asia

Partnering & Value Chain, Level 4 Target & P3 Assessment

Source: Baidu

03 MaaS | Asia

LAYER 1				LAYER 2		LAYER 3		LAYER 4	LAYER 5	LAYER 6		
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Sensors	Computing HW, SoC	Virtual Driver	Virtual testing, V&V, OS	Vehicles	Components	Physical & Administration	Virtual Fleet Management	Passenger app	Entertainment & advertisement	3^{rd} party HD Maps	Cloud	V2X & Others
OUSTER 🔴 HESAI 🔴 ROBOSENSE 🔴 ZVISION 🟢 ON 🔴	intel 🔴 NVIDIA 🔴 NXP 🔴	Bai du 百度 apollo [illegible] 🟢		ARCFOX 🟢🔴 GAC 🔴 HONGQI 🔴 JIDU 🟢 LINCOLN 🔴 BAIC 🔴 CHERY 🔴 VOYAH 🔴	HFCC 🔴	Swiss Re 🔴	Bai du 百度 🔵	Bai du 百度 🔵 首汽约车 🔴 Grab 🔴	Not announced	CARMERA 🔴 tomtom 🔴	Microsoft 🔴	NXP 🔴 InnoFusion 🔴 SAMSUNG 🔴 中国移动 China Mobile 🔴
HESAI 🔴 ROBOSENSE 🔴	NVIDIA 🔴 Horizon Robotics 🔴	WeRide 文远知行 BOSCH 🟢🔴		YUTONG 🟢🔴 RENAULT NISSAN MITSUBISHI 🔴 XPENG 🔴 LINCOLN 🔴 广汽集团 GAC GROUP 🟢🔴 DFM 🔴			WeRide 文远知行 🔵	WeRide 文远知行 🔵 Guangzhou Public Transport 广州公交 🔴 高德 AutoNavi 🔴 ON TIME 🟢🔴	Not announced	Not announced		
LUMINAR 🔴 HESAI 🔴 ROBOSENSE 🔴 pony.ai 🔵 (Sensor fusion)	NVIDIA 🔴 Horizon Robotics 🔴 pony.ai 🔵	pony.ai		TOYOTA 🟢🔴 广汽丰田 🟢🔴 广汽集团 GAC GROUP 🔴 SAIC 🔴 LEXUS 🔴		BOSCH 🔴	Jin Jiang International 锦江国际 🔴	pony.ai 🔵 ON TIME 🔴 曹操专车 CAOCAO 🔴 T3出行 🔴	Not announced	NAVINFO 🔴		

Core Business 🔴 **Partnership** or supplier deal 🟢 **Investment** 🔵 **Acquisition** 🔵 **Parent / Subsidiary** ◆ **Update**

03 MaaS | Asia

LAYER 1				LAYER 2		LAYER 3		LAYER 4	LAYER 5	LAYER 6		
Sensors / SoC / Computing HW		SW-Stack		Self-Driving ready Vehicle		Fleet Operations		Mobility & Platform Provider	Rider Experience/ Content Prov.	Infrastructure		
Sensors	Computing HW, SoC	Virtual Driver	Virtual testing, V&V, OS	Vehicles	Components	Physical & Administration	Virtual Fleet Management	Passenger app	Entertainment & advertisement	3rd party HD Maps	Cloud	V2X & Others
autoX 🔵 HESAI 🔴 arbe 🔴 [illegible] 🔴 dji 🔴 SiLC 🔴	NVIDIA 🔴	autoX		FCA 🔴 HiPhi 🔴 [illegible] 🟢 HONDA 🔴 BYD 🔴 SAIC 🟢 Great Wall 🔴		Not announced		autoX 🔵 高德 🔴	Not announced			阿里巴巴 Alibaba.com 🟢
OUSTER 🔴 HESAI 🔴 Valeo 🟢🔴 Benewake 🟢	NVIDIA 🔴	Valeo 🟢🔴 DiDi 🔵		北汽集团 BAIC Group 🔴 TOYOTA 🟢🔴 广汽集团 GAC GROUP 🟢🔴 VOLVO 🔴 XPENG 🔴	GOODYEAR 🔴	DiDi 🔵		DiDi	DEEPMIRROR 🔴		NVIDIA 🔴	INCHTEK 🔴
OUSTER 🔴 [illegible] 🔵 ZVISION 🔴 [illegible] 🔴	NVIDIA 🔴	DEEPROUTE.Ai		DFM 🔴 SAIC 🔴			曹操专车 CAOCAO 🔴	曹操专车 CAOCAO 🔴	Not announced	Tencent 腾讯 🔴 SD maps – probably consumer vehicles only ◆	Microsoft 🔴 阿里巴巴 Alibaba.com 🔴	

Core Business 🔴 **Partnership** or supplier deal 🟢 **Investment** 🔵 **Acquisition** 🔵 **Parent / Subsidiary** ◆ **Update**

03 MaaS | Asia 🇨🇳

LAYER 1				LAYER 2		LAYER 3		LAYER 4	LAYER 5	LAYER 6		
Sensors / SoC / Computing HW		SW-Stack		Self-Driving ready Vehicle		Fleet Operations		Mobility & Platform Provider	Rider Experience/ Content Prov.	Infrastructure		
Sensors	Computing HW, SoC	Virtual Driver	Virtual testing, V&V, OS	Vehicles	Components	Physical & Administration	Virtual Fleet Management	Passenger app	Entertainment & advertisement	3rd party HD Maps	Cloud	V2X & Others
[illegible] 🔴 HESAI 🔴	**Horizon Robotics** Continental 🔴 NVIDIA 🔴 NXP 🔴 UAES 🔴 SAIC 🔴 intel 🟢	MAXIEYE 🔴 MINIEYE 🟢 UNTOUCH 🟢 Zong Mu 🟢 轻舟智航 QCRAFT 🔴 JF 🔴 ax 🔴	ThunderSoft 🟢🔴 WNDRVR 🔴 STRADVISION 🔴	VOLKSWAGEN 🟢🔴 🔴 理想 🔴 SAIC 🔴 gm 🔴 AION 🔴 HONGQI 🔴 Great Wall 🟢 CHERY 🟢🔴 [illegible] 🔴 FAW GROUP 🟢 [illegible] 🔴 BYD 🔴 BAIC 🔴	[illegible] 🔴	Not announced		Not announced	UNTOUCH 未动科技 🔴	NAVINFO 🔴	APTIV 🔴	[illegible] 🔴
BOSCH 🟢	NVIDIA 🔴	**momenta**		LINCOLN 🔴 SAIC 🟢 NIO 🟢 TOYOTA 🟢 BYD 🟢 gm 🟢 🟢 🔴		MSSAD Aioi Nissay Dowa Insurance 🔴		享道出行 🟢 Momenta GO 🔵	Not announced	Ambarella 🔴	Tencent 腾讯 🟢 aws 🔴	

Core Business 🔴 **Partnership** or supplier deal 🟢 **Investment** 🔵 **Acquisition** 🔵 **Parent / Subsidiary** ❗ **Update**

03 MaaS | Asia

LAYER 1				LAYER 2		LAYER 3		LAYER 4	LAYER 5	LAYER 6		
Sensors / SoC / Computing HW		SW-Stack		Self-Driving ready Vehicle		Fleet Operations		Mobility & Platform Provider	Rider Experience/ Content Prov.	Infrastructure		
Sensors	Computing HW, SoC	Virtual Driver	Virtual testing, V&V, OS	Vehicles	Components	Physical & Administration	Virtual Fleet Management	Passenger app	Entertainment & advertisement	3rd party HD Maps	Cloud	V2X & Others
mobileye 🔴 QUANERGY 🔴	mobileye 🔴	mobileye 🔴 WAYMO 🔴 pony.ai 🔴 Bai百度 🔴 zenseact 🔵		GEELY VOLVO 🔵	Autoliv 🔴 SMART EYE 🔴	Not announced		曹操专车 CAOCAO 🔵 StaRides 🟢🔴	Not announced	高德 🔴	Tencent 腾讯 🔴	
LUMINAR 🔴 HESAI 🔴 ZVISION 🟢 ZF 🔴 RoboSense 🔴🟢	Horizon Robotics 🔴 TTTech 🟢🔴	pony.ai 🔴 autoX 🟢 momenta 🟢 [illegible] 🔴		SAIC		Not announced		享道出行 🔵 cerence 🔴	Not announced	DEEPMAP 🔴 mobileye 🔴		
RoboSense 🔴	NVIDIA 🔴	pony.ai 🟢 Horizon Robotics 🟢 Bai百度 🔴		FAW GROUP HONGQI		Not announced		Not announced	Not announced	Not announced		

▭ Core Business 🔴 **Partnership** or supplier deal 🟢 **Investment** 🩵 **Acquisition** 🔵 **Parent / Subsidiary** ◆ **Update**

PARTNERING & VALUE CHAIN

03 MaaS | Asia 🇨🇳

	LAYER 1				LAYER 2		LAYER 3		LAYER 4	LAYER 5	LAYER 6		
	Sensors / SoC / Computing HW		**SW-Stack**		**Self-Driving ready Vehicle**		**Fleet Operations**		**Mobility & Platform Provider**	**Rider Experience/ Content Prov.**	**Infrastructure**		
	Sensors	Computing HW, SoC	Virtual Driver	Virtual testing, V&V, OS	Vehicles	Components	Physical & Administration	Virtual Fleet Management	Passenger app	Entertainment & advertisement	3rd party HD Maps	Cloud	V2X & Others
NEW	Not announced		Yukuang Tech 🔴		robomart 🔴 ❗ pix moving	elaphe Propulsion Technologies 🔴 TierIV 🔴	Yukuang Tech 🔴		Cloud 🔴 🔴	Not announced	Not announced		
	HESAI 🔴 🔴 OUSTER 🔴	NVIDIA 🔴 Horizon Robotics 🔴	轻舟智航 QCRAFT		轻舟智航 QCRAFT 🔵 DFM 🔴 FOTON 🔴		🔴		T3出行 🔴	Not announced	Not announced		
		WeRide 🔴🟢	WeRide 🔴🟢		YUTONG		WiTricity 🔴		Not announced	Not announced	Not announced		

Core Business 🔴 **Partnership** or supplier deal 🟢 **Investment** 🔵 **Acquisition** 🔵 **Parent / Subsidiary** ❗ **Update**

03 MaaS | Asia

	LAYER 1				LAYER 2		LAYER 3		LAYER 4	LAYER 5	LAYER 6		
	Sensors / SoC / Computing HW		**SW-Stack**		**Self-Driving ready Vehicle**		**Fleet Operations**		**Mobility & Platform Provider**	**Rider Experience/ Content Prov.**	**Infrastructure**		
	Sensors	Computing HW, SoC	Virtual Driver	Virtual testing, V&V, OS	Vehicles	Components	Physical & Administration	Virtual Fleet Management	Passenger app	Entertainment & advertisement	3rd party HD Maps	Cloud	V2X & Others
NEW		SAMSUNG 🔴 42dot 🔵	42dot		HYUNDAI MOTOR GROUP 🔵	42dot 🔵		42dot 🔵	🔵	Not announced	Not announced		
	LUMINAR 🔴 AISIN 🔵 DENSO Crafting the Core 🔴 ZF 🔴 robosense 🔴	NVIDIA 🔴 AVCC 🔴	Aurora 🟢 pony.ai 🟢🔴 May Mobility 🟢 lyft Level 5 🩵 momenta 🟢	Applied Intuition 🔴 parallel domain 🟢 Apex.AI 🟢	TOYOTA			Aurora 🔴 RIDECELL 🟢	Grab 🟢 Uber 🟢🔴 DiDi 🟢🔴	Not announced	CARMERA 🩵 tomtom 🔴 NTT DATA 🔴 MAXAR 🔴 DYNAMIC MAP PLATFORM 🔴 momenta 🔴 here 🔴	aws 🟢	PERCEPTIVE AUTOMATA 🟢
	OUSTER 🔴 ZENDAR. 🟢 Opsys Technologies 🔴	APTIV 🔴 Motional 🟢🔴 NVIDIA 🔴	APTIV 🔴 Motional 🟢🔴 Aurora 🟢 pony.ai 🔴 42dot 🩵 Bai百度 🔴 IONQ 🔴		HYUNDAI MOTOR GROUP		BOTRIDE 🔵🔴		BOTRIDE 🔵🔴 Grab 🔴 AIRS 🔴 i.M 🔴	Not announced	here 🔴		

Core Business 🔴 **Partnership** or supplier deal 🟢 **Investment** 🩵 **Acquisition** 🔵 **Parent / Subsidiary** ◆ **Update**

LEVEL 4 TARGET & P3 ASSESSMENT

03 MaaS | Asia

	What to expect?	Latest News		Announced L4 target 1)				
				´23	´24	´25	´26	´27
Baidu 百度	**Baidu Apollo** has accumulated a total of **more than 32mn km,** holds **permits for first fully driverless taxi service** in CN and **processed 3.3m autonomous ride orders** by September 2023. Baidu is an absolute heavyweight in the Chinese AD market and, in our view, the current leading company in China.	• Baidu's Apollo Go permitted for passenger-carrying Robotaxi service to Beijing Daxing Airport. *(23.02.2024)* UPDATE	READ	Claimed L4 target reached early 2021. (Cangzhou: 130 square kilometers)				
WeRide 文远知行	WeRide was the **first AD company in China** to operate a fleet with **>100 vehicles** for AD testing and was permitted to fest **fully driverless cars** both in **China** and the **USA**. Considering >20mn autonomous kilometers, WeRide is among the strongest AD players. WeRide also offers L2+ solutions.	• WeRide approved to provide Robotaxi shuttle service from Beijing Daxing International Airport. *(23.02.2024)* UPDATE	READ	L4 reached by 2022: Guangzhou International Bio Island				
pony.ai	Pony's AVs have traveled **>21mn kilometers on urban roads & highways** by April 2023, holding **permits to offer driverless rides in China and test its AVs in the US**. Pony also offers L2+ solutions to OEMs. As the BC for AD MaaS will remain negative in the medium term, that's a reasonable move.	• Pony.ai launches pilot Robotaxi service between Beijing Yizhuang, Beijing Daxing International Airport. *(23.02.2024)* UPDATE	READ	L4 reached by 2023 in pilot zone Yizhuang, Beijing and Guangzhou				
autoX	AutoX's **focus is on China and the Asia Pacific markets**. However, it also holds a permit to **transport passengers** on **public roads** in California and is planning a robotaxi service in San Francisco. With a fleet of **more than 1000 vehicles in China**, AutoX is a **leading player** in this market.	• AutoX permitted to conduct RoboTaxi road tests with empty driver's seat in Guangzhou city. *(29.01.2024)* UPDATE	READ	Claimed L4 target reached early 2021. (Shenzhen)				
DiDi	Following an 18-month suspension by the Chinese authorities, Didi was permitted to sign up new users by 2023. Its **active user base was 500mn** in 2020, receiving >**40 bn trip requests daily**. This means great market power - however, it has become **quiet around DiDi's AV division**.	• DiDi Autonomous Driving joins hands with Goodyear, INCHTEK, DeepMirror. *(23.11.2023)* UPDATE	READ			◆		
DEEPROUTE.Ai	**DeepRoute claims to offer the most affordable SDS on the market**. In the meantime, DeepRoute has covered **10 million autonomous kilometers** on public roads by 09/23 and holds permission to carry passengers in China. System performance in China is stunning.	• DeepRoute.ai partners with Tencent Map; unveils collaboration for 2024 smart driving cars release. *(09.01.2024)* UPDATE	READ			◆		
Horizon Robotics	Horizon Robotics now has **partnerships with many well-known OEMs and Tier1s** with whom they are **jointly developing autonomous driving functions based on their Journey chip**. It is therefore a very strong AI-chip market player, without focusing on deploying own robotaxi fleets.	• Horizon Robotics open-sources Sparse4D autonomous driving algorithm. *(23.01.2024)* UPDATE	READ	Not announced.				

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1) Definition L4 target: a robotaxi service that is publicly available in a specific ODD and operated without a safety driver.

03 MaaS | Asia

	What to expect?	Latest News		Announced L4 target 1)				
				´23	´24	´25	´26	´27
momenta	Momenta **attracted attention** primarily due to **investments** (e.g., from Toyota, Mercedes-Benz, and Bosch). Although Momenta operates a robotaxi fleet in China, the **focus currently seems to be clearly on L2+ solutions for OEMs**, rather than on the MaaS use case.	• Momenta officially released Mpilot Pro. *(17.04.2023)*	READ		◆			
GEELY	In 2021, **Geely and Waymo** teamed up to **integrate the Waymo Driver** into an autonomous ride-hailing Zeekr vehicle. This beauty was presented to the public by end of 2022. Geely **focuses primarily on partnerships** with SDS providers.	• Geely's 'Xingrui' supercomputing center goes online. *(28.01.2023)*	READ		◆ Zeekr/Waymo			
SAIC	By August 2022, SAIC accumulated **400,000km of automated driving testing** in China. SAIC has **partnered will well-known SDS providers**, such as Momenta and Pony.ai, to develop self-driving vehicles.	• SAIC-backed Xiangdao Chuxing kicks off Robotaxi pilot operation in Shenzhen. *(28.12.2022)*	READ			◆		
FAW GROUP	FAW's focus is primarily on privately owned vehicles. However, **its EV brand Hongqui** and its **3rd-generation robotaxi** rides on the same platform as its mass-produced vehicle to achieve economies of scale. With **Baidu, a strong SDS partner** is at FAW's side	• 3rd-Gen Hongqi L4 Robotaxi passes unmanned driving license test in Beijing. *(28.12.2023)* UPDATE	READ	Not announced.				
PIX	PIX Moving shares the vision of rebuilding the city with a special form of vehicles called **Moving Spaces**. These **multi-functional pods** can serve as moving working spaces or vending machines, among others. Great concept for technology-driven Asian markets and beyond.	• Robomart partners with PIX Moving to build mobile retail stores on top of PIX's skateboard chassis platform. *(26.01.2024)* NEW	READ	Not announced.				
轻舟智航 QCRAFT	QCraft is hardly known in the AD market and holds a **permit to test robobuses** in Beijing. The company has **strong competition in China** but could fill a niche with robobuses that established robotaxi providers may not want to fill.	• Beijing grants first autonomous driving road test license to large-size public bus. *(17.10.2023)*	READ	Not announced.				
YUTONG	Yutong is China's top bus manufacturer and the world's largest one. For the AD MaaS Case, Yutong provides its **purpose-built electric robobus**, which is already operating driverless on public roads in cooperation with SDS provider WeRide. Yutong **will thus remain true to its core business.**	• WiTricity and YuTong Bus revolutionize public Transportation with Wireless Charging for Autonomous E-Buses. *(10.02.2023)*	READ	L4 reached by 2022 together with WeRide: Guangzhou International Bio Island				

1) Definition L4 target: a robotaxi service that is publicly available in a specific ODD and operated without a safety driver.

03 MaaS | Asia

	What to expect?	Latest News		Announced L4 target 1)				
				´23	´24	´25	´26	´27
42dot	Acquired by Hyundai Motor Group in 2022, 42dot is the **groups' global software center**. 42dot and Hyundai showcased 'software-defined vehicle' (SDV) technologies under development to lead to a '**Software-defined Everything' (SDx) ecosystem beyond mobility** at CES 2024.	• Samsung partners with self-driving tech company to develop AI-based smart vehicle platform. *(04.08.2023)* NEW	READ	Not announced.				
TOYOTA	In the AD space, Toyota is **focusing primarily on partnerships, investments and acquisitions**. The extensive portfolio includes, for example, Lyft Level 5, Momenta, pony.ai or May Mobility. Toyota is pursuing **robotaxi services with Aurora**. However, we doubt that this will happen.	• Pony.ai teams up with Toyota China, GAC Toyota on Robotaxi development. *(04.08.2023)*	READ		◆			
HYUNDAI MOTOR GROUP	Hyundai and Aptiv jointly established **Motional** to develop robotaxis. Moreover, the **acquisition of 42dot** is **intended to strengthen capabilities**. We are curious to what extent Hyundai, apart from Motional, will therefore position itself in the AD business in the future.	• IonQ and Hyundai announce expansion of partnership to improve quantum computing. *(08.12.2022)*	READ	◆ Motional				

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1) Definition L4 target: a robotaxi service that is publicly available in a specific ODD and operated without a safety driver.

04

MaaS | Europe

Partnering & Value Chain, Level 4 Target & P3 Assessment

Source: VWCV

04 MaaS | Europe

LAYER 1				LAYER 2		LAYER 3		LAYER 4	LAYER 5	LAYER 6		
Sensors / SoC / Computing HW		SW-Stack		Self-Driving ready Vehicle		Fleet Operations		Mobility & Platform Provider	Rider Experience/ Content Prov.	Infrastructure		
Sensors	Computing HW, SoC	Virtual Driver	Virtual testing, V&V, OS	Vehicles	Components	Physical & Administration	Virtual Fleet Management	Passenger app	Entertainment & advertisement	3rd party HD Maps	Cloud	V2X & Others
mobileye 🔴		mobileye 🔴		▨ Commercial Vehicles		MOIA 🔵		MOIA 🔵	Not announced	Not announced		
Waymo 🔴 Luminar 🔴	NVIDIA 🔴	Waymo 🔴 Baidu 百度 🔴 No further announcements DiDi 🔴 zenseact 🔵	Apex.AI 🟢	▨ Volvo Geely 🔵		Not announced		Uber 🔴	Not announced	tomtom 🔴 NAVINFO 🔴		
mobileye 🔴		mobileye 🔴		▨ HOLON pininfarina 🔴	cognizant 🔴 Continental Engineering Services 🔴 ❗	beep 🔴 HOCHBAHN 🔴	MOIA 🔴	beep 🔴 HOCHBAHN 🔴 MOIA 🔴	Not announced		valtech mobility 🔴 ❗	

▨ **Core Business** 🔴 **Partnership** or supplier deal 🟢 **Investment** 🟦 **Acquisition** 🔵 **Parent / Subsidiary** ❗ **Update**

04 MaaS | Europe

LAYER 1				LAYER 2		LAYER 3		LAYER 4	LAYER 5	LAYER 6		
Sensors / SoC / Computing HW		**SW-Stack**		**Self-Driving ready Vehicle**		**Fleet Operations**		**Mobility & Platform Provider**	**Rider Experience/ Content Prov.**	**Infrastructure**		
Sensors	Computing HW, SoC	Virtual Driver	Virtual testing, V&V, OS	Vehicles	Components	Physical & Administration	Virtual Fleet Management	Passenger app	Entertainment & advertisement	3rd party HD Maps	Cloud	V2X & Others
Continental 🟢🔴 Velodyne Lidar 🔴 Cepton 🔴 Ouster 🔴	NVIDIA 🔴 Continental 🟢🔴 Kalray 🔴	EasyMile	Ansys 🔴 TrustInSoft 🔴	Stellantis 🔴 Renault Group 🔴 [illegible] 🔴 IVECO 🔴			ottopia 🔴 DriveU.auto 🔴 Applied Autonomy 🔴	EasyMile 🔴 ioki 🔴 via 🔴	Not announced	Not announced		
Velodyne Lidar 🔴 Valeo 🔴 Hesai 🔴	NVIDIA 🔴	navya		navya 🔵 bluebus 🔴 tron-e 🔴	REE 🔴		Keolis 🔴 holo 🔴 PADAM 🔴	Keolis 🔴 PADAM 🔴	Not announced	Not announced		
Navtech Radar 🔴 Hesai 🔴	NVIDIA 🔴 ZF 🟢🔴	oxa	Google Cloud 🔴	Ford 🔴 Applied EV 🔴 NEVS 🔴 eVersum 🔴		ibott 🔴 bp 🟢🔴 beep 🔴		ocado group 🟢🔴 beep 🔴	Not announced		Tencent 腾讯 🟢 Google Cloud 🔴	

Core Business 🔴 **Partnership** or supplier deal 🟢 **Investment** 🔹 **Acquisition** 🔵 **Parent / Subsidiary** ❗ **Update**

04 MaaS | Europe

LAYER 1				LAYER 2		LAYER 3		LAYER 4	LAYER 5	LAYER 6		
Sensors / SoC / Computing HW		SW-Stack		Self-Driving ready Vehicle		Fleet Operations		Mobility & Platform Provider	Rider Experience/ Content Prov.	Infrastructure		
Sensors	Computing HW, SoC	Virtual Driver	Virtual testing, V&V, OS	Vehicles	Components	Physical & Administration	Virtual Fleet Management	Passenger app	Entertainment & advertisement	3rd party HD Maps	Cloud	V2X & Others
	NVIDIA ●	IMAGRY MAPLESS AUTONOMOUS DRIVING		Otokar ●		●		Not announced	Not announced	Not announced		
mobileye ●		mobileye ●		MAN		MVG ●		MVV ●	Not announced	Not announced		
OUSTER ●		auvetech		auvetech ●	●		APPLIED AUTONOMY ●	Robo ●	Not announced			NET MODULE ●

Core Business ● **Partnership** or supplier deal ● **Investment** ● **Acquisition** ● **Parent / Subsidiary** ◆ **Update**

04 MaaS | Europe

LAYER 1				LAYER 2		LAYER 3		LAYER 4	LAYER 5	LAYER 6		
Sensors / SoC / Computing HW		SW-Stack		Self-Driving ready Vehicle		Fleet Operations		Mobility & Platform Provider	Rider Experience/ Content Prov.	Infrastructure		
Sensors	Computing HW, SoC	Virtual Driver	Virtual testing, V&V, OS	Vehicles	Components	Physical & Administration	Virtual Fleet Management	Passenger app	Entertainment & advertisement	3rd party HD Maps	Cloud	V2X & Others
	NVIDIA 🔴 ◆!	**WAYVE**		JAGUAR 🔴		Admiral 🔴		Not announced	Not announced		Microsoft 🔴	
Yandex 🔵 Velodyne Lidar 🔴	NVIDIA 🔴	**Yandex**		HYUNDAI MOTOR GROUP 🔴 TOYOTA 🔴			Яндекс Go 🔵	Яндекс Go 🔵 Uber 🟢	Not announced	Not announced		
mobileye 🔴	intel 🔴	WeRide 🟢 RENAULT NISSAN MITSUBISHI 🔵 WAYMO 🔴		**RENAULT NISSAN MITSUBISHI**			transdev 🔴 NASA 🔴	transdev 🔴 Easy Ride 🟢 WAYMO 🔴	Not announced	tomtom 🔴		

Core Business 🔴 **Partnership** or supplier deal 🟢 **Investment** 🩵 **Acquisition** 🔵 **Parent / Subsidiary** ◆! **Update**

04 MaaS | Europe

	LAYER 1				LAYER 2		LAYER 3		LAYER 4	LAYER 5	LAYER 6		
	Sensors / SoC / Computing HW		SW-Stack		Self-Driving ready Vehicle		Fleet Operations		Mobility & Platform Provider	Rider Experience/ Content Prov.	Infrastructure		
	Sensors	Computing HW, SoC	Virtual Driver	Virtual testing, V&V, OS	Vehicles	Components	Physical & Administration	Virtual Fleet Management	Passenger app	Entertainment & advertisement	3rd party HD Maps	Cloud	V2X & Others
NEW	mobileye ●		mobileye ●		VDL ●	SCHAEFFLER	Not announced		Not announced	Not announced	Not announced		
	mobileye ●		mobileye ●		RIMAC ● KIA ● P3		P3 ●		P3 ●	Not announced		Microsoft ●	

Core Business ● **Partnership** or supplier deal ● **Investment** ● **Acquisition** ● **Parent / Subsidiary** ◆ **Update**

LEVEL 4 TARGET & P3 ASSESSMENT

04 MaaS | Europe

	What to expect?	Latest News		Announced L4 target 1)				
				´23	´24	´25	´26	´27
Commercial Vehicles	Of all the European OEMs in the MaaS segment, VW Commercial Vehicles is the most ambitious one. VW **collaborated** and **tested with SDS providers early on**. After **Argo's shutdown** , VW announced **Mobileye** technology to be integrated into the ID.Buzz AD. Promising collaboration!	- Federal government and Hamburg put autonomous ridepooling project on the road. *(23.10.2023)*	READ			◆		
VOLVO	There is **no clear strategy in the AD MaaS case**. Volvo has committed to **develop robotaxis with Waymo** - nothing has happened since. Volvo seems to be focusing instead on the development of self-driving trucks with its partners.	- Volvo Cars to debut autonomous driving Ride Pilot feature in California. (06.01.2022)	READ	Not announced.				
HOLON	**Benteler** established HOLON as its new **AD business unit**, working closely with SDS supplier Mobileye, fleet operator Beep to develop autonomous shuttles services based on HOLON's mover. As **special purpose vehicles could be an USP** in the future we are curious about HOLON's future	- Benteler is about to secure a multi-million investment for autonomous HOLON Mover. *(07.02.2024)* UPDATE	READ			◆		
EASY MILE	EasyMile has been deplored vehicles >30 countries and >300 locations. the **EZ10 is the most widely used autonomous shuttle**. However, to remain competitive, the **ODD** and **SDS performance** of the **must be significantly enhanced** to be able co compete against other AV companies.	- KelRide project: Europe's largest connected operating area for autonomous shuttles starts in Kelheim. *(05.12.2023)*	READ	L4 permission on one public road in France.				
navya	NAVYA assets were **acquired by Gaussin Macnica Mobility (Gama)** in 2023. As the technology is limited to **fixed routes** and **low speed applications**, it will be quite challenging to compete with more mature AV players. Gated areas seem to be the only promising use case in the future.	- Gaussin and Macnica have taken over Navya. New entity GAMA to showcase a driverless shuttle at Busworld. *(03.10.2023)*	READ	Not announced.				
oxa	Oxbotica is rather flying under the radar, although it already has an exciting past, milestones and partnerships. For example, **Oxbotica has partnered with ZF to deploy passenger shuttles** operating 24/7 on fixed routes. Let's see what the platform is capable of.	- Oxa deploys its commercial self-driving software for the first time as AV shuttles launch for passengers in Florida, US. *(27.02.2024)* UPDATE	READ	Not announced.				
IMAGRY MAPLESS AUTONOMOUS DRIVING	Imagery's technology relies on **multiple 360° cameras** and is based on a **deep neural network** that learns to drive by imitating human behavior. Thanks to the cooperation with Continental, Imagry is now also known beyond Israel - we are eagerly awaiting first bus deployments in Europe.	- Imagry unveils safe Driver Overwatch™, an autonomous safety feature for young and elderly drivers, at CES 2024. *(09.01.2024)* UPDATE	READ	Not announced.				

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1) Definition L4 target: a robotaxi service that is publicly available in a specific ODD and operated without a safety driver.

LEVEL 4 TARGET & P3 ASSESSMENT

04 MaaS | Europe

	What to expect?	Latest News		Announced L4 target 1)				
				´23	´24	´25	´26	´27
MAN	MAN has not yet made an appearance in the bus segment in the context of autonomous driving. The **MINGA** project, in which MAN has a **strong partner at its side in SDS provider Mobileye**, is the first step. We see great added value in automated city buses and are excited about the project.	- MAN Truck & Bus to make city buses autonomous with Mobileye. *(17.05.2023)*	READ	Not announced.				
auvetech	The Estonian startup offers autonomous and sustainable last-mile solution and claims to develop the **first autonomous hydrogen vehicle** in the world. Although there are already pilot projects, we do not believe that the company will be able to prevail against the well-known shuttle providers.	- World's first autonomous shuttle helicopter detection test – Auve Tech Iseauto leading the WayBOLDLY. *(01.06.2023)*	READ	Not announced.				
WAYVE	Wayve does **not rely on a traditional AV stack, HD maps** and **hand-coded rules** but **rather focuses on its deep learning AI technology** and cameras - an ambitious approach in the competitive AD market, where even Tesla is subject to strong criticism.	- Wayve adds referential segmentation 'show and tell' capability to LINGO-1 VLAM. *(17.11.2023)*	READ	Not announced.				
Yandex	The 'Russian Google' was the first company to launch **a robotaxi ride-hailing service in a European city**. As Russia is internationally isolated, Yandex **will no longer play a role in the AV market**.	- Russia's Yandex lays off two dozen US-based workers from its robot and self-driving teams. *(29.03.2022)*	READ	Not announced.				
RENAULT NISSAN MITSUBISHI	Renault-Nissan-Mitsubishi **do not appear to be pursuing any autonomous mobility activities of its own**. Instead, there is a **cooperation with Waymo** and an **investment in WeRide**. But even these collaborations have become very quiet in the meantime. We believe: **Nothing will happen anymore.**	- Renault, Nissan & Mitsubishi Motors announce common roadmap. *(27.01.2022)*	READ					
SCHAEFFLER	**Schaeffler joined forces with VDL** to build shuttles based on its rolling chassis and VDL's expertise in vehicle bodies. The shuttle will be **powered by Mobileye's SDS** while first road tests are to be expected earliest 2025. Now it's essential to bag first partnerships with fleet operators and PTAs.	- Schaeffler and VDL Groep to team up on self-driving shuttles. *(31.08.2023)*	READ	Not announced – first road testing to be expected earliest 2025.				
P3	P3 Mobility creates an AV ecosystem consisting of three pillars: an **autonomous electric vehicle** for ride hailing, specialized **infrastructure**, and a mobility **service platform**. The goal is to reshape future mobility and create a unique user experience. Let's see if cities are open for AV ride hailing.	- Project 3 Mobility and Mobileye announce collaboration for scalable urban autonomous mobility project. *(13.02.2024)*	READ				◆	

1) Definition L4 target: a robotaxi service that is publicly available in a specific ODD and operated without a safety driver.

Ownership

05

Ownership

Use Cases & Layer Description

05 Ownership

				Private Ground	Highway	Urban	Suburban	Rural
				Airport, factory yards, fields, etc.	Highways, 2+ lane roads	City center, designated streets	Federal highway, residential areas	Rural roads, gravel road
Owner-ship	Parking			home yard parking (L4)	-	self parking pilot car park (L4), urban self parking (L5)	self parking pilot parking place (L4) [e.g., supermarket], self parking (L5)	
	Driving			-	pilot (L2+), pilot (L3), chauffeur (L4)	urban highway / ring roads pilot (L3) , city chauffeur (L4/5)	commuter pilot (L3/L4) , chauffeur (L5)	
MaaS	Ride Hailing	M		-	-	robotaxi	robotaxi	robotaxi
	Low Speed	ML		low speed AD shuttle (<25km/h)	-	low speed AD shuttle (<25km/h)		-
	Ride Pooling	M		private robo shuttle	-	robo shuttle	robo shuttle	robo shuttle
		L		private robo shuttle	hub-to-hub robo shuttle	robo shuttle	robo shuttle	robo shuttle
		XL		private robobus	hub-to-hub robobus	robobus	robobus	robobus

05 Ownership Layer Description

LAYER 1		LAYER 2	LAYER 3	LAYER 4
Sensor Set / SoC / Computing HW	SW-Stack / Virtual Driver	Self-Driving ready Vehicle	Rider Experience / Content Provider	Infrastructure

Self-Driving System (SDS) is the sum of all necessary systems to realize self driving level 4 (SAE).
Key functionalities are sensor data fusion, object detection, localization, prediction, environment interpretation, trajectory planning and actuator control.

The HW stack includes sensors, SoC and computing platforms, for example, while the SW stack covers the virtual driver, among others.

Self-Driving Vehicles (SDV) are considered L4 ready vehicles with an integrated and homologated SDS (sensors, computing hardware and software), which operate in a specific ODD (Operational Design Domain).

The **Content Provider** for **Rider Experience** owns a software platform that acts as middleware to service partners. Digital content (e.g., media), digital products (e.g., productivity tools) and digital services (e.g., X-as-a-Service offers) are part of this platform.

The service area and its **infrastructure** are core elements to enable an AD service. Infrastructure includes the vehicles' IT infrastructure (especially cloud services and backend), V2X technology and takes into account human behavior prediction in that specific scenery.

05 Ownership Layer Description

EXEMPLARY TASKS PER LAYER

LAYER 1		LAYER 2	LAYER 3	LAYER 4
Sensor Set / SoC / Computing HW	SW-Stack / Virtual Driver	Self-Driving ready Vehicle	Rider Experience / Content Provider	Infrastructure
HW development	SW development	Design & development	TV & streaming	Localization
HW production	Simulation	Redundant chassis	Shopping	3rd party HD maps
After sales	Prediction	SDS integration	Education	V2X (e.g., cellular, satellite, WIFI)
Automotive approval	SDS licensing	SDV testing	Working	Cloud infrastructure
Sensor testing & approval	SW testing & approval	After sales	Gaming	Teleoperations
⋮	HD mapping	Production	⋮	Human behavior prediction
	Verification & validation	Logistics		Service area
	⋮	Sales channel		⋮
		Homologation		
		Pricing		
		⋮		

06

Ownership | NAR

Partnering & Value Chain, Level 4 Target & P3 Assessment

Source: Cadillac / GM

06 Ownership | NAR 🇺🇸

LAYER 1				LAYER 2		LAYER 3	LAYER 4		
Sensors / SoC / Computing HW		**SW-Stack**		**Self-Driving ready Vehicle**		**Rider Experience/ Content Prov.**	**Infrastructure**		
Sensors	Computing HW, SoC	Virtual Driver	Virtual testing & validation & OS	Vehicles	Components	Entertainment & advertisement	3rd party HD Maps	Cloud	V2X & Others
TESLA 🔵	SAMSUNG 🔴 tsmc 🔴	TESLA 🔵		TESLA		TESLA 🔵	Not announced		
OUSTER 🔴 CEPTON 🔴	Qualcomm 🔴 UNTETHER AI 🔴 mobileye 🔴	Cruise 🔵 Oculii 🟢 gm 🔵 momenta 🟢 Oak Ridge 🔴	Applied Intuition 🔴	gm		gm 🔵	mobileye 🔴 DYNAMIC MAP PLATFORM 🔴	Microsoft 🔴	
mobileye 🔴 OUSTER 🔴		mobileye 🔴 Baidu 百度 🔴 SAIPS 🔹 [illegible] 🔵 [illegible] 🔴		Ford		Not announced	mobileye 🔴 EMG 🔴 DEEPMAP 🔴 Civil Maps 🟢	Au 🔴	

Core Business 🔴 **Partnership** or supplier deal 🟢 **Investment** 🔹 **Acquisition** 🔵 **Parent / Subsidiary** ❗ **Update**

06 Ownership | NAR 🇺🇸

LAYER 1				LAYER 2		LAYER 3	LAYER 4		
Sensors / SoC / Computing HW		SW-Stack		Self-Driving ready Vehicle		Rider Experience/ Content Prov.	Infrastructure		
Sensors	Computing HW, SoC	Virtual Driver	Virtual testing & validation & OS	Vehicles	Components	Entertainment & advertisement	3rd party HD Maps	Cloud	V2X & Others
mobileye 🔵 Valeo 🔴	mobileye 🔵 恒润科技 🔴 ❗	mobileye	ecarx 🔴	Ford 🔴 HONDA 🔴 PORSCHE 🔴 ZEEKR 🔴 gm 🔴 VOLKSWAGEN GROUP 🔴 GWM 🔴 BMW 🔴 polestar 🔴 STELLANTIS 🔴 Mahindra 🔴 ❗		Not announced	VOLKSWAGEN GROUP 🔴		

Core Business 🔴 **Partnership** or supplier deal 🟢 **Investment** ● **Acquisition** 🔵 **Parent / Subsidiary** ❗ **Update**

06 Ownership | NAR

	What to expect?	Latest News		Announced L4 target 1)				
				´23	´24	´25	´26	´27
TESLA	The **only company** to exclusively follow a **vision-based approach,** which is **cheaper** compared to a **LiDAR** based system. Tesla **collects an enormous amount of data** in **shadow mode** – however, from our point of view, the Autopilot is still a Level 2+ system.	- Tesla recalls Autopilot software in 2 million vehicles. *(13.12.2023)* UPDATE	READ	FSD beta available in US – but still L2+ system				
gm	While **GM-backed Cruise is focusing on robotaxi services** there are rumors that Cruise's technology could also power luxury self-driving Cadillacs for ownership. **In China, GM has invested in Momenta**, while also providing hands-free ADAS in the US, starting with Cadillac. Overall strategy unclear.	- GM's hands-free Super Cruise expands to 750,000 miles. *(14.02.2024)* UPDATE	READ			◆		
Ford	After getting off the robotaxi business with Argo.AI, Ford said **to focus on developing differentiated L2+ and L3 applications** for privately used cars. Just like in the robotaxi business, Ford will probably **not develop its SDS in-house** - who the future partner will be is still open.	- Ford brings BlueCruise technology to Germany. [German] *(28.08.2023)*	READ	Not announced.				
mobileye	Mobileye is the **leading supplier for camera-based driver assistance systems**. In addition to L4 technology for, **SuperVision is Mobileye's state-of-the-art L2+ system**, which has already convinced first renowned OEMs. We are very much looking forward to testing it on European roads.	- HiRain to mass produce first Mobileye EyeQ6-based ADAS system in China. *(22.01.2024)* UPDATE	READ	Not announced.				

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1) Definition L4 target: an automated driving system that does not require the driver to take over in a specific ODD

07

Ownership | Asia

Partnering & Value Chain, Level 4 Target & P3 Assessment

Source: XPeng

07 Ownership | Asia

LAYER 1				LAYER 2		LAYER 3	LAYER 4		
Sensors / SoC / Computing HW		**SW-Stack**		**Self-Driving ready Vehicle**		**Rider Experience/ Content Prov.**	**Infrastructure**		
Sensors	Computing HW, SoC	Virtual Driver	Virtual testing, V&V, OS	Vehicles	Components	Entertainment & advertisement	3rd party HD Maps	Cloud	V2X & Others
HESAI 🔴 BOSCH 🔴 Si 🟢🔴 NXP 🔴	NVIDIA 🔴 RHINO Tech 🟢	NIO 🔵		**NIO** JAC 🔴	Continental 🔴	nreal 🔴 Qualcomm 🔴		Tencent 腾讯 🔴	Qualcomm 🔴
ZVISION 🟢 LIVOX 🔴	NVIDIA 🔴	XPENG 🔵		**XPENG**		Qualcomm 🔴 Not announced	高德 🔴	Alibaba Cloud 🔴	
🔴	mobileye 🔴 NVIDIA 🔴	mobileye 🔴 NIRA 🔴		**ZEEKR** GEELY 🔵		Not announced	mobileye 🔴		

Core Business 🔴 **Partnership** or supplier deal 🟢 **Investment** ● **Acquisition** 🔵 **Parent / Subsidiary** ❗ **Update**

07 Ownership | Asia

LAYER 1				LAYER 2		LAYER 3	LAYER 4		
Sensors / SoC / Computing HW		SW-Stack		Self-Driving ready Vehicle		Rider Experience/ Content Prov.	Infrastructure		
Sensors	Computing HW, SoC	Virtual Driver	Virtual testing, V&V, OS	Vehicles	Components	Entertainment & advertisement	3rd party HD Maps	Cloud	V2X & Others
robosense 🟢🔴 Baidu 百度 apollo 🔴 [illegible] 🔵	NVIDIA 🔴 黑芝麻 🔴 Horizon Robotics 🔴	momenta 🟢🔴 Baidu 百度 apollo 🔴 nullmax AI 🔴		BYD		Not announced			HUAWEI 🔴
ibeo 🔴 robosense 🔴 HESAI 🔴	mobileye 🔴 Qualcomm 🔴 芯驰 SemiDrive 🔴 Horizon Robotics 🟢 NVIDIA 🔴 ❗	mobileye 🔴 HAOMO.AI 🔵 Oculii 🔴 LiangDao 🔴 nullmax AI 🔴		GWM		Not announced	NAVINFO 🔴		HUAWEI 🔴 中国移动 China Mobile 🔴
robosense 🔴 HUAWEI 🔴 arbe 🔴	BOSCH 🔴 Baidu 百度 apollo 🔴	DiDi 🔴	HUAWEI 🔴 Baidu 百度 apollo 🔴	BAIC		Not announced	EMG 易图通 🔴 HUAWEI 🔴		中国移动 China Mobile 🔴 ❗

Core Business 🔴 **Partnership** or supplier deal 🟢 **Investment** 🩵 **Acquisition** 🔵 **Parent / Subsidiary** ❗ **Update**

07 Ownership | Asia 🇨🇳

LAYER 1				LAYER 2		LAYER 3	LAYER 4		
Sensors / SoC / Computing HW		SW-Stack		Self-Driving ready Vehicle		Rider Experience/ Content Prov.	Infrastructure		
Sensors	Computing HW, SoC	Virtual Driver	Virtual testing, V&V, OS	Vehicles	Components	Entertainment & advertisement	3rd party HD Maps	Cloud	V2X & Others
LUMINAR 🔴 mobileye 🔴 robosense 🟢🔴 ZF 🔴 ZVISION 🟢	芯驰 SemiDrive 🔴 Qualcomm 🔴 TTTech 🟢🔴 HESAI 🔴	Horizon Robotics 🔴 momenta 🟢🔴 Bai du 百度 apollo 🔴 nullmax AI 🔴		SAIC		Not announced	mobileye 🔴 here 🔴		ZTE 🔴
Continental 🔴 BOSCH 🔴	NVIDIA 🔴	LUCID 🔵		LUCID		Not announced	Not announced		
HESAI 🔴	NVIDIA 🔴 Horizon Robotics 🔴 德赛西威 🔴	Li Auto 🔵		Li Auto		Not announced	Not announced		

Core Business 🔴 **Partnership** or supplier deal 🟢 **Investment** 🔹 **Acquisition** 🔵 **Parent / Subsidiary** ❗ **Update**

07 Ownership | Asia

LAYER 1				LAYER 2		LAYER 3	LAYER 4		
Sensors / SoC / Computing HW		SW-Stack		Self-Driving ready Vehicle		Rider Experience/ Content Prov.	Infrastructure		
Sensors	Computing HW, SoC	Virtual Driver	Virtual testing, V&V, OS	Vehicles	Components	Entertainment & advertisement	3rd party HD Maps	Cloud	V2X & Others
HESAI 🔴 HUAWEI 🔴 SenseAuto 🔴 ❗	HUAWEI 🔴 Horizon Robotics 🔴 NVIDIA 🔴 SenseAuto 🔴	MINIEYE 🔴 SenseAuto 🔴	HUAWEI 🔴 BlackBerry 🔴	NETA HOZON 🔵		Not announced		HUAWEI 🔴	HUAWEI 🔴
🟢 HESAI 🔴	RHINO Tech 🟢 NVIDIA 🔴 ❗	mi 🟢 DeepMotion 🔹 Zong Mu 🟢		Trugo Tech 🟢	mi 🔵	Not announced	Zong Mu 🟢		
HESAI 🔴	NVIDIA 🔴	nullmax AI 🔴	BlackBerry 🔴	华人运通 HUMAN HORIZONS 🔵 HiPhi		Not announced		HUAWEI 🔴	华人运通 HUMAN HORIZONS 🔵

Core Business 🔴 **Partnership** or supplier deal 🟢 **Investment** 🔹 **Acquisition** 🔵 **Parent / Subsidiary** ❗ **Update**

07 Ownership | Asia

LAYER 1				LAYER 2		LAYER 3	LAYER 4		
Sensors / SoC / Computing HW		SW-Stack		Self-Driving ready Vehicle		Rider Experience/ Content Prov.	Infrastructure		
Sensors	Computing HW, SoC	Virtual Driver	Virtual testing, V&V, OS	Vehicles	Components	Entertainment & advertisement	3rd party HD Maps	Cloud	V2X & Others
robosense 🔴 HESAI 🔴	Cambricon 寒武纪科技 🔴 Horizon Robotics 🟢 BLACK SESAME 🔴 mobileye 🔴 NVIDIA 🔴	Baidu 百度 🔴 nullmax AI 🔴 mobileye 🔴		FAW HONGQI 🔵		Not announced			QUECTEL 🔴
❗ QUANERGY 🔴 dji 🔴 mobileye 🔴	NVIDIA 🔴 mobileye 🔴 Horizon Robotics 🔴	Baidu 百度 🔴 MINIEYE 🔴 dji ❗ 🔴 nullmax AI 🔴		CHERY EXEED 星途 🔵	BTL 🔴 ❗	iFLYTEK 🔴	mobileye 🔴 ❗		QUANERGY 🔴 BOE 🔴
robosense 🔴	Horizon Robotics 🔴	HOLOMATIC 禾多科技 🟢		GAC AION 埃安 🔵		Not announced			HUAWEI 🔴

Core Business 🔴 **Partnership** or supplier deal 🟢 **Investment** 🔹 **Acquisition** 🔵 **Parent / Subsidiary** ❗ **Update**

07 Ownership | Asia

LAYER 1				LAYER 2		LAYER 3	LAYER 4		
Sensors / SoC / Computing HW		SW-Stack		Self-Driving ready Vehicle		Rider Experience/ Content Prov.	Infrastructure		
Sensors	Computing HW, SoC	Virtual Driver	Virtual testing, V&V, OS	Vehicles	Components	Entertainment & advertisement	3rd party HD Maps	Cloud	V2X & Others
HESAI 🔴	Horizon Robotics 🔴	Bai du 百度 🔴	HUAWEI 🔴	长安汽车 CHANGAN 深蓝汽车 🔵 🔵		HUAWEI 🔴		Bai du 百度 🔴	
	BLACK SESAME 🔴🟢	Bai du 百度 🔴		DONGFENG DONGFENG MOTOR CORPORATION		Not announced		HUAWEI 🔴	
	NVIDIA 🔴 ❗	Bai du 百度 🟢		GEELY 🔴🟢		Not announced	Not announced		

Core Business 🔴 **Partnership** or supplier deal 🟢 **Investment** 🔹 **Acquisition** 🔵 **Parent / Subsidiary** ❗ **Update**

07 Ownership | Asia

	LAYER 1				LAYER 2		LAYER 3	LAYER 4		
	Sensors / SoC / Computing HW		SW-Stack		Self-Driving ready Vehicle		Rider Experience/ Content Prov.	Infrastructure		
	Sensors	Computing HW, SoC	Virtual Driver	Virtual testing, V&V, OS	Vehicles	Components	Entertainment & advertisement	3rd party HD Maps	Cloud	V2X & Others
		HUAWEI 🔵	HUAWEI 🔵 智行者 🔴		ARCFOX 🔴 Audi 🔴 北汽集团 BAIC GROUP 🔴 JAC 🔴 CHANGAN 🔴 广汽集团 🔴 🔴		Not announced	HUAWEI		PATEO 🔴
NEW	KANKAN 🔴	BLACK SESAME 🔴 TEXAS INSTRUMENTS 🔴 NVIDIA 🔴 Horizon Robotics 🔴 HUAWEI 🔴 Ambarella 🔴	nullmax AI		Ford 🔴 BYD 🔴 SAIC 🔴 FAW 🔴 CHERY 🔴 GWM 🔴		Not announced	NAVINFO 🔴		
NEW		NVIDIA 🔴	momenta 🔴		SAIC 🔵		Not announced			阿里巴巴 Alibaba.com 🔵

▨ Core Business 🔴 **Partnership** or supplier deal 🟢 **Investment** 🔵 **Acquisition** 🔵 **Parent / Subsidiary** ◆ **Update**

07 Ownership | Asia

	LAYER 1				LAYER 2		LAYER 3	LAYER 4		
	Sensors / SoC / Computing HW		SW-Stack		Self-Driving ready Vehicle		Rider Experience/ Content Prov.	Infrastructure		
	Sensors	Computing HW, SoC	Virtual Driver	Virtual testing, V&V, OS	Vehicles	Components	Entertainment & advertisement	3rd party HD Maps	Cloud	V2X & Others
	OUSTER 🔴 Valeo 🔴 mobileye 🔴	RENESAS 🔴 mobileye 🔴 Qualcomm 🔴	autoX 🔴 cruise 🔴🟢 helm.ai 🟢		HONDA		SONY 🔴	DYNAMIC MAP PLATFORM 🔴 Baidu百度 | apollo 🔴		
NEW	robosense 🔴	Qualcomm 🔴 G-PULSE 🔴	HAOMO.AI		GWM 🔴		Not announced	NAVINFO 🔴		

Core Business 🔴 **Partnership** or supplier deal 🟢 **Investment** 🔵 **Acquisition** ● **Parent / Subsidiary** ♦ **Update**

LEVEL 4 TARGET & P3 ASSESSMENT

07 Ownership | Asia

	What to expect?	Latest News		Announced L4 target 1)				
				´23	´24	´25	´26	´27
NIO	NIO's ET7 is **said to be able to drive autonomously and put existing systems (e.g., Teslas) in their place**. What the system is actually capable of and whether the capabilities only look good on paper will become clear once the ET7 is released with all its functionalities.	• NIO to produce own autonomous driving chips in 1-2 years, says company executive. *(17.08.2023)*	READ	Not announced.				
XPENG	XPeng is another Chinese Tesla competitor with ambitious goals. The vehicles are equipped with **modern ADAS** are, according to their own statements, **capable of driving at least at Level 3**. As with NIO, **XPeng is a bit of a surprise** when it comes to **actual AD performance**.	• XPENG to develop global XNGP intelligent assisted driving system in 2025. *(05.02.2024)* UPDATE	READ	Not announced.				
ZEEKR	Geely's EV brand **develops the SPV robotaxi for Waymo** while **incorporating Mobileye's SuperVision system for private owned cars**. Whether Zeekr can claim to be a premium brand remains to be seen, but the technological partnerships are promising.	• Wave of EV makers choose NVIDIA DRIVE for automated driving. *(08.01.2024)* UPDATE	READ		◆			
BYD	In December 2021, **BYD and Momenta**, one of China's major SDS developers, formed a **joint venture for autonomous driving**. While BYD's AD activities were very quiet before, this cooperation is an **important step for BYD to keep up with other Chinese EV brands** in terms of AD.	• BYD receives conditional L3 autonomous driving vehicle testing license in July 2023. *(27.12.2023)* UPDATE	READ	Not announced.				
GWM	GWM aims to provide complete mobility ecosystems with dedicated brands for the European markets. **Regarding AD**, GWM has been working with companies such as **Mobileye or Qualcomm**. Once first vehicles are delivered in Europe, the systems' performance can be seriously assessed.	• Wave of EV makers choose NVIDIA DRIVE for automated driving. *(08.01.2024)* UPDATE	READ	Not announced.				
BAIC	BAIC seems to rely mainly on a Baidu partnership towards AVs, which rather pursues MaaS. In the private ownership segment, **Arcfox models are equipped with Huawei software and sensor suite**. However, AD activities of other competitors seem to be much more distinctive.	• ARCFOX granted L3 highway autonomous driving vehicle testing license in Beijing. *(22.12.2023)* UPDATE	READ			◆		
SAIC	China's largest carmaker intends to equip premium electric vehicle models with **Momenta-developed intelligent driving technology**. SAIC may not seem as 'fancy' in its outward appearance as some startups from China, but it is a serious market player due to its size, expertise and financial strength.	• SAIC Motor, DIAS, TTTech-Auto AG deepen partnership for ADAS technology development. *(13.11.2023)*	READ	Not announced.				

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1) Definition L4 target: an automated driving system that does not require the driver to take over in a specific ODD

LEVEL 4 TARGET & P3 ASSESSMENT

07 Ownership | Asia

	What to expect?	Latest News		Announced L4 target 1)				
				´23	´24	´25	´26	´27
LUCID	Lucid's advanced luxury EVs are about to be equipped with its **DreamDrive ADAS systems**, consisting of **up to 32 sensors** and offering **more than 30 driver-assistance features**. Since hardly anything is known about partnerships, the **SW is apparently primarily developed in-house**.	- Driving on Air: Lucid Group builds intelligent EVs on NVIDIA DRIVE. *(22.03.2022)*	READ	Not announced.				
Li Auto	Li Auto is another EV company aiming for autonomous driving. While Li **claims** their **technology will soon be competitive with Tesla's Autopilot**, they have **yet to prove those capabilities**. Like other Chinese EV companies, Li Auto is more of a grab bag with regards to AD.	- Wave of EV makers choose NVIDIA DRIVE for automated driving. *(08.01.2024)* UPDATE	READ	Not announced.				
NETA	NETA Auto, a Hozon Auto brand, is one of several Chinese OEMs that has entered into **in-depth cooperation with Huawei**. Furthermore, teaming of with Hesai for future vehicle models shall further enhance automated driving capabilities.	- NETA S receives OTA update featuring SenseAuto's highway navigation assistance solution. *(01.02.2024)* UPDATE	READ	Not announced.				
mi	Xiaomi sets sight on several autonomous electric vehicle brands by **substantially investing in smart car technology**. An **initial invest of $500m** boosts the development of its in-house AD solution for their own own EV brand. Xiaomi could catch up with other market players in the PO segment.	- Wave of EV makers choose NVIDIA DRIVE for automated driving. *(08.01.2024)* UPDATE	READ	Not announced.				
HiPhi	HiPhi, a **brand of Human Horizons** is developing the '**HiPhi Pilot**', providing redundant and safe intelligent driving features aiming at both L3 and L4. At this point, too little is known about the AD capabilities to seriously assess the company.	- Human Horizons, Huawei Cloud partner on dedicated intelligent driving cloud. *(25.07.2023)*	READ	Not announced.				
FAW	FAW planned to offer an L4-capable system as early as 2020 – which was not achieved. Now FAW aims to offer a **fully functional autonomous driving system by 2030** - this new timeline seems more realistic.	- Hesai announces major design win with leading automotive OEM for in-cabin lidar. *(23.09.2023)*	READ				Beyond ◆	
CHERY	Through **various partnerships**, the company is driving the development of intelligent vehicles. At the Shanghai Auto Show 2021, Chery presented a concept with a purported Level 4 driving function. **Chery plans to offer L4-capable vehicles in 2025**. Not much time left.	- EXEED, Chery Auto's luxury brand, chooses Mobileye and WBTL to launch first cloud-enhanced driver-assist in China. *(15.01.2024)* UPDATE	READ			◆		

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1) Definition L4 target: an automated driving system that does not require the driver to take over in a specific ODD

LEVEL 4 TARGET & P3 ASSESSMENT

07 Ownership | Asia

	What to expect?	Latest News		Announced L4 target[1]				
				´23	´24	´25	´26	´27
GAC	GAC is the fifth largest car manufacturer in China and sells its vehicles under various brands. The company has always **worked closely with Huawei** and plans to produce L4 vehicles under its own AION brand from 2024 as a manufacturing partner of Huawei.	• GAC Group obtains L3 autonomous vehicle road test license in Guangzhou. *(10.01.2024)* UPDATE	READ		◆			
长安汽车 CHANGAN	CHANGAN is **working closely with Huawei on Level 4 Autopilot**, 5G, and C-V2X, and plans to offer **L4 capabilities in 2025**. Recently, the company announced a strategic cooperation with Geely, among others, to combine strengths and share resources in the development of autonomous cars.	• AVATR 11 Harmony Upgraded Edition goes on sale, offering elevated smart driving capabilities. *(08.01.2024)* UPDATE	READ			◆		
DONGFENG DONGFENG MOTOR CORPORATION	Dongfeng is demonstrating its capabilities with 40 **robotaxis in Wuhan**, which are operating on 10 **fixed routes**. The self-driving taxis use Baidu navigation and positioning systems, high-resolution cameras, lidar and millimeter wave radar as well as 5G technology.	• VOYAH plans to equip more models with Baidu Apollo’s intelligent driving solution. *(27.10.2023)*	READ			Not announced.		
	JI YUE is a joint venture between Geely and Baidu. The first production model relies on solely visual perception algorithms and thus a **pure vision approach**. The company intends to cover 200 cities nationwide with its advanced urban intelligent driving functions by end of 2024.	• Ji Yue 01 rolls out first major OTA upgrade, debuts OCC-based pure visual intelligent driving feature. *(15.01.2024)* UPDATE	READ			Not announced.		
HUAWEI	It is still unclear whether Huawei wants to ‘become an OEM’ or rather a **Tier1**. Huawei has **invested a lot in smart vehicle solutions** while its customer base is growing. Unless the autonomous division is sold, Huawei's power could continue to grow and result in China’s Bosch.	• Huawei: Harmony Intelligent Mobility Alliance ventures including AITO are not divested to new company. *(27.11.2023)*	READ			◆		
nullmax AI	Nullmax pursues a **‘Machine Learning First’** approach and has **teamed up with several OEMs, chip suppliers and other companies**. While the depth of cooperation is often unclear, you should keep an eye on Nullmax and its **vision-based, multi-sensor fusion and perception technology** route.	• Nullmax deepens collaboration with Black Sesame Technologies for integrated NOA solutions. *(15.01.2024)* NEW	READ			Not announced.		
	IM Motors, **co-founded by SAIC Motor, Zhangjiang Hi-Tech, and Alibaba** pushes its AD capabilities through **joint development with Momenta**. While urban NOA was implemented swiftly, IM also obtained the official AV testing license for highway/expressway in Shanghai for L3 testing.	• IM Motors rolls out IM AD urban NOA function in Shanghai. *(24.01.2024)* NEW	READ			Not announced.		

1) Definition L4 target: an automated driving system that does not require the driver to take over in a specific ODD

07 Ownership | Asia

	What to expect?	Latest News		Announced L4 target 1)				
				´23	´24	´25	´26	´27
HONDA	Wile providing its own "SENSING" ADAS, Honda has attracted attention primarily through **investing in GM's Cruise for MaaS initiatives.** An **investment in Helm.ai** , however, is intended to benefit the company's own software and AI competencies.	- Honda unveils SENSING 360+ system. *(28.11.2023)*	READ			◆		
HAOMO.AI	Haomo.ai is **backed by GWM** and develops its urban navigation-assisted Hpilot for mass-production. By Feb 2024, it has been **integrated in over 20 vehicle models**, achieving >120 mn km of assisted driving. Gathering a huge amount of data may be beneficial towards L4 development.	- Haomo.ai bags over 100 million yuan in B1 funding round. *(22.02.2024)* NEW	READ	Not announced.				

1) Definition L4 target: an automated driving system that does not require the driver to take over in a specific ODD

08

Ownership | Europe

Partnering & Value Chain, Level 4 Target & P3 Assessment

Source: Mercedes-Benz

08 Ownership | Europe

LAYER 1				LAYER 2		LAYER 3	LAYER 4		
Sensors / SoC / Computing HW		SW-Stack		Self-Driving ready Vehicle		Rider Experience/ Content Prov.	Infrastructure		
Sensors	Computing HW, SoC	Virtual Driver	Virtual testing, V&V, OS	Vehicles	Components	Entertainment & advertisement	3rd party HD Maps	Cloud	V2X & Others
LUMINAR 🟢🔴 BOSCH 🔴 Valeo 🔴 veoneer 🔴	NVIDIA 🔴 brainchip 🔴 Qualcomm 🔴	NVIDIA 🔴 Bai百度 🔴 momenta 🟢				Mercedes me 🟦 ZYNC 🔴	DEEPMAP 🟦 here 🟢🔴		Tencent 腾讯 🔴
INNOVIZ TECHNOLOGIES 🔴 APTIV 🔴 MAGNA 🔴 veoneer 🔴 Valeo 🔴	mobileye 🔴 Qualcomm 🔴	Arriver 🔴 Valeo 🔴 AutoBrains 🟢 Tencent 腾讯 🔴 STELLANTIS 🔴	TTTech 🔴 BlackBerry 🔴	BMW	Continental 🔴	BMW CONNECTED DRIVE 🟦 AirConsole 🔴	here 🟢🔴	aws 🔴	ottopia 🔴
mobileye 🔴 INNOVIZ TECHNOLOGIES 🔴	NVIDIA 🔴 Qualcomm 🔴 CARIAD 🟦	Hella Aglaia 🔵 UNDERSTAND.AI 🔴 INTENTA 🔵 Horizon Robotics 🟢🔴 BOSCH 🔴	CARIAD 🟦 BlackBerry 🔴 Luxoft 🔴 TTTech 🟢	VOLKSWAGEN GROUP		Not announced	tomtom 🔴 mobileye 🔴 here 🟢 高德 AutoNavi 🔴 NIRA DYNAMICS 🟦	Microsoft 🔴	verizon 🔴 HUAWEI 🔴

Core Business 🔴 **Partnership** or supplier deal 🟢 **Investment** 🔵 **Acquisition** 🟦 **Parent / Subsidiary** ❗ **Update**

08 Ownership | Europe

LAYER 1				LAYER 2		LAYER 3	LAYER 4		
Sensors / SoC / Computing HW		SW-Stack		Self-Driving ready Vehicle		Rider Experience/ Content Prov.	Infrastructure		
Sensors	Computing HW, SoC	Virtual Driver	Virtual testing, V&V, OS	Vehicles	Components	Entertainment & advertisement	3rd party HD Maps	Cloud	V2X & Others
Valeo 🔴	mobileye 🔴 Qualcomm 🔴 FOXCONN 🔴	WAYMO 🔴 BMW 🔴	aiMotive 🔵	STELLANTIS		Not announced	mobileye 🔴 tomtom 🔴		
INNOVIZ TECHNOLOGIES 🔴 OUSTER 🔴 LeddarTech 🔴 APTIV ●	Horizon Robotics 🔴	ottomatika 🔵 nuTonomy 🔵	TTTech 🟢 WNDRVR 🔵	HYUNDAI MOTOR GROUP 🟢🔴 🔴	APTIV	Not announced		CONTROLTEC 🔵	
Continental ● AEYE 🟢	Horizon Robotics 🔴 Ambarella 🔴 avcc 🔴 NVIDIA 🔴 RECOGNI 🟢🔴	iMAGRY MAPLESS AUTONOMOUS DRIVING 🔴 RECOGNI 🟢🔴 AutoBrains. 🟢🔴 cartica 🟢 [illegible] 🟢 魔视智能 MOTOVIS 🟢 [illegible] 🟢	Apex.AI 🟢🔴	BMW 🔴 easy MILE 🟢🔴	Continental	Not announced	here 🟢	aws 🔴	iteris 🔴

Core Business 🔴 **Partnership** or supplier deal 🟢 **Investment** 🔵 **Acquisition** ● **Parent / Subsidiary** ❗ **Update**

08 Ownership | Europe

LAYER 1				LAYER 2		LAYER 3	LAYER 4		
Sensors / SoC / Computing HW		SW-Stack		Self-Driving ready Vehicle		Rider Experience/ Content Prov.	Infrastructure		
Sensors	Computing HW, SoC	Virtual Driver	Virtual testing, V&V, OS	Vehicles	Components	Entertainment & advertisement	3rd party HD Maps	Cloud	V2X & Others
BOSCH 🔵 HESAI 🟢 Webasto 🔴	RECOGNI 🔴🟢 NVIDIA 🔴 AVCC 🔴 Ambarella 🔴 BOSCH 🔴	UAI 🔴 momenta 🟢 WeRide 🟢 FIVE AI 🩵 RECOGNI 🔴🟢 CARIAD 🔴		🔴	BOSCH nEXT G 🔴	Not announced	tomtom 🔴 DEEPMAP 🔴 here 🟢 atlatec 🩵	Microsoft 🔴	
mobileye 🔴 LUMINAR 🔴	NVIDIA 🔴	mobileye 🔴		polestar		polestar 🔵 Google 🔴	Google 🔴		

Core Business 🔴 **Partnership** or supplier deal 🟢 **Investment** 🩵 **Acquisition** 🔵 **Parent / Subsidiary** ❗ **Update**

LEVEL 4 TARGET & P3 ASSESSMENT

08 Ownership | Europe

	What to expect?	Latest News		Announced L4 target [1)] ´23	´24	´25	´26	´27
	After ending its partnership with BMW for the time being, Mercedes made big headlines in 2021: its **Drive Pilot is the world's first** ADAS to gain **type approval for a L3 system**. Now its ODD must be expanded to really offer premium customers added value.	- Automated driving revolution: Mercedes-Benz announces U.S. availability of DRIVE PILOT – the world's first certified SAE Level 3 system for the U.S. market. *(27.09.2023)*	READ	Not announced.				
BMW	BMW seems to have greatly **reduced its own activities with regard to L3 and L4** and **instead focuses on partnerships** - most recently with Stellantis. BMW is difficult to assess at present but must be careful not to be left behind in international comparison.	- HERE HD Live Map powers BMW Personal Pilot Level 3 highly automated driving function. *(13.12.2023)* UPDATE	READ	Not announced.				
VOLKSWAGEN GROUP	**CARIAD is primarily responsible for software development** in the **private ownership** segment. There is also a development partnership with Bosch. We are watching the development of CARIAD and are curious to see whether they can live up to their great task.	- CARIAD joins coalition for greater road safety through V2X technology. *(03.11.2023)*	READ	Not announced.				
STELLANTIS	Stellantis is working on **L3 and L4 solutions with technology partners** - especially **BMW and Waymo**. In 2023, Stellantis launched its L2 hands-free driver assistance system, which will be integrated into the 2024 Jeep Grand Cherokee.	- Stellantis quietly launched its hands-free driver-assist system. *(15.02.2024)* UPDATE	READ	Not announced.				
APTIV	Aptiv has been a **leading company** in the development of **ADAS** for more than 20 years. **MaaS activities** are pursued with Motional, a **joint venture with Hyundai**. Aptiv has acquired or at least invested in software companies to strengthen in-house capabilities towards ADAS and AD.	- Horizon Robotics, Aptiv join forces to develop localized intelligent driving solutions. *(03.07.2023)*	READ	◆ Motional (MaaS).				
Continental	Continental **spun off its own AD unit**. It will be exciting to see how Continental will fare in the market compared to already established players like Mobileye. However, partnerships and investments in AI companies show that Conti **will be increasingly involved in the SDS area**.	- Continental integrates Imagry's autonomous driving technology to support automated parking for mass market passenger cars. *(22.05.2023)*	READ		◆			
BOSCH	Bosch focuses on both SAE Level 1-3 solutions for private vehicles and solutions for higher levels of automation (what we believe is MaaS). The **acquisition of Five AI could** also further **strengthen Bosch's AD market positioning**. A German full stack provider? We are curious.	- CES world premiere: Bosch unites infotainment and driver assistance functions on one chip. *(05.12.2023)*	READ	Not announced.				

1) Definition L4 target: an automated driving system that does not require the driver to take over in a specific ODD

LEVEL 4 TARGET & P3 ASSESSMENT

08 Ownership | Europe

	What to expect?	Latest News		Announced L4 target 1)				
				´23	´24	´25	´26	´27
polestar	Polestar is a renowned EV player in the EU market. While ADAS of both Polestar 1 and 2 can’t compete with many competitors, there is supposed to be a **significant leap with Polestar 3 and 4**. With **NVIDIA, Luminar and especially Mobileye**, they have strong technology partners at their side.	• Polestar 4 to integrate Luminar LiDAR with Mobileye Chauffeur. *(09.11.2023)*	READ	Not announced.				

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1) Definition L4 target: an automated driving system that does not require the driver to take over in a specific ODD

Goods Transport

09

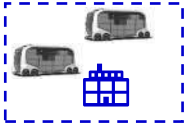
TaaS & Carrier-Owned

Use Cases, Market Insights & Layer Description

09 TaaS & Carrier-Owned

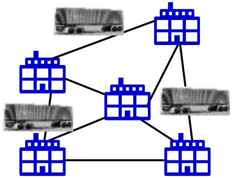
	Private Ground	**Highway**	**Urban**	**Suburban**	**Rural**
	Home, airport, factory yards, fields, etc.	Highways, 2+ lane roads	City center, designated streets	Federal highway, residential areas	Rural roads, gravel road
Transport **S** 	last mile delivery	-	last mile delivery	last mile delivery	-
Transport **ML** 	automated yards, e.g., intralogistics trucks (L4/5)	-	hub-to-spoke robo transporter	hub-to-spoke robo transporter	robo transporter
Transport **XL** 	automated yards, e.g., intralogistics trucks (L4/5)	hub-to-hub robo truck	-	-	-
Platooning 	automated yards, e.g., intralogistics trucks (L4/5)	hub-to-hub robo truck	-	-	-
XaaS 	e. g. snow clearing (L4/5), roboharvesters	-	e. g. street sweeping machines (L4/5)	e. g. street sweeping machines (L4/5)	robo tractor

AUTOMATED YARDS



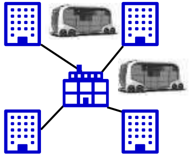
transportation with closed areas, yards, hub or similar confined areas

HUB-TO-HUB



Hub-to-hub transportation between logistic hubs incl. drayage run

HUB-AND-SPOKE

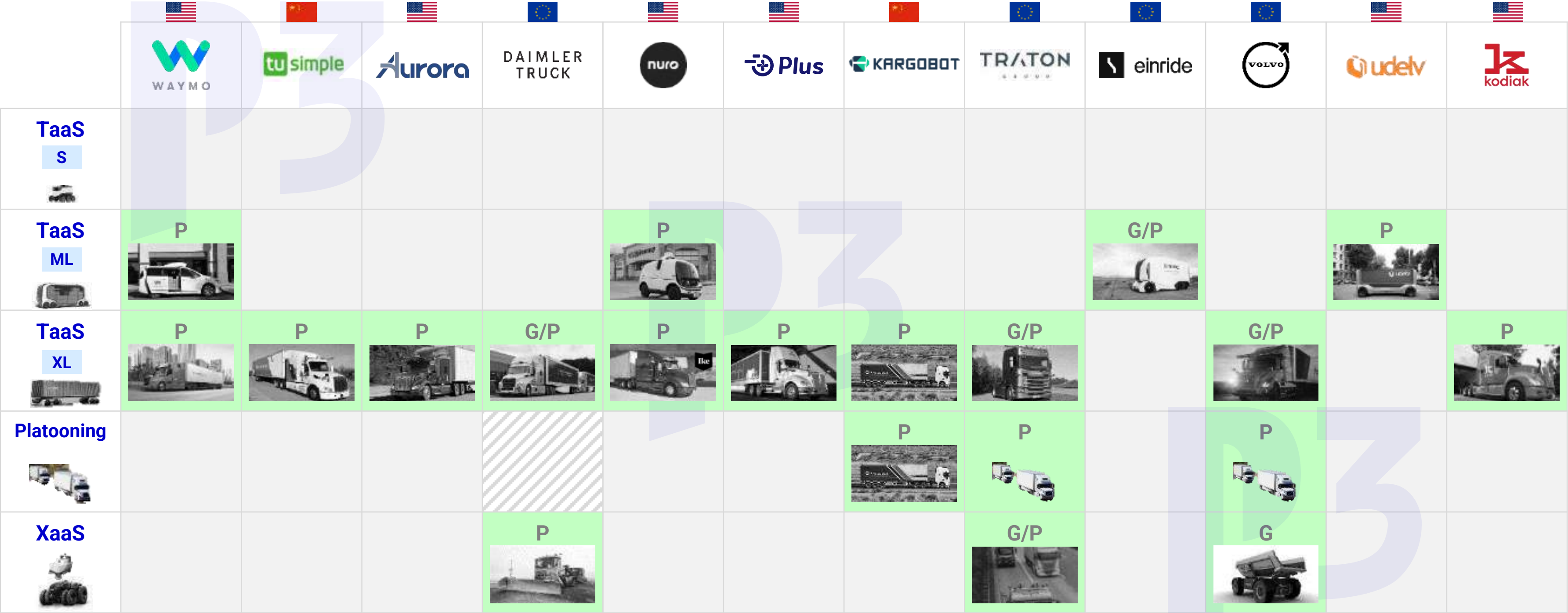


Hub-and-spoke transportation from a hub to different spokes incl. drayage runs

ROBO TRANSPORTER

Robotransporter
Free float autonomous driving transport vehicles & other use cases such as shuttles

09 TaaS & Carrier-Owned



	🇺🇸 WAYMO	🇨🇳 tusimple	🇺🇸 Aurora	🇪🇺 DAIMLER TRUCK	🇺🇸 nuro	🇺🇸 Plus	🇨🇳 KARGOBOT	🇪🇺 TRATON	🇪🇺 einride	🇪🇺 VOLVO	🇺🇸 udelv	🇺🇸 kodiak
TaaS **S**												
TaaS **ML**	P				P				G/P		P	
TaaS **XL**	P	P	P	G/P	P	P	P	G/P		G/P		P
Platooning				▨			P	P		P		
XaaS				P				G/P		G		

🟩 Activities ⬜ No activities ▨ Stopped activities G=Gated Area P=Public Area

09 TaaS & Carrier-Owned | Longlist

	🇺🇸 Gatik	🇺🇸 amazon	🇨🇳 pony.ai	🇪🇺 IVECO	🇺🇸 Ford	🇺🇸 TESLA	🇨🇳 TRUNK主线科技	🇨🇳 INCEPTIO TECHNOLOGY	🇪🇺 STARSHIP	🇪🇺 Yandex	🇺🇸 TORC	🇺🇸 LOCOMOTION
TaaS **S**		🟩 P			🟩 P				🟩 G/P	🟩 P		
TaaS **ML**	🟩 P	🟩 P	🟩 P		🟩 P							
TaaS **XL**		🟩 P	🟩 P	🟩 P	🟩 P	🟩 P	🟩 P	🟩 P			🟩 P	
Platooning			🟩 P	🟩 P	🟩 P	🟩 P						🟩 P
XaaS												

🟩 Activities ⬜ No activities ▨ Stopped activities G=Gated Area P=Public Area

09 TaaS & Carrier-Owned | Longlist

UPDATE

	🇨🇳 SAIC	🇨🇳 NEOLIX	🇰🇷 HYUNDAI MOTOR GROUP	🇪🇺 DAF	🇺🇸 cruise	🇨🇳 阿里巴巴 Alibaba.com	🇨🇳 SHACMAN	🇨🇳 UNITY DRIVE	🇺🇸 FACTION	🇨🇦 nuport	🇨🇦 waabi	🇨🇳
TaaS **S** 			P 									
TaaS **ML** 		P 			P 	G 		P 	P 			P 
TaaS **XL** 	G/P 					P Da Man Lv - No picture available yet	G 			TBD 	P 	
Platooning 			P 	P 								
XaaS 								G/P 				p 

🟩 Activities ⬜ No activities ▨ Stopped activities G=Gated Area P=Public Area

09 TaaS & Carrier-Owned | Longlist

	🇪🇺 WAYVE	🇺🇸 serve	🇺🇸 Motional	🇪🇺 DELIVERS.AI	🇨🇳 westwell 西井科技	🇺🇸 kiwibot	🇺🇸 cartken	🇪🇺 STREETDRONE	🇨🇳 DEEPROUTE.AI	🇪🇺 TERAKI	🇨🇳 whale dynamic 惠尔智能	🇨🇳
TaaS **S** 		🟩 P 		🟩 P 		🟩 P 	🟩 P 			🟩 P 		
TaaS **ML** 	🟩 P 		🟩 P 					🟩 P 	🟩 P 		🟩 P 	
TaaS **XL** 					🟩 P 							🟩 P 
Platooning 												
XaaS 												

🟩 Activities ⬜ No activities ▨ Stopped activities G=Gated Area P=Public Area

09 TaaS & Carrier-Owned | Longlist

	🇨🇳 AUTRA TECH	🇪🇺 ZF	🇺🇸 MAGNA	🇪🇺 CLEVON	🇪🇺 driveblocks	🇨🇳 DEEPWAY	🇪🇺 LOXO	🇪🇺 Goggo network	🇨🇳 宏景智驾 HONG JING Drive	🇺🇸 tiny mile	🇺🇸 OTTONOMY.IO	🇰🇷 NEUBILITY
TaaS **S** 			🟩 P 	🟩 P 						🟩 P 	🟩 P 	🟩 P 
TaaS **ML** 							🟩 P 	🟩 P 				
TaaS **XL** 	🟩 P 	🟩 P 			🟩 P 	🟩 P 			🟩 P 			
Platooning 												
XaaS 					🟩 G 							

🟩 Activities ⬜ No activities ▨ Stopped activities G=Gated Area P=Public Area

09 TaaS & Carrier-Owned | Longlist

	🇺🇸 STACK	NEW 🇪🇺 robione	NEW 🇨🇳 九识 ZELOS
TaaS **S** 			
TaaS **ML** 		🟩 P 	🟩 P 
TaaS **XL** 	🟩 P 		
Platooning 			
XaaS 			

🟩 Activities ⬜ No activities ▨ Stopped activities G=Gated Area P=Public Area

09 Goods Transport Layer Description

LAYER 1		LAYER 2	LAYER 3	LAYER 4	LAYER 5
Sensor Set / SoC / Computing HW	SW-Stack / Virtual Driver	Self-Driving ready Vehicle	Fleet, Hub & Tele Operations	Transport & Platform Provider	Infrastructure

Self-Driving System (SDS) is the sum of all necessary systems to realize self driving level 4 (SAE). Key functionalities are sensor data fusion, object detection, localization, prediction, environment interpretation, trajectory planning and actuator control.

The HW stack includes sensors, SoC and computing platforms, for example, while the SW stack covers the virtual driver, among others.

Self-Driving Vehicles (SDV) are considered L4 ready vehicles with an integrated and homologated SDS (sensors, computing hardware and software), which operate in a specific ODD (Operational Design Domain).

Fleet Operators potentially own, operate and maintain a fleet of self-driving vehicles. It may be necessary that a fleet operator is responsible for fleet intelligence functions and technical supervision or remote control (**remote assistance**). In case of TaaS the fleet operator may also be responsible for **hub operations** within the freight network. Therefore, Layer 3 covers both physical and digital fleet operations.

Transport providers (i.e., carriers) carry goods from shippers (e.g., grocery stores) to B2B or B2C customers using autonomous vehicles. Freight matching may be executed by **Platform providers** that connect shippers and carriers or transport demand and supply. They are responsible for order management or disposition planning based on data analysis and simulation.

The service area and its **infrastructure** are core elements to enable an AD service. Infrastructure includes the vehicles' IT infrastructure (especially cloud services and backend), V2X technology and takes into account human behavior prediction in that specific scenery.

09 Goods Transport Layer Description

EXEMPLARY TASKS PER LAYER

LAYER 1

Sensor Set / SoC / Computing HW

- HW development
- HW production
- After sales
- Automotive approval
- Sensor testing & approval

⋮

Virtual Driver (SW-Stack)

- SW development
- Simulation
- Prediction
- SDS licensing
- SW testing & approval
- HD Mapping
- Verification & validation

⋮

LAYER 2

Self-Driving ready Vehicle

- Design & development
- Redundant chassis
- SDS integration
- SDV testing
- After sales
- Production
- Logistics
- Sales channel
- Homologation
- Pricing

⋮

LAYER 3

Fleet, Hub & Tele Operations

- Fleet financing
- Insurance
- Fleet depot
- Cleaning
- Maintenance
- Backend (Layer 1-4)
- Concessions
- Fleet Control Center
- Teleoperations
- Hub Operations
- Driver sideline activities

⋮

LAYER 4

Transport & Platform Provider

- Logistics platform
- Interface connection
- Disposition planning
- Fleet Intelligence (e.g., fleet & ride optimization)
- Order management
- Booking
- Routing
- Pricing
- Payment
- Customer service
- Customer authentication (delivery services)

⋮

LAYER 5

Infrastructure

- Localization
- 3rd party HD maps
- V2X (e.g., cellular, satellite, WIFI)
- Cloud infrastructure
- Service area

⋮

10

TaaS & Carrier-Owned NAR

Partnering & Value Chain, Level 4 Target & P3 Assessment

Source: Daimler Truck

10 TaaS & Carrier-Owned | NAR 🇺🇸

LAYER 1				LAYER 2		LAYER 3		LAYER 4	LAYER 5		
Sensors / SoC / Computing HW		SW-Stack		Self-Driving ready Vehicle		Fleet, Hub & Tele Operations		Transport & Platform Provider	Infrastructure		
Sensors	Computing HW, SoC	Virtual Driver	Virtual testing, V&V, OS	Vehicles	Components	Physical & Administration	Virtual Fleet Management	Digital freight matching / Transport	3rd party HD Maps	Cloud	V2X & Others
WAYMO 🔵	intel 🔴	WAYMO ▨		FREIGHTLINER 🔴		Not announced		Partnerships with Uber Freight, J.B. Hunt, UPS, and C.H. Robinson have ended by July 2023 due to focus on ride haling	Not announced		
LUMINAR 🟢 AEVA 🔴 ♦		TORC ▨ algolux 🔹	TNO innovation for life 🔴 Applied Intuition 🔴 foretellix 🔴	FREIGHTLINER 🔵		PENSKE 🔴		SCHNEIDER 🔴 C.R.England 🔴 Uber Freight 🔴 ♦		aws 🔴	
Plus 🔵 OUSTER 🔴 TELEDYNE FLIR 🔴 AEVA 🔴 LUMINAR 🔴	NVIDIA 🔴	Plus ▨	BlackBerry 🟢	PACCAR 🔴 NAVISTAR 🔴 IVECO 🔴 SAIC 🟢 FAW GROUP 🔴 JAC 🔴	Cummins 🔴 VELOCITI 🔴 SCHAEFFLER 🔴 BOSCH 🔴	GOODYEAR 🔴		amazon 🟢 SF EXPRESS 顺丰速运 🔴 货车帮 🔴 CJ 荣庆物流 Rokin Logistics 🔴 WORLDEX 🔴 ZTO 中通快递 ZTO EXPRESS 🔴 DSV dm 🔴		aws 🔴	Transurban 🔴

▨ **Core Business** 🔴 **Partnership** or supplier deal 🟢 **Investment** 🔹 **Acquisition** 🔵 **Parent / Subsidiary** ♦ **Update**

10 TaaS & Carrier-Owned | NAR

LAYER 1				LAYER 2		LAYER 3		LAYER 4	LAYER 5		
Sensors / SoC / Computing HW		**Virtual Driver (SW-Stack)**		**Self-Driving ready Vehicle**		**Fleet, Hub & Tele Operations**		**Transport & Platform Provider**	**Infrastructure**		
Sensors	Computing HW, SoC	Virtual Driver	Virtual testing, V&V, OS	Vehicles	Components	Physical & Administration	Virtual Fleet Management	Digital freight matching / Transport	3rd party HD Maps	Cloud / Data Storage	V2X & Others
LUMINAR 🔴 HESAI 🔴 ZF 🔴	NVIDIA 🔴 Ambarella 🔴	kodiak	Applied Intuition 🔴	KENWORTH The World's Best 🔴 PACCAR 🔴 BMW 🟢	Cummins 🔴 VICOR 🔴	SK 🔴 BRIDGESTONE 🔴🟢 Pilot 🔴🟢 Ryder 🔴 ❗		ceva 🔴 U.S. XPRESS 🔴 10 ROADS 🔴 IKEA 🔴 WERNER ENTERPRISES 🔴 Forward 🔴 Tyson 🔴 C.R.England 🔴 LOADSMITH 🔴 MAERSK 🔴	Not announced		Drivewyze 🔴
Not announced		waabi		Peterbilt 🔴 VOLVO 🟢		Not announced		Uber Freight 🔴	Not announced		
Aurora 🔵 blackmore 🔹 OURS 🔹 Continental 🔴	NVIDIA 🔴 Continental 🔴	Aurora Uber ATG 🔹		PACCAR 🔴 FCA 🔴 DAF 🔴 KENWORTH 🔴 VOLVO 🔴	Continental 🔴	Ryder 🔴	Aurora 🔵	FedEx 🔴 amazon 🟢 U.S. XPRESS 🔴 Uber Freight 🔴 WERNER ENTERPRISES 🔴 Covenant 🔴 Hirschbach 🔴		aws 🔴	Continental 🔴

Core Business 🔴 **Partnership** or supplier deal 🟢 **Investment** 🔹 **Acquisition** 🔵 **Parent / Subsidiary** ❗ **Update**

10 TaaS & Carrier-Owned | NAR 🇺🇸

LAYER 1				LAYER 2		LAYER 3		LAYER 4	LAYER 5		
Sensors / SoC / Computing HW		**Virtual Driver (SW-Stack)**		**Self-Driving ready Vehicle**		**Fleet, Hub & Tele Operations**		**Transport & Platform Provider**	**Infrastructure**		
Sensors	Computing HW, SoC	Virtual Driver	Virtual testing, V&V, OS	Vehicles	Components	Physical & Administration	Virtual Fleet Management	Digital freight matching / Transport	3rd party HD Maps	Cloud / Data Storage	V2X & Others
OUSTER 🔴		Gatik		ISUZU 🔴 Ford 🔴	Cummins 🔴 GOODYEAR 🟢🔴	GOODYEAR 🟢🔴 Ryder 🟢🔴 chargepoin+ 🔴		Walmart 🔴 express 🔴 KBX 🔴 GP Georgia-Pacific 🔴 pitney bowes 🔴 Kroger 🔴 Tyson 🔴	Not announced		
HESAI 🔴 OUSTER 🔴 LUMINAR 🔴	NVIDIA 🔴 arm 🔴 ❗	nuro Ike 🔵	foretellix 🔴 ❗	nuro ● BYD 🔴 TOYOTA 🟢	Autoliv 🔴		nuro ●	ELEVEN 🔴 Domino's Pizza 🔴 Kroger 🔴 NFI 🔴 Uber 🔴 FedEx 🔴 Walmart 🔴 DHL 🔴 Ryder 🔴		Google 🔴	
Velodyne Lidar 🔴 SAIPS 🔵		DELIVERS.AI 🟢	AVL 🔴	Ford		Not announced		Hermes 🔴 Walmart 🔴 POSTMATES 🔴 Domino's Pizza 🔴	Not announced		

Core Business 🔴 **Partnership** or supplier deal 🟢 **Investment** 🔵 **Acquisition** ● **Parent / Subsidiary** ❗ **Update**

10 TaaS & Carrier-Owned | NAR 🇺🇸

LAYER 1		LAYER 2	LAYER 3	LAYER 4	LAYER 5
Sensors / SoC / Computing HW	**Virtual Driver (SW-Stack)**	**Self-Driving ready Vehicle**	**Fleet, Hub & Tele Operations**	**Transport & Platform Provider**	**Infrastructure**
Sensors Computing HW, SoC	Virtual Driver Virtual testing, V&V, OS	Vehicles Components	Physical & Administration Virtual Fleet Management	Digital freight matching / Transport	3rd party HD Maps Cloud / Data Storage V2X & Others
mobileye 🔴 OUSTER 🔴	mobileye 🔴	udelv TOYOTA 🔴 Ford 🔴	udelv 🔵	Planzer 🔴 ZIEGLER 🔴 DONLEN 🔴 Walmart 🔴 XL 🔴	mobileye 🔴
Not announced	Aurora 🟢 Plus 🔴	RIVIAN 🟢 CANVAS technology 🔹 dispatch 🔹	Not announced	amazon	aws 🔵
TESLA 🔵 tsmc 🔴	TESLA 🔵	TESLA	Not announced	Not announced	Not announced

Core Business 🔴 **Partnership** or supplier deal 🟢 **Investment** 🔹 **Acquisition** 🔵 **Parent / Subsidiary** ❗ **Update**

LEVEL 4 TARGET & P3 ASSESSMENT

10 TaaS & Carrier-Owned | NAR

	What to expect?	Latest News		Announced L4 target [1) ´23	´24	´25	´26	´27
WAYMO	The Waymo Driver has **over a decade of deep AD experience** including **millions of miles on public roads** and **billions of miles in simulation**. In particular, we believe that the partnership with Daimler offers a bright future perspective for Waymo's freight haulage initiative.	- Waymo puts the brakes on self-driving trucks program. *(26.07.2023)*	READ	Focus on ride hailing				
TORC	Torc is an independent **subsidiary of Daimler Truck AG** and the **first AV company to enter an integrated partnership** with a **truck OEM**. Torc and DT are ramping up development and testing in the US. Increased public visibility in 2022 shows Torc is **a leading autonomous trucking company**.	- Daimler Truck and TORC Robotics select Aeva to supply advanced 4D LiDAR technology for series-production autonomous trucks. *(09.01.2024)* UPDATE	READ					◆
Plus	PlusDrive follows an **evolutionary path from L2++ to L4**. **First European pilot projects in cooperation with IVECO were announced**. That's a different approach as pilot projects of leading tech providers have so far been limited mainly to US and China.	- Plus launches open platform for autonomy to scale deployment of all levels of autonomous driving technology. *(13.02.2024)* UPDATE	READ		◆			
kodiak	Kodiak Robotics develops autonomous technology for long-haul trucking and carried the **first commercial freight just eight months after being founded.** After long considering Kodiak as an acquisition candidate, they seem to be becoming **one of the strongest players in the market**.	- Ryder adds Kodiak Robotics to its autonomous trucking dance card. *(23.01.2024)* UPDATE	READ			◆		
waabi	Toronto-based Waabi is renowned for both it's founder and its **closed-loop simulator**, Waabi World, which targets an **AI-first approach**. Waabi has entered promising partnerships with Volvo and Uber Freight. The company is worth observing.	- Waabi partners with MIT Center for Transportation & Logistics, becomes first AV company to join the supply chain exchange. *(02.11.2023)*	READ					
Aurora	In addition to MaaS, Aurora is **focusing primarily on TaaS** and has already entered into truck **collaborations with PACCAR and Volvo**. These **collaborations promise to scale their test fleet** to get their product ready for production. To survive, Aurora now has to deliver.	- Self-driving vehicle company Aurora cuts 3% of its workforce. *(24.01.2024)* UPDATE	READ					◆
Gatik	Gatik focuses on **short-haul, B2B logistics** for the **retail industry.** More specifically, hub-and-spoke supply chain operations. The vehicles are restricted to **fixed, repeatable routes.** Gatik has found a niche that no other market player is dedicated to now.	- Goodyear and Gatik further advance safety of autonomous vehicles with tire intelligence integration. *(09.01.2024)* UPDATE	READ	Claimed L4 target reached late 2021. (Arkansas: short-haul coop. with Walmart)				

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1) Definition L4 target: commercial self-driving service operated within a specific ODD without a safety driver.

10 TaaS & Carrier-Owned | NAR 🇺🇸

	What to expect?	Latest News		Announced L4 target 1)				
				´23	´24	´25	´26	´27
nuro	Nuro is a **pioneer in last-mile deliveries** with a special purpose vehicle. Contrary to media reports and its own statements, however, it is very difficult to see a vehicle 'in the wild'. **Scaling** thus **seems to prove difficult**…	• Arm and Nuro Partner to Deliver AI-first Autonomous Technology for Commercial Scale. *(22.02.2024)* UPDATE	READ	Claimed L4 target reached early 2021. (Houston: TaaS ML, coop. with Domino's)				
Ford	After Argo's shutdown, it's unclear how Ford will proceed for urban delivery. Nevertheless, **Ford Otosan is cooperating with AVL** in this area. Whether they can keep up with the leading AD Truck companies remains questionable.	• Ford, VW-backed Argo AI is shutting down. *(26.10.2022)*	READ	Not announced.				
udelv	Udelv has been doing **commercial deliveries for Walmart** for some time. With the **'Transporter'** they now have their own **versatile special purpose vehicle**, equipped with Mobileye's promising SDS. Exciting concept that needs to be proven.	• Ziegler orders autonomous and electric delivery vehicles from the company Udelv. *(05.01.2022)*	READ	◆				
amazon	Amazon has **invested in Aurora and conducted road tests with Embark**. Their goal could be to cover the entire logistics chain - in the future also with autonomous trucks, delivery vehicles and last mile delivery solutions.	• Amazon stops field tests of its delivery robot Scout. *(07.10.2022)*	READ	Not announced.				
TESLA	Little is still known about Tesla's Semi Truck. According to the company, it will be the first vehicle to drive fully autonomously. The truck is to be equipped with **'enhanced' autopilot functionalities for automated highway driving**. At least we still have doubts.	• Apple chip maker TSMC to manufacture Tesla's new FSD hardware. *(23.11.2022)*	READ	Not announced.				

1) Definition L4 target: commercial self-driving service operated within a specific ODD without a safety driver.

11

TaaS & Carrier-Owned Asia

Partnering & Value Chain, Level 4 Target & P3 Assessment

Source: Pony.ai

11 TaaS & Carrier-Owned | Asia

LAYER 1				LAYER 2		LAYER 3		LAYER 4	LAYER 5		
Sensors / SoC / Computing HW		**SW-Stack**		**Self-Driving ready Vehicle**		**Fleet, Hub & Tele Operations**		**Transport & Platform Provider**	**Infrastructure**		
Sensors	Computing HW, SoC	Virtual Driver	Virtual testing, V&V, OS	Vehicles	Components	Physical & Administration	Virtual Fleet Management	Digital freight matching / Transport	3rd party HD Maps	Cloud	V2X & Others
LUMINAR 🔴 HESAI 🔴 [illegible] 🔴 pony.ai 🔵		pony.ai		HYUNDAI MOTOR GROUP 🔴 SANY 🟢🔴 中国重汽 SINOTRUK 🟢🔴 NEOLIX 🔴		CYANTRON 🟢🔴		Yamibuy 🔴 [illegible] 🟢🔴 Meituan 🔴	Not announced		
HESAI 🔴	NVIDIA 🔴	WeRide 文远知行		JMC 🔴		Not announced		ZTO 中通快递 ZTO EXPRESS 🔴	Not announced		
OUSTER 🔴 TRUNK 主线科技 🔵 BOSCH 🟢	Horizon Robotics 🔴	TRUNK 主线科技		中国重汽 SINOTRUK 🔴 北汽集团 BAIC Group 🟢 NIO 🟢		TRUNK 主线科技 🔵		德邦 🔴 sto 申通快递 express 🔴 [illegible] 🔴 [illegible] 🔴 JDL 京东物流 🔴 [illegible] 🔴	Not announced		

▨ **Core Business** 🔴 **Partnership** or supplier deal 🟢 **Investment** 🔹 **Acquisition** 🔵 **Parent / Subsidiary** ◆ **Update**

11 TaaS & Carrier-Owned | Asia

LAYER 1				LAYER 2		LAYER 3		LAYER 4	LAYER 5		
Sensors / SoC / Computing HW		SW-Stack		Self-Driving ready Vehicle		Fleet, Hub & Tele Operations		Transport & Platform Provider	Infrastructure		
Sensors	Computing HW, SoC	Virtual Driver	Virtual testing, V&V, OS	Vehicles	Components	Physical & Administration	Virtual Fleet Management	Digital freight matching / Transport	3rd party HD Maps	Cloud	V2X & Others
[illegible] 🔴 ZVISION 🔴 BOSCH 🔴	Ambarella 🔴 Horizon Robotics 🔴	**INCEPTIO TECHNOLOGY**		NIO 🟢 DONGFENG 🔴 中国重汽 SINOTRUK 🔴	ZF 🔴	Not announced		JDL 京东物流 🟢 Meituan 🟢 壹米滴答 🔴 KYE 跨越速运 KUAYUE-EXPRESS 🔴 德邦快递 DEPPON EXPRESS 🔴 [illegible] 🔴 SF EXRPESS 顺丰速运 🔴 中国邮政 CHINA POST 🔴 中国物流 China Logistics 🔴 ZTO 中通快递 ZTO FREIGHT 🔴 sto 申通快递 express 🔴 Nestlé 🔴 [illegible] 🔴 Uton 🔴	NAVINFO 🔴		
HESAI 🔴		SAIC 🔴 Plus 🟢		**SAIC**		Not announced		Not announced	Not announced		
OUSTER 🔴 HESAI 🔴	Horizon Robotics 🔴 NVIDIA 🔴	pony.ai 🔴 **NEOLIX**		NEOLIX ●		Not announced		Yum China 🔴 KFC 🔴 Pizza Hut 🔴 foodpanda 🔴 Meituan 🔴 JDL 京东物流 🔴 FedEx 🔴 Grab Food 🔴			NCS 🔴 FIXPOSITION 🔴

Core Business 🔴 **Partnership** or supplier deal 🟢 **Investment** 🔵 **Acquisition** ● **Parent / Subsidiary** ❗ **Update**

11 TaaS & Carrier-Owned | Asia

LAYER 1				LAYER 2		LAYER 3		LAYER 4	LAYER 5		
Sensors / SoC / Computing HW		SW-Stack		Self-Driving ready Vehicle		Fleet, Hub & Tele Operations		Transport & Platform Provider	Infrastructure		
Sensors	Computing HW, SoC	Virtual Driver	Virtual testing, V&V, OS	Vehicles	Components	Physical & Administration	Virtual Fleet Management	Digital freight matching / Transport	3^{rd} party HD Maps	Cloud	V2X & Others
OUSTER 🔴 [illegible] 🔵 HESAI 🔴 robosense 🔴 ZVISION 🔴	NVIDIA 🔴	▨ DEEPROUTE.AI	▨	ISUZU 🔴		Not announced		Alibaba 🟢 德邦快递 DEPPON EXPRESS 🔴	Tencent 腾讯 🔴 SD maps – probably consumer vehicles only ❗		
HESAI 🔴 arbe 🔴 WEIFU威孚 🔴	Horizon Robotics 🟢 ❗	▨ KARGOBOT	▨	SHACMAN 🔴		Not announced		Not announced	Not announced		
Not announced		Baidu 百度 apollo 🔵		▨ DEEPWAY	▨	Not announced		SAP 🔴 LIONBRIDGE 🔵			Qualcomm 🔴

▨ **Core Business** 🔴 **Partnership** or supplier deal 🟢 **Investment** 🔵 **Acquisition** 🔵 **Parent / Subsidiary** ❗ **Update**

11 TaaS & Carrier-Owned | Asia 🇨🇳

LAYER 1				LAYER 2		LAYER 3		LAYER 4	LAYER 5		
Sensors / SoC / Computing HW		SW-Stack		Self-Driving ready Vehicle		Fleet, Hub & Tele Operations		Transport & Platform Provider	Infrastructure		
Sensors	Computing HW, SoC	Virtual Driver	Virtual testing, V&V, OS	Vehicles	Components	Physical & Administration	Virtual Fleet Management	Digital freight matching / Transport	3rd party HD Maps	Cloud	V2X & Others
LUMINAR 🔴	NVIDIA 🟢	tu simple	aws 🔴	TRATON 🟢		GOODYEAR 🟢		Not announced		aws 🔴	
HESAI 🔴				SHACMAN 🔴		Ryder 🔴					
ROBOSENSE 🔴						HILLWOOD 🔴					
AEVA 🔴											
SONY 🔴											
SI 🔴											
ZF 🔴											

Core Business 🔴 **Partnership** or supplier deal 🟢 **Investment** 🔵 **Acquisition** 🔵 **Parent / Subsidiary** ❗ **Update**

11 TaaS & Carrier-Owned | Asia

	What to expect?	Latest News		Announced L4 target [1]				
				´23	´24	´25	´26	´27
pony.ai	In public, Pony.ai is rather known for its L2+ solutions for OEMs as well as robotaxi deployments. However, Pony **will jointly develop premium autonomous heavy-duty truck with SANY and Sinotrans**. They are among the **pioneers in the Chinese self-driving truck market**.	- Pony.ai permitted to conduct Level 4 autonomous truck platooning tests in Guangzhou. *(22.11.2023)* UPDATE	READ		◆			
WeRide 文远知行	WeRide, initially focusing on Robotaxi business, unveiled **China's very first L4 self-driving cargo van** in September 2021. While WeRide is a leader in China in terms of robotaxis, we are curious to see if they will take this position in the logistics space as well.	- JMC, WeRide to start pilot operation of autonomous urban freight service in late 2023. *(12.07.2023)*	READ	Not announced.				
TRUNK 主线科技	**Investments from Bosch, Nio and BAIC** made Trunk.Tech known outside. It is without question **one of the most promising startups** in the Chinese self-driving truck / freight haulage space.	- Trunk.Tech, CMST to jointly build smart bulk commodity logistics transportation project. *(28.12.2022)*	READ	Not announced.				
INCEPTIO TECHNOLOGY	Chinese startup with the **aim to build a nation-wide freight network** using autonomous trucks. Unlike other AV truck companies, **Inceptio initially focuses on L3**. However, Inceptio could possibly be a hidden champion among autonomous trucks with regard to full autonomy - at least in China.	- Dongfeng, Inceptio Technology delivers co-developed smart heavy-duty trucks. *(27.11.2023)* UPDATE	READ		◆			
SAIC	The '**intelligent driving control system**' is independently developed by SAIC. Beyond that, little is known about the trucks from one of China's largest automotive manufacturer.	- Hesai Technology to deliver ADAS lidar for SAIC motor's new commercial vehicles. *(07.07.2023)*	READ	Not announced.				
NEOLIX	Nearly **1,000 Neolix delivery vehicles have been deployed** in nine countries and **over 30 cities worldwide**, with a cumulative mileage of more than 1.3 million kilometers. The shuttle may be compared with Nuro, which is currently focused exclusively on the US market.	- Pony.ai, Neolix team up on large-scale unmanned delivery application. *(22.03.2023)*	READ		◆			
DEEPROUTE.Ai	DeepRoute.ai **announced an autonomous medium-duty truck business line for urban logistics**. Having started a first commercialization project with Deppon Logistics, DeepRoute is **backed by Alibaba and its huge network** of ecommerce, logistics & community shopping, among others. Reads well.	- DeepRoute.ai collaborates with DEPPON LOGISTICS Co., LTD to expedite commercialization. *(20.06.2022)*	READ	Not announced.				

[1] Definition L4 target: commercial self-driving service operated within a specific ODD without a safety driver.

11 TaaS & Carrier-Owned | Asia

	What to expect?	Latest News		Announced L4 target[1]				
				´23	´24	´25	´26	´27
KARGOBOT	**KargoBot** was launched during Auto Shanghai 2023 **by MaaS giant DiDi** and focuses on a pilot vehicle approach with a human driver onboard and multiple L4 trucks following its lead. We will closely trace KargoBot's development.	- DiDi-backed KargoBot launches autonomous freight operations in Xinjiang. *(05.02.2024)* UPDATE	READ	Not announced.				
DEEP WAY	DeepWay - a **subsidiary of Baidu** - plans to offer heavy Level-3-trucks by June 2023. The vehicles will have a range of 300 km, and in addition to a fast-charging function, it will also be possible to swap batteries in 6 minutes. The integration of fuel cells is planned for the future.	- DeepWay delivers intelligent new energy heavy-duty trucks in Guangxi. *(04.12.2023)* UPDATE	READ		Between 2024 and 2026.			
tu simple	After the **end of the Navistar partnership** and withdrawal of unprofitable routes from its autonomous freight network, TuSimple's was eventually **exiting the US market by end of 2023**. As a leading self-driving truck developer in the US, the focus will now be in the Asian market.	- TuSimple announces intention to delist from Nasdaq. *(05.12.2023)* UPDATE	READ	Not announced.				

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[1] Definition L4 target: commercial self-driving service operated within a specific ODD without a safety driver.

12

TaaS & Carrier-Owned Europe

Partnering & Value Chain, Level 4 Target & P3 Assessment

Source: TRATON

12 TaaS & Carrier-Owned | Europe

LAYER 1				LAYER 2		LAYER 3		LAYER 4	LAYER 5		
Sensors / SoC / Computing HW		**SW-Stack**		**Self-Driving ready Vehicle**		**Fleet, Hub & Tele Operations**		**Transport & Platform Provider**	**Infrastructure**		
Sensors	Computing HW, SoC	Virtual Driver	Virtual testing, V&V, OS	Vehicles	Components	Physical & Administration	Virtual Fleet Management	Digital freight matching / Transport	3rd party HD Maps	Cloud	V2X & Others
Luminar 🟢🔴 AEVA 🔴 ❗		TORC 🔵 Waymo 🔴	Applied Intuition 🔴 Apex.AI 🟢	DAIMLER TRUCK		Not announced		Not announced	tomtom 🔴	aws 🔴	
Not announced		TuSimple 🟢🔴 TRATON ●	Applied Intuition 🔴 BTC embedded systems 🔴	TRATON	Knorr-Bremse 🔴 LEONI 🔴 BOSCH 🔴	FERNRIDE 🔴		HAVI 🔴 Ahola Transport 🔴			Die Autobahn 🔴
	NVIDIA 🔴	einride ● embotech 🔴		einride		einride ●		OATLY! 🔴 GE Appliances 🔴 Michelin 🔴 DB Schenker 🔴 Lidl 🔴	DEEPMAP 🔴		

Core Business 🔴 **Partnership** or supplier deal 🟢 **Investment** 🔵 **Acquisition** ● **Parent / Subsidiary** ❗ **Update**

12 TaaS & Carrier-Owned | Europe

LAYER 1				LAYER 2		LAYER 3		LAYER 4	LAYER 5		
Sensors / SoC / Computing HW		SW-Stack		Self-Driving ready Vehicle		Fleet, Hub & Tele Operations		Transport & Platform Provider	Infrastructure		
Sensors	Computing HW, SoC	Virtual Driver	Virtual testing, V&V, OS	Vehicles	Components	Physical & Administration	Virtual Fleet Management	Digital freight matching / Transport	3rd party HD Maps	Cloud	V2X & Others
	NVIDIA 🔴	Aurora 🔴 waabi 🟢	foretellix 🔴	**VOLVO** ISUZU 🔴			VOLVO 🔵	DFDS 🔴 DHL 🔴 Uber Freight 🔴 ascend 🔴 CONVOY 🔴		Not announced	
Yandex 🔵		**Yandex**		Yandex 🔵		Not announced		GRUBHUB 🔴 ПОЧТА РОССИИ 🔴 Яндекс Еда 🔴 Яндекс Лавка 🔴 беру! 🔴		Not announced	
Plus 🔴	NVIDIA 🔴	Plus 🔴		**IVECO**		Not announced		DSV dm 🔴	here 🔴		Continental 🔴

Core Business 🔴 **Partnership** or supplier deal 🟢 **Investment** ● **Acquisition** 🔵 **Parent / Subsidiary** ❗ **Update**

12 TaaS & Carrier-Owned | Europe

LAYER 1				LAYER 2		LAYER 3		LAYER 4	LAYER 5		
Sensors / SoC / Computing HW		SW-Stack		Self-Driving ready Vehicle		Fleet, Hub & Tele Operations		Transport & Platform Provider	Infrastructure		
Sensors	Computing HW, SoC	Virtual Driver	Virtual testing, V&V, OS	Vehicles	Components	Physical & Administration	Virtual Fleet Management	Digital freight matching / Transport	3rd party HD Maps	Cloud	V2X & Others
Not announced		▨ WAYVE		MAXUS 🔴 JAGUAR 🔴		Admiral 🔴		ocado GROUP 🔴 dpd 🔴 ASDA 🔴		Microsoft 🔴	
kodiak 🔴	tusimple 🔴 ZF ●	ZF ● embotech 🔴🟢 STRADVISION 🔴🟢		CLEVON 🔴	▨ ZF LOCOMOTION 🔴		ZF ●	ZF ●		Microsoft 🔴	
Si 🔴		▨ driveblocks	Applied Intuition 🔴 Apex.AI 🔴		pepper 🔴 SCHAEFFLER PARAVAN 🔴	Not announced		Not announced		Not announced	

▨ **Core Business** 🔴 **Partnership** or supplier deal 🟢 **Investment** 🔵 **Acquisition** ● **Parent / Subsidiary** ◆ **Update**

12 TaaS & Carrier-Owned | Europe

LAYER 1				LAYER 2		LAYER 3		LAYER 4	LAYER 5		
Sensors / SoC / Computing HW		SW-Stack		Self-Driving ready Vehicle		Fleet, Hub & Tele Operations		Transport & Platform Provider	Infrastructure		
Sensors	Computing HW, SoC	Virtual Driver	Virtual testing, V&V, OS	Vehicles	Components	Physical & Administration	Virtual Fleet Management	Digital freight matching / Transport	3rd party HD Maps	Cloud	V2X & Others
INNOVIZ TECHNOLOGIES 🔴			ROSAS 🔴	**LOXO**		NOVIV 🔴	HEIA-FR HTA-FR 🔴	MIGROS 🔴	Not announced		
	mobileye 🔴	oxa 🔴 mobileye 🔴	oxa 🔴	DELIVERS.AI 🔴 OTTONOMY.IO 🔴 NEUBILITY 🔴		**Goggo network**	oxa 🔴 mobileye 🔴	Carrefour 🔴 Glovo 🔴 flipdish 🔴 Dia 🔴 🔴 areas 🔴 Pascual 🔴	Not announced		
	NVIDIA 🔴 Texas Instruments 🔴	STARSHIP 🔵		**STARSHIP**		Not announced		GRUBHUB 🔴 🔴 veriff 🔴 DOORDASH 🔴 Domino's Pizza 🔴 co op 🔴 Bolt 🔴	Not announced		

Core Business 🔴 **Partnership** or supplier deal 🟢 **Investment** 🔵 **Acquisition** 🔵 **Parent / Subsidiary** ❗ **Update**

12 TaaS & Carrier-Owned | Europe

	What to expect?	Latest News		Announced L4 target 1)				
				´23	´24	´25	´26	´27
DAIMLER TRUCK	In addition to developing its own **SDS with subsidiary Torc**, the **Waymo Driver will be integrated into Daimler trucks**. This is an important step towards putting Daimler self-driving trucks on US roads. There is **no roadmap for the domestic market** yet.	- Daimler Truck and TORC Robotics select Aeva to supply advanced 4D LiDAR technology for series-production autonomous trucks. *(09.01.2024)* UPDATE	READ	Not announced.				
TRATON	**Investing in** and partnering with **TuSimple**, seems to be a good approach to bring autonomous trucks on the roads. However, it is **not announced how deep the partnership goes**. TRATON is hardly associated with autonomous trucking at present. In addition, TuSimple has run into difficulties.	- Autonomous truck sets course for the motorway. *(24.10.2023)*	READ		◆			
einride	The **Einride Pod** is unique from other self-driving trucks in that it has **no driver's cab**. The pod is now available for pre-order - **Level 3 and 4 features are expected to be available earliest 2023**. Whether these functions can keep their promise remains to be seen. We at least have doubts.	- Einride deploys first full time, daily commercial autonomous operations in partnership with GE Appliances. *(13.11.2023)* UPDATE	READ	L4 target reached within a very low complex ODD				
VOLVO	**Volvo and Aurora jointly develop autonomous trucks** that will be available through Uber Freight in the future. In addition, **Volvo invested in Waabi** and thus betting on a second horse. The approach seems to make sense in order not to be dependent on an SDS provider in its self-driving roadmap.	- Volvo Autonomous Solutions broadens operations in Texas, poised to revolutionize freight transport. *(08.06.2023)*	READ	Not announced.				
Yandex	As Russia is internationally isolated, Yandex will no longer play a role in the AV market.	- Russia's Yandex lays off two dozen US-based workers from its robot and self-driving teams. *(29.03.2022)*	READ	Claimed L4 target reached. (Moscow: TaaS S)				
IVECO	**IVECO and Plus are jointly developing self-driving trucks**, which is already completing its **first test drives in Europe**. **Pilot projects have already been announced** - so the two could be pioneers for autonomous trucks in Europe.	- IVECO, Plus, dm-drogerie markt and DSV launch automated trucking pilot in Germany. *(15.11.2023)*	READ	Not announced.				
WAYVE	Wayve does **not rely on a traditional AV stack**, **HD maps** and **hand-coded rules** but **rather focuses on its deep learning AI technology** and cameras - an ambitious undertaking in the competitive AD market. Let's see what's next for Wayve in the logistics space.	- Asda and Wayve launch UK's largest self-driving grocery home delivery trial. *(17.04.2023)*	READ	Not announced.				

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1) Definition L4 target: commercial self-driving service operated within a specific ODD without a safety driver.

12 TaaS & Carrier-Owned | Europe

	What to expect?	Latest News		Announced L4 target [1]				
				´23	´24	´25	´26	´27
ZF	ZF offers a **comprehensive portfolio for commercial vehicle automation** such as sensors and high-performance computers. While ZF has already **supplied L4 truck companies**, we are curious if ZF wants to become a full-stack provider with an own virtual driver - that would be ambitious.	• Clevon collaborates with ZF to orchestrate driverless last-mile delivery fleets. *(22.02.2023)*	READ	Not announced.				
driveblocks	driveblocks develops a **modular; scalable AD software** stack for commercial vehicles. **It allows OEMs/Tier1 to integrate it with their vehicles and solutions in an open and flexible way**. The solution targets the EU market first and is a differentiating, but also ambitious approach compared to other players.	• driveblocks and Apex.AI partner to offer the Mapless Autonomy Platform on top of safety-certified software development framework Apex.Grace. *(16.10.2023)*	READ	Not announced.				
LOXO	LOXO'S last mile delivery vehicle is reminiscent of some US and Chinese market players' solutions but is the **first vehicle of its kind made in Europe**. **Commercial success** in Europe **requires both a technically mature solution and a profitable business case**. Both will be a **huge challenge for LOXO**…	• Innoviz and LOXO enhance strategic partnership, deploying LiDAR technology in zero-emission autonomous delivery vehicles *(29.06.2023)*	READ	Not announced.				
Goggo network	**Goggo builds a European network** for **middle and last mile delivery services**. Mobileye and Oxbotica have been signed up - concrete details on the delivery services (e.g., vehicle type) are not yet known. We are curious to see whew Goggo will position itself in the future ecosystem.	• Pascual makes the first delivery in Spain for hospitality with an autonomous robot by Goggo Network [ES only]. *(31.05.2023)*	READ	Not announced.				
STARSHIP	Starship delivery robots completed **>6mn autonomous deliveries**. It is **unlikely that these robots will become widely accepted for last mile delivery**. However, there could certainly be use cases in gated areas.	• Tallinn-based Starship Technologies raises €83.6 million to make the robot delivery take over the streets. *(06.02.2024)* UPDATE	READ	Claimed L4 target reached. (UCLA / Bridgewater State University: TaaS S)				

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[1] Definition L4 target: commercial self-driving service operated within a specific ODD without a safety driver.

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X-as-a-Service

Use Cases and Market Insights

Source: Scania

13 XaaS

		Use Case	Exemplary Players
	**Municipal**	City/ street cleaning, snow removal, waste disposal service	TROMBIA ALBA ENWAY VIA WeRide 智行者 IDRIVERPLUS AW REMONDIS ROBOTICS
	**Airport**	Parking, runway snow cleaning, passenger transport, fueling, baggage handling, catering, ground maintenance	S.R navya be fluid oxbotica Rotterdam The Hague Airport Fraport YOUR LONDON AIRPORT Gatwick IAG Cargo VANDERLANDE
	**Harbor**	Cargo container, ferry on/ off loading (passenger/ food & beverage)	ISEE DFDS VOLVO PORT OF GOTHENBURG HELSINGBORGS HAMN PORT OF HELSINGBORG Port of Rotterdam SHACMAN HHLA tu simple KALMAR 秦皇岛港股份有限公司 QINHUANGDAO PORT CO., LTD.
	**Intralogistics**	Goods transport	THIRD WAVE AUTOMATION ups einride tu simple KALMAR EASY MILE DB SCHENKER embotech VECNA robotics FERNRIDE
	**Agriculture**	Harvesting, mowing works, seeding	VOLVO FENDT CLAAS NEW HOLLAND USACUCAR COGNITIVE PILOT STEV MOTION JOHN DEERE CNH INDUSTRIAL Acc ZTRACTOR BLUE WHITE ROBOTICS
	**Mining**	Mine haulage, spare part transport	VOLVO HITACHI CATERPILLAR SafeAI SUNCOR RioTinto WAYTOUS 慧拓 KOMATSU FMG Fortescue sensible 4 CODELCO

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