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Mapping the Automated Mobility Ecosystem

Landscape and Key Developments

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Contents

Abstract

This report presents a preliminary landscape analysis of the Connected, Cooperative and Automated Mobility (CCAM) ecosystem, based on the initial data collected through the Global CCAM Observatory. As the database continues to evolve, some information may be outdated or not yet fully validated. The analysis covers 122 automated mobility services and maps 1,940 component–supplier pairs across 937 unique companies operating in 12 technology categories. The report examines the geographic distribution of service deployments, the composition and sourcing patterns of technology stacks, and the structure of the industrial ecosystem underpinning automated driving. A dedicated assessment of Europe's position reveals that EU-based suppliers account for approximately 18% of all mapped component–supplier pairs and 165 unique companies, with relative strengths in connectivity, cybersecurity, and V2X communication, but notable gaps in software-intensive categories such as AI and planning, cloud infrastructure, and ADS development. The analysis further explores partnership networks among CCAM actors and provides an overview of technology maturity levels and market trends across key component domains. The findings are intended to support evidence-based policymaking on the competitiveness and strategic autonomy of the European CCAM sector.

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Executive Summary

The present report is the first deliverable of the Global CCAM Observatory, currently being established by the Joint Research Centre on behalf of the European Commission. It provides the results of the first attempt to map the global industrial ecosystem contributing to Connected and Automated Mobility (CCAM) across services, suppliers, and enabling technologies.

The report tries to shed light on the EU's position in a rapidly evolving global and highly specialised sector of the automotive market where technological leadership, particularly in software and AI-driven components, is becoming critical. The Observatory aims to combine deployment, supply chain, and technology maturity data into a single analytical framework to support future actions by the European Commission and the relevant EU stakeholders.

Key Conclusions

The global CCAM ecosystem is growing rapidly but remains in transition. Most deployments are still at pilot stage, and **market leadership is not yet fully established**. However, this window is narrowing as dominant technologies and business models begin to emerge.

A **clear structural gap** seems visible in Europe's position:

- The EU is **particularly strong in some parts of the hardware layer** (e.g., sensors, vehicle systems, vehicle control, and actuators).
- It is relatively **less represented in software-driven areas**, such as artificial intelligence and decision-making systems — the parts of the value chain where future control and value are likely to concentrate.

At the same time:

- Large-scale commercial deployments are **concentrated in the United States and China** with smaller countries such as United Arab Emirates and Singapore emerging fast as a result of the internal political pressure.
- European activity remains fragmented and predominantly at pilot stage.

Industry trends are also starting to emerge:

- Leading developers are increasingly **integrating key technologies in-house**, especially software.
- This shifts influence away from suppliers and towards **platform owners**.

As a result, the EU faces increasing reliance on external suppliers, particularly in software-related technologies, where non-EU providers hold a leading position. While global supply chains ensure access to innovation, they also create strategic vulnerabilities, including exposure to geopolitical risks. Unfortunately, the fastest-growing technology areas — such as AI, connectivity, and advanced data processing — are the same areas where European presence remains comparatively limited.

Report Highlights

A market in transition

- The sector is expanding quickly but is not yet mature.

- Most technologies and firms are still evolving, leaving room for new entries — though this window may narrow as the market matures.

Global leadership is uneven

- The United States and China lead in **real-world deployment and commercial scale**.
- The EU has a **broad supply base**, but this has not yet translated into comparable deployment leadership.

Europe's strengths and weaknesses

- Strong position mostly in **hardware and engineering-intensive technologies**.
- Limited presence in **several automated driving software and AI layers**, which are becoming the core of automated driving systems.

Innovation gaps

- European startups focus mainly on **specialised components**, not integrated systems.
- A limited number of EU firms are currently developing **end-to-end platforms or large-scale services**.

Rising dependencies

- The EU relies heavily on **non-EU suppliers**, especially in critical software domains.
- Some technologies show **high geographic concentration**, increasing exposure to external risks.

Technology trends

- Growth is strongest in **AI, connectivity, and advanced sensing**.
- These are also the areas where Europe's position is weakest, creating a **strategic mismatch** between opportunity and capability.

1. Introduction

1.1. Background and Context

This section sets the background for the report by outlining the evolution of automated driving systems and their increasing relevance for policy and industrial strategy. It highlights both the technological progress from driver assistance to higher levels of automation and the growing importance of CCAM within the global competitive landscape and European policy framework.

1.1.1. Evolution of Driving Automation Systems

Driving automation systems have developed significantly over the past decade, evolving from basic driver assistance features to increasingly advanced automation capabilities. Early systems focused on specific functions such as adaptive cruise control or lane keeping assistance, operating under the direct supervision of a human driver. More recently, advances in sensing, artificial intelligence, connectivity and high-performance computing have enabled vehicles to handle complex driving tasks in defined operational domains, moving the technology towards SAE Level 4 ("SAE," 2021) driving automation (high driving automation).

Today, automated mobility (from SAE L3-L5) relies on the integration of a broad set of technological components spanning hardware systems such as sensors and computing platforms, software layers responsible for perception, planning and control, connectivity infrastructure linking vehicles to external services, alongside safety assurance frameworks that govern validation, verification, and certification of these systems. Development is increasingly moving from isolated research prototypes to real-world pilot deployments and commercial testing, highlighting the importance of understanding not only the technologies themselves but also the industrial ecosystem that produces and deploys them.

1.1.2. Policy and Market Relevance

Connected, cooperative and automated mobility (CCAM) has become an important area of focus for both transport policy and industrial strategy in Europe. The development of automated driving technologies raises hopes related to road safety, traffic efficiency, accessibility for underserved populations, and environmental sustainability. At the same time, it represents a strategic field of technological competition in which significant investments are being made by automotive manufacturers, technology companies and public authorities worldwide. Previous JRC analyses have also highlighted the growing importance of CCAM for Europe's industrial competitiveness and policy objectives (Alonso et al., 2019).

At the European level, the importance of coordinated action is reflected in several policy initiatives. The European Commission's Industrial Action Plan for the European automotive sector (European Commission, 2025) highlights the importance of digitalisation, automation, resilience, and innovation in maintaining the competitiveness of the European automotive industry. In parallel, the EU regulatory framework for AVs has begun to establish harmonised rules for the type-approval of automated driving systems through Commission Implementing Regulation (EU) 2022/1426 (European Commission, 2022). Against this backdrop, understanding the structure and dynamics of the global CCAM ecosystem is essential for informed policymaking, particularly regarding strategic autonomy and the positioning of European industry within global value chains.

1.2. Objectives and Scope of this Report

1.2.1. The CCAM Global Observatory

The CCAM Global Observatory is an initiative implemented by the Joint Research Centre in cooperation with DG RTD. It provides a structured knowledge hub for collecting, organising and analysing information on the automated mobility global ecosystem. The Observatory is built around a relational database comprising eight interlinked tables covering industry actors, technology components and their suppliers, market trends, deployed services, service-component linkages, partnerships and European startups.

Rather than relying on isolated pieces of data, the Observatory integrates multiple layers of information into a coherent analytical framework. This structured mapping supports a better understanding of where technological capabilities are concentrated, how value chains are organised, and where strategic dependencies or gaps may exist with particular attention to Europe's position within the global landscape.

1.2.2. Methodological Approach

The Observatory's analytical base combines structured desk research from public reports, official sources and sector-specific publications with an exploratory phase supported by agentic AI tools. All findings are grounded in verified, publicly available information. The resulting database is maintained through the integration of the Europe Media Monitor service, which provides automated daily scanning of media sources in multiple languages to ensure timeliness. The data used for this analysis were collected from October 2025 to early February 2026.

To ensure reliability, the Observatory applies multiple validation mechanisms. These include internal validation through targeted site visits and semi-structured interviews with service operators and ADS manufacturers, as well as external expert review by regional specialists covering the Chinese, US and European markets.

1.2.3. Why Mapping AV Ecosystem Matters

The AV ecosystem is technologically complex and involves a wide range of actors, including vehicle manufacturers, technology providers, sensor and component suppliers, mobility service operators, infrastructure providers and public authorities. Mapping this ecosystem is essential to understand how technological capabilities are distributed across actors and regions, how value chains are structured, and where strategic dependencies may arise.

A particularly important dimension is the assessment of Europe's position within the global landscape. Examining Europe alongside other regions helps identify differences in deployment scale, market structure and competitive positioning. Ecosystem mapping also supports more informed policy decisions by highlighting areas where public funding, research programmes or regulatory interventions may be needed.

1.2.4. Target Users and Stakeholders

The Observatory is designed to serve policymakers and public authorities seeking a structured overview of the AV sector, industry stakeholders wishing to understand the broader ecosystem in which they operate, and researchers requiring a reliable source of structured information for analysis and comparative studies.

1.2.5. Limitations of the Analysis

This report presents a preliminary landscape analysis of the CCAM ecosystem, based on the initial data collected through the European CCAM Observatory. As the database continues to evolve, some information may be outdated or not yet fully validated. The report provides an initial illustration of the Observatory's analytical approach and highlights early trends that may evolve as the dataset matures. Where relevant, illustrative examples of companies are included to support the analysis; these are indicative only and not exhaustive.

Furthermore, the analysis focuses specifically on vehicle-side technologies and does not cover infrastructure-based connectivity elements, such as roadside units for accident warnings or systems supporting mobility-as-a-service (MaaS).

1.2.6. Structure of this Report

This report is organised as follows. Chapter 2 examines the global landscape of CCAM service deployments, covering geographic distribution, service types and operational models. Chapter 3 analyses the technology stack used in real-world deployments. Chapter 4 presents the industrial ecosystem, including the full supplier landscape by technology domain, geographic origin, provider tier structure, and the EU's competitive positioning. Chapter 5 focuses specifically on European stakeholder presence, including supplier participation and the startup ecosystem. Chapter 6 maps partnership and collaboration patterns across the sector. Chapter 7 assesses technology maturity and market growth signals. Chapter 8 synthesises the cross-cutting findings and their implications.

2. Global CCAM Service Deployment Landscape

This analysis focuses on automated mobility services operating at SAE Level 3 and above, with a primary emphasis on Level 4 deployments. Each service represents a distinct operational service, including both passenger and freight applications. The dataset includes services worldwide, rather than being limited to European activities. It covers operational services provided by companies and organisations involved in real-world deployments, while excluding purely research-based or experimental projects without identifiable service operations. As a result, the analysis reflects the current state of practical implementation rather than early-stage research activities.

2.1. Overview of Services

The mapped service landscape comprises 122 automated mobility services, of which 119 are active at the beginning of 2026 and 3 are historical records classified as paused or discontinued. Within the active sample, the distribution is tilted towards earlier deployment stages: 64 services are classified as late-stage pilots, while 55 are already operating commercially. This indicates that the sector is still in a transition phase. While commercial services are increasingly common, a large share of deployments remain in pilot mode as companies continue to test technology performance, operational models, and regulatory frameworks.

Most services operate using SAE Level 4 automation. In the current dataset, 94 services explicitly report Level 4, while one service is classified as Level 3 and 27 entries do not specify the automation level in publicly available sources. The strong presence of Level 4 systems reflects the operational design of current services, which are typically deployed in geofenced environments or under specific operational conditions rather than in fully open road networks.

The timing of service launches also shows a clear acceleration in recent years. Although a small number of entries in the dataset trace back to the late 1990s and early 2010s, these dates often reflect the establishment of the companies or the initiation of related mobility services, rather than the deployment of automated driving functionalities. In practice, automated mobility services have emerged much more recently. In particular, 16 services started in 2023, 14 in 2024, and 29 in 2025. This recent increase suggests that automated mobility technologies are gradually moving from demonstration projects towards more structured operational deployments.

The landscape of service providers is also diverse. Provider tiers are derived using an evidence-based scoring framework applied at the service level. This framework incorporates multiple dimensions, including operational scale (fleet size), geographic breadth (number of metropolitan areas), maturity of deployment (e.g. driver-out operations and operational continuity), degree of commercialisation (presence of paying users and partners), and backing or regulatory approval. Services are scored on a 0–9 scale and classified as major (≥6 points with demonstrated operational maturity), emerging (3–5 points), or niche (≤2 points). Based on this methodology, the dataset identifies 12 major providers, 25 emerging providers, and 84 niche providers.

The major-provider group in the current dataset includes Waymo in U.S. robotaxi operations; Serve Robotics and Starship Technologies in delivery-bot services in the United States and Europe; Aurora and Gatik AI in U.S. autonomous trucking; Pony.ai and WeRide in Chinese robotaxi and shuttle services; and SW Mobility, Kakao Mobility, and Newmo in East Asian robotaxi deployments. These actors stand out because they combine comparatively larger operational scale with more mature deployment profiles, including commercial services, multi-city operations, and, in several cases, driverless or highly automated operations.

The emerging tier includes a second group of providers that already show meaningful scale or strategic relevance but remain less mature or less geographically established than the major actors. This includes Zoox in U.S. robotaxi pilots, Kodiak Robotics and Volvo Autonomous Solutions in autonomous trucking in the United States, Baidu Apollo Go, AutoX, and DiDi Autonomous Driving in Chinese robotaxi services, JD Logistics and Inceptio in freight and delivery applications in China, as well as WeRide and Uber in Abu Dhabi and Einride in Europe and the Gulf region. In addition, major mining and industrial automation systems such as Komatsu, Caterpillar, Volvo Autonomous Solutions, and Mineral Resources in Australia illustrate the importance of off-road and industrial autonomous freight services within the emerging segment.

The niche tier is much broader and captures the long tail of specialised or geographically limited deployments. In passenger transport, this includes shuttle-oriented services such as Navya, 2getthere, Aurrigo, Karsan, and Keolis in Europe, as well as several public-transport and shuttle experiments in South Korea, Israel, Singapore, and Canada. In freight and delivery, notable niche services include Cartken, Tiny Mile, Avride, Clevon, RIVR, Ottobot, Meituan, Neolix, Rakuten, Panasonic’s HAKOBO/PIMTO, and DeliRo. The niche segment also includes a large number of mining and industrial freight services, such as Liebherr, Sandvik, Hitachi, and Epiroc, as well as discontinued or paused cases such as Embark and Cruise. This broad niche category highlights the experimental and highly fragmented character of the sector, where many services remain local, use-case specific, or still in pilot configuration.

Across use cases, robotaxi and delivery-bot services are the most visible among major and emerging actors, while autonomous trucking is particularly relevant in the U.S., China, Australia, and mining-related operations. Shuttle services, by contrast, are more strongly represented in the niche tier, where deployments are often limited to campuses, airports, business districts, or public-transport demonstration routes. Geographically, the highest concentration of major and emerging actors is found in North America and Asia, especially in the United States, China, South Korea, Japan, and the Gulf region, while Europe is characterised by a larger number of smaller-scale shuttle and delivery deployments.

To further illustrate the distribution of leading actors across operational models, **Table 1** presents the main providers classified as “major” in the dataset, grouped by service type.

Table 1. Major automated mobility service providers by operational model by February 2026

Service Type	Major Providers
Robotaxi	Waymo, Pony.ai, WeRide, SW Mobility, Kakao Mobility, Newmo
Autonomous Trucks	Aurora Innovation, Gatik AI
Delivery Robots	Serve Robotics, Starship Technologies
Shuttle	WeRide

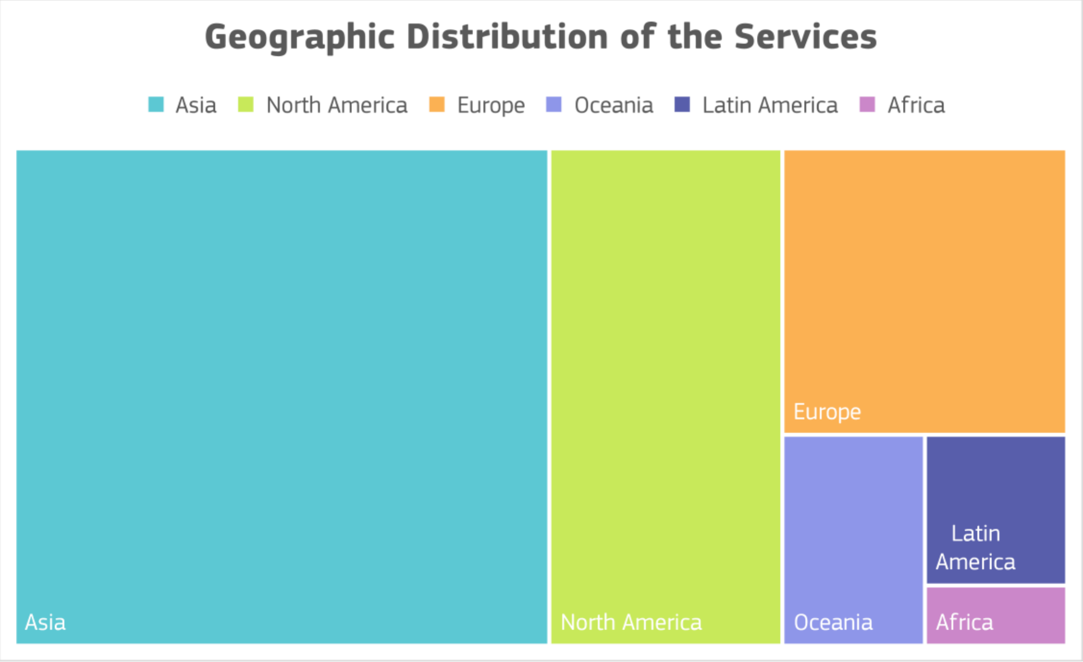
Source: JRC analysis.

The relatively small number of providers in each service type reflects both the strict criteria used to define “major” actors and the current structure of the market. While a larger number of companies are active across all service types, only a limited subset has achieved the scale, geographic breadth, and operational maturity required to operate at commercial or near-commercial level. The table also highlights differences across segments: robotaxi services involve a broader group of major operators, while autonomous trucking and delivery services are more concentrated among a smaller number of leading providers.

2.2. Geographic Distribution of the Services

The global distribution of automated mobility services is highly uneven as can be seen in Figure 1. According to the dataset, Asia hosts the largest number of services, with 62 recorded deployments. It is followed by North America with 27 services and Europe with 19 services. Other regions appear less frequently in the database, including Oceania (7 services), Latin America (5), and Africa (2).

Figure 1. Global distribution of automated mobility services.



Source: JRC analysis.

At country level, the United States and China represent the most important deployment markets. Both countries host a large number of pilot projects and commercial services across several operational models. The United Arab Emirates also appears prominently in the dataset, reflecting the strong policy interest of the country in testing and deploying automated mobility solutions.

In Europe, services are spread across multiple countries rather than concentrated in a single leading market. Deployments appear in countries such as Germany, Netherlands, France, Sweden, Norway, Switzerland, UK and Spain, among others. This suggests that European activity is geographically distributed across several national pilot programmes and urban experiments rather than concentrated in one dominant location.

Different service types also show distinct geographic patterns. Passenger services, particularly robotaxis and automated shuttles, are mostly deployed in urban environments. Freight services often operate along logistics routes, ports, or industrial areas. Delivery robots are typically deployed in compact urban districts, campuses, or residential neighbourhoods where low-speed automated systems can operate safely.

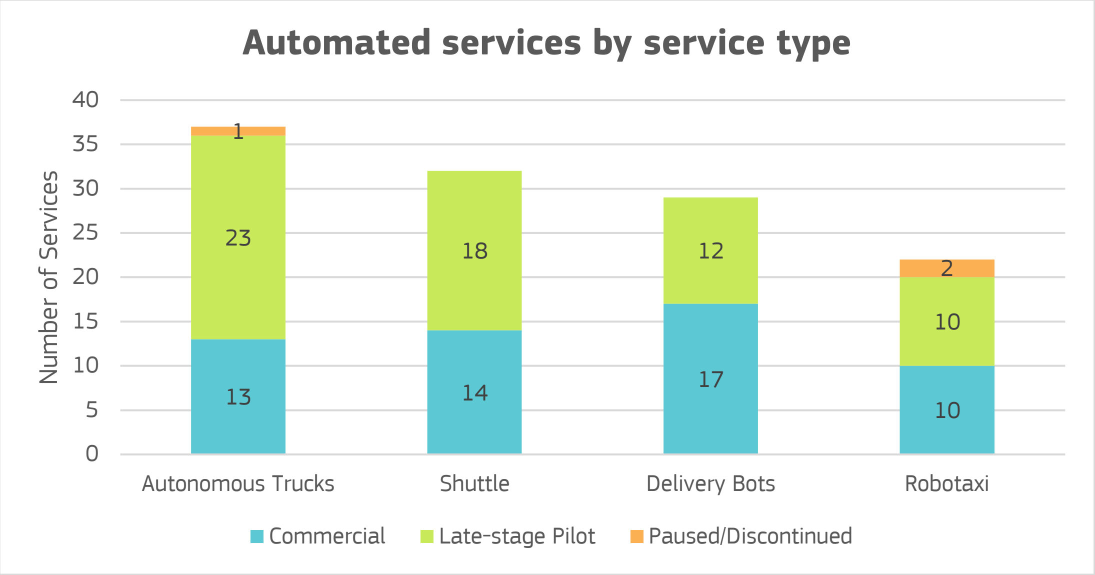
2.3. Service Types and Operational Models

The services recorded in the CCAM Observatory database cover a wide range of operational models and can be divided into passenger mobility services and freight or logistics services. In the dataset, the number of freight-related deployments is slightly higher compared to passenger services, with 66 services linked to goods transport and logistics and 55 services focused on passenger mobility, while one service combines elements of both categories.

This distribution shows that the development of CCAM technologies is not mainly focused on passenger transport as one might expect and despite the visibility often given to robotaxi services in public discussions. Instead, freight and logistics applications already represent an important share of real-world deployments. A key driver behind this trend is the potential to reduce labour costs, particularly in sectors such as trucking and last-mile delivery, where driver or operator expenses represent a significant share of total operating costs and where shortage of drivers is expected in the years to come.

In more detail and as shown in Figure 2 among the main four operational models -automated trucking, automated shuttle services, delivery robots, and robotaxis- automated trucking currently represents the largest group, with 37 services recorded in the database (36 active). These deployments typically focus on long-distance freight transport or hub-to-hub logistics operations, where vehicles travel along highway corridors. Such environments tend to reduce the complexity of the driving task compared with dense urban settings. At the same time, the economic rationale is particularly strong, as automation aims to address driver shortages and reduce labour costs in long-haul logistics. Examples include Aurora Innovation in the United States, which is scaling driverless freight operations in Texas, and Gatik AI, focusing on middle-mile logistics for retail partners. Their strategies are centred on expanding along specific freight corridors and building long-term partnerships with logistics operators.

Figure 2. Active Services as identified in the CCAM Observatory database.



Source: JRC analysis.

The second largest category consists of automated shuttle services, with 32 deployments identified. Shuttle operations are commonly implemented in geographically constrained environments such as university campuses, airports, business parks or residential districts. These services often follow fixed routes and operate at moderate speeds, which simplifies both the technical requirements and the regulatory approval process. For this reason, shuttle services are frequently used as an intermediate step between experimental testing and broader commercial deployment. While cost reduction is less immediate than in freight, automation allows operators to reduce or eventually remove onboard drivers in public transport services. Examples include WeRide, which operates autonomous shuttle and robobus services, including larger-capacity “robobus” vehicles (i.e. automated minibuses designed for urban passenger transport), in multiple Chinese cities, and Navya in Europe, focusing on controlled environments such as campuses and airports. Their strategies typically involve gradual scaling within defined service areas and integration into public transport ecosystems.

Delivery robots represent another significant segment of the service landscape, with 29 services recorded in the dataset. These systems are generally designed for last-mile logistics and typically operate at low speeds in urban districts, campuses, or residential areas. Their smaller size and lower operating speeds reduce the technical challenges associated with automated navigation. In this segment, reducing delivery costs and addressing labour constraints in last-mile logistics is a primary motivation. Companies such as Serve Robotics in the United States and Starship Technologies, active across U.S. campuses and European cities, are expanding multi-city operations and forming partnerships with food delivery platforms. Their strategy focuses on scaling fleet size and increasing delivery density in urban areas.

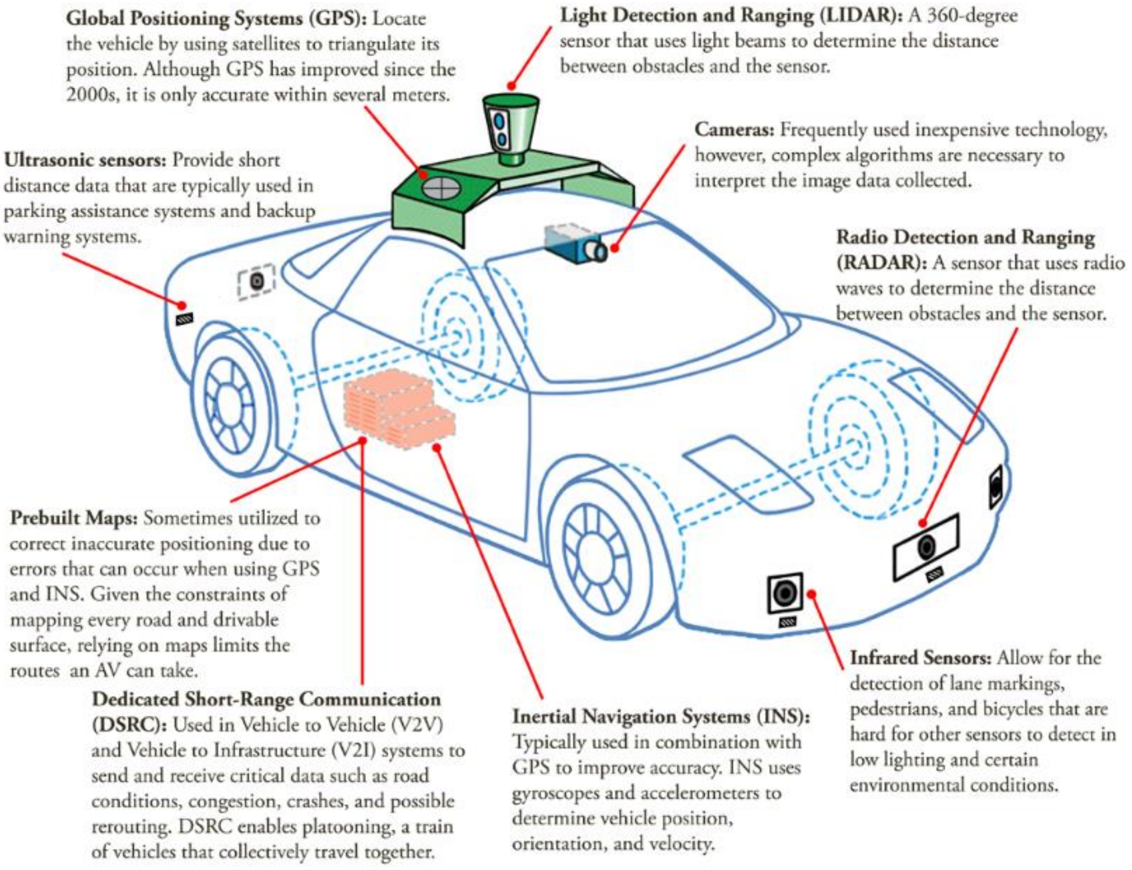
In contrast, robotaxi services, while highly visible in the news, account for a smaller share of the recorded deployments, with 22 services identified. Operating driverless passenger services in dense urban environments requires advanced perception systems, HD mapping in many current system architectures, complex decision-making algorithms, and robust safety validation. However, some providers are increasingly exploring approaches with reduced reliance on pre-mapped environments, leveraging more generalised perception and real-time scene understanding. These technical challenges are often combined with demanding regulatory requirements, especially when services operate without a safety driver. As a result, robotaxi deployments have generally progressed slowly, typically starting with geofenced operating areas and expanding gradually as operational experience accumulates. Nevertheless, the long-term objective is to eliminate driver costs in ride-hailing services, which could significantly reshape urban mobility economics. Key examples include Waymo in the United States, operating fully driverless services in multiple cities, and Pony.ai in China, focusing on large-scale urban robotaxi deployment. Their strategies involve progressive geographic expansion and integration with mobility platforms, including partnerships with ride-hailing applications—for example, Waymo’s collaboration with Uber—and, in other markets, potential integration with local platforms such as DiDi.

3. Technology Stack in CCAM Deployments

To better structure this landscape, the technologies are grouped into categories reflecting the main layers of automated driving systems. **Table 2** below presents the core inventory of technological components that collectively form the technological stack of automated driving systems. Each entry represents a hardware or software element that contributes to enabling automated driving functionalities. These elements can be developed by different suppliers, integrated into various vehicle platforms, and combined in various ways depending on the design choices of the automated driving system.

The stack reflects the layered architecture typically used in automated driving systems. At the base are sensing and data collection technologies, which capture raw information about the vehicle's surroundings using different sensing modalities such as laser, radio waves, optical imaging, or sound. These sensing inputs are complemented by localisation and mapping technologies that determine the vehicle's position in space and relate it to high-definition maps of the road environment. **Figure 3** provides an overview of representative sensing, localisation, mapping, and communication technologies used in automated driving systems.

Figure 3. Representative sensing, localisation, mapping, and communication technologies supporting automated driving systems.



Global Positioning Systems (GPS): Locate the vehicle by using satellites to triangulate its position. Although GPS has improved since the 2000s, it is only accurate within several meters.

Light Detection and Ranging (LIDAR): A 360-degree sensor that uses light beams to determine the distance between obstacles and the sensor.

Cameras: Frequently used inexpensive technology, however, complex algorithms are necessary to interpret the image data collected.

Ultrasonic sensors: Provide short distance data that are typically used in parking assistance systems and backup warning systems.

Radio Detection and Ranging (RADAR): A sensor that uses radio waves to determine the distance between obstacles and the sensor.

Prebuilt Maps: Sometimes utilized to correct inaccurate positioning due to errors that can occur when using GPS and INS. Given the constraints of mapping every road and drivable surface, relying on maps limits the routes an AV can take.

Dedicated Short-Range Communication (DSRC): Used in Vehicle to Vehicle (V2V) and Vehicle to Infrastructure (V2I) systems to send and receive critical data such as road conditions, congestion, crashes, and possible rerouting. DSRC enables platooning, a train of vehicles that collectively travel together.

Inertial Navigation Systems (INS): Typically used in combination with GPS to improve accuracy. INS uses gyroscopes and accelerometers to determine vehicle position, orientation, and velocity.

Infrared Sensors: Allow for the detection of lane markings, pedestrians, and bicycles that are hard for other sensors to detect in low lighting and certain environmental conditions.

Source: University of Michigan, Center for Sustainable Systems (2025).

On top of this, environment understanding and artificial intelligence components can be found. These technologies process the incoming sensor data to detect and classify objects, interpret the driving environment, and anticipate the behaviour of other road users. Machine learning models and perception algorithms play a central role in transforming raw sensor inputs into structured representations of the surrounding environment.

Once the environment is understood, decision and planning technologies determine how the AV should act. These components are responsible for generating safe and efficient trajectories, selecting appropriate driving behaviours, and ensuring that vehicle actions remain consistent with traffic rules and operational constraints. Alternatively, emerging End-to-End (E2E) AI architectures streamline this process by utilizing a single, integrated deep learning model. Unlike modular systems, E2E models can map raw sensor data directly to control outputs, potentially reducing the complexity of hand-coded rules and minimizing information loss between separate perception and planning layers. The resulting commands are then executed by vehicle control and actuation systems, which translate software decisions into physical steering, braking, and acceleration actions.

In addition to these core driving functions, AVs rely on a broader digital and computing infrastructure. Middleware platforms manage communication between software modules and hardware components, while onboard compute systems provide the processing capacity required for real-time perception, planning, and control. Connectivity technologies further extend system capabilities by enabling communication with external infrastructure, cloud services, and other vehicles.

Due to the high level of system integration and connectivity involved in automated driving, cybersecurity plays an important role in protecting the platform and its functions. These technologies help ensure that communication channels remain secure, support the safe delivery of software updates, and protect sensitive operational data generated by the vehicle. Human–machine interaction technologies are also an important part of the system, providing the interfaces through which the vehicle communicates with its occupants and, in some cases, with other road users.

Lastly, simulation and scenario-based testing platforms, together with safety analysis and verification tools, support the development and deployment process by enabling large-scale virtual testing, scenario generation, and structured validation of automated driving systems. Simulation platforms allow developers to evaluate system behaviour across a wide range of traffic scenarios and environmental conditions, while safety analysis and verification tools support systematic assessment, test management, and compliance with safety requirements. For the purposes of the Global CCAM Observatory, a total of 45 technology categories have been identified and presented in **Table 2**:

Table 2. Technology stack for automated vehicles

No	Name	Description
Sensing & Data Collection		
1	LiDAR	Laser-based sensor producing high-resolution 3D point clouds.
2	Radar	Radio wave-based sensor for detecting objects in various weather conditions.
3	Cameras	Optical sensors capturing 2D/3D visual data for perception and object recognition.
4	Infrared Camera	Thermal imaging camera for detecting heat signatures in low-visibility environments.
5	Ultrasonic Sensors	Short-range sound-based sensors for detecting nearby obstacles.

Localisation & Mapping		
6	HD Maps & Localisation Data	High-definition maps and localisation layers supporting AV navigation.
7	GNSS Receivers	Satellite-based positioning system providing location data.
8	Inertial Measurement Unit (IMU)	Sensor measuring acceleration and rotation to support localisation.
9	Wheel Encoders	Sensors measuring wheel rotation for odometry.
10	SLAM Algorithms	Algorithms for mapping the environment and localising within it.
Environment Understanding		
11	Object Detection & Classification	Algorithms to detect and classify objects in sensor data.
12	Semantic Segmentation	Pixel-level classification of the environment.
13	Free Space Detection	Identification of drivable and non-drivable areas.
14	Obstacle Tracking & Motion Prediction	Tracking objects over time and predicting their motion.
15	Environment Perception Fusion	Combining data from multiple sensors for robust scene understanding.
AI & Machine Learning		
16	Object Detection Models	AI models identifying vehicles, pedestrians and other objects.
17	Semantic Segmentation Models	Models assigning class labels to each pixel in an image.
18	Sensor Fusion Models	AI models combining LiDAR, radar and camera inputs.
19	Behaviour Prediction Models	Models forecasting future movements of road users.
20	End-to-End AI Autonomous Driving Stack	AI-first stacks mapping sensor inputs directly to driving decisions.
21	Modular AD Software Stack (Perception–Planning–Control)	Classical pipeline separating perception, localisation, prediction and planning modules.
Decision & Planning		
22	Path Planning Algorithms	Algorithms generating safe and efficient trajectories.
23	Decision-Making & Policy Layer	High-level decision logic governing AV actions.
24	Trajectory Optimisation	Fine-tuning trajectories for comfort, safety and efficiency.
Vehicle Control & Actuation		
25	Vehicle Control Unit (VCU)	Central controller coordinating powertrain, braking and steering.
26	Drive-by-Wire Actuation Systems	Electronic systems replacing mechanical linkages.
Middleware & Integration		
27	SDV Middleware & Data Distribution Frameworks	Middleware frameworks enabling publish–subscribe messaging and service APIs.
28	In-Vehicle Communication Backbone (TSN / Automotive Ethernet)	Deterministic high-bandwidth in-vehicle networking.
29	Vehicle OS, Hypervisor & HAL (RTOS)	Real-time OS and hypervisors enabling safe, partitioned execution.
30	Developer Tools, SDKs & Simulation Frameworks	Toolchains and CI/CD environments for AV software development.
Compute & Infrastructure		

31	High-Performance Domain Controllers & AI Compute	Central AI accelerators running perception and planning workloads.
32	Cloud Storage & Model Training Infrastructure	Cloud infrastructure for fleet data storage and AI training.
33	ECUs & Microcontrollers	Conventional control units for body, chassis and ADAS functions.
34	5G NR Modems	Cellular modules enabling high-throughput, low-latency vehicle connectivity.
35	Edge Compute & MEC Nodes	Edge nodes providing low-latency processing for AV and V2X functions.
Connectivity (V2X)		
36	C-V2X Communication Modules	Cellular V2X modules for vehicle-to-everything communication.
37	IEEE 802.11p / ITS-G5 Modules	Dedicated short-range communication modules.
38	V2X Message Handling & Stacks	Software stack managing V2X message encoding and decoding.
Cybersecurity		
39	Security Certificates & PKI for V2X	Public key infrastructure securing V2X communication.
40	Threat Detection Systems	Systems identifying malicious activity in AV systems.
41	Secure OTA Update Infrastructure	Systems for secure over-the-air software updates.
42	Data Protection & Privacy Mechanisms	Safeguards ensuring confidentiality and regulatory compliance.
HMI & Interaction		
43	HMI & Interaction Technologies	Interfaces enabling interaction between AV, occupants and road users.
Safety Assurance & Validation		
44	Simulation & Scenario-Based Testing Platforms	Platforms for virtual scenario testing and validation.
45	Safety Analysis & Verification Tools	Tools for safety analysis, verification and test management.

Source: JRC analysis.

4. Industrial Ecosystem

This section examines the structure of the global CCAM industrial ecosystem, focusing on the distribution of actors across the value chain and the organisation of the supplier landscape. It provides a detailed view of how companies are positioned by role, technology domain, geographic origin, and level of maturity, highlighting key patterns of concentration, competition, and strategic positioning.

4.1. Key Industry Actors

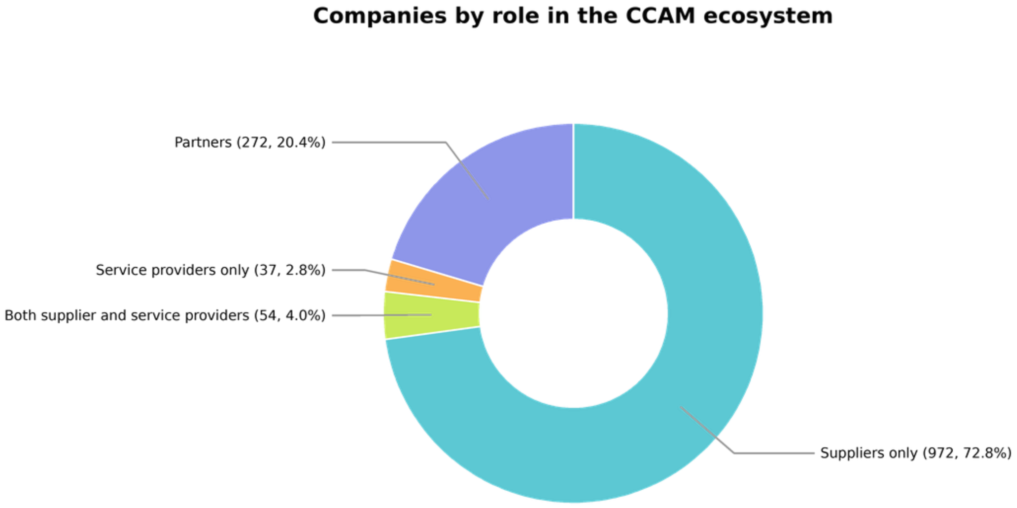
The CCAM Observatory database identifies 1,335 companies and organisations active in the automated mobility ecosystem performing different roles across the value chain, including technology development, component supply, and the operation of automated mobility services. **Figure 4** shows the distribution of companies according to their role within the ecosystem.

Most companies in the dataset are involved in the supply of technologies and components used in automated driving systems. In total, 972 companies operate exclusively as technology suppliers, providing hardware, software platforms, sensors, computing systems, or other enabling technologies. A much smaller group of companies focuses on the operation of automated mobility services. The database records 37 companies that operate services but are not classified as technology suppliers, indicating that they primarily focus on service deployment and integration rather than in-house technology development. Examples include Uber Technologies Inc., Keolis Group, SF Express, and Aramex. These actors typically integrate technologies developed by external suppliers in order to deploy robotaxi, shuttle, or freight services.

Some companies combine both roles. 54 actors in the dataset are classified as both suppliers and service operators, meaning that they develop technological components while also operating automated mobility services. These companies often control key parts of the technology stack internally. In practice, this internal development is primarily focused on software components, such as the automated driving system and system integration, while several hardware layers, including sensors, computing platforms, and vehicle manufacturing, are typically sourced from specialised external suppliers. This reflects the different levels of complexity and industrial requirements across the technology stack.

The also database includes 272 partners that are active in the broader ecosystem but are not explicitly classified as suppliers or service operators in the database. These companies may contribute through activities such as research and development, infrastructure, software platforms, or other supporting services. In many cases, these actors correspond to commercial or integration partners that enable service deployment. For example, digital platforms such as Uber Eats, DoorDash, and Foodora facilitate last-mile delivery services, while logistics operators such as DHL Group and DP World support freight applications.

Figure 4. Distribution of actors identified in the Observatory database according to their role.

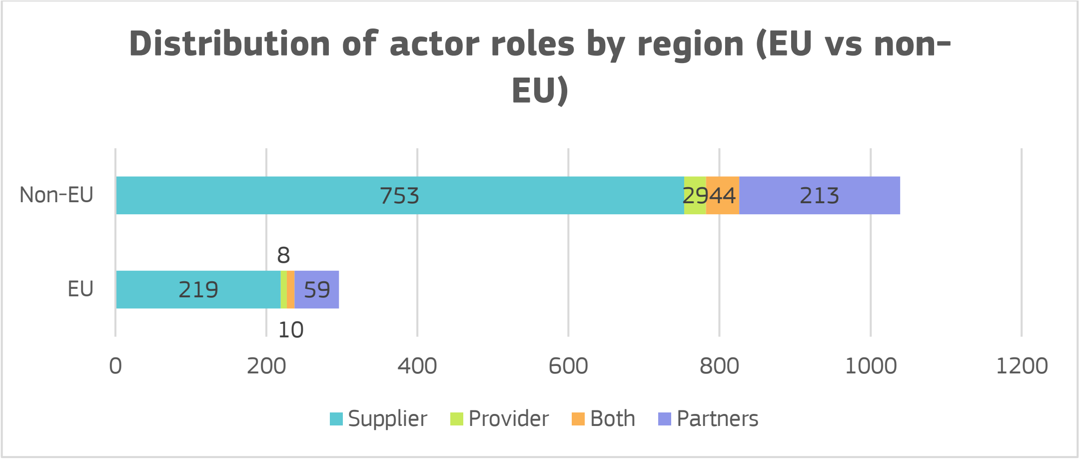


Source: JRC analysis.

The geographic distribution of companies shows the global nature of the automated driving industry. 296 actors in the dataset are EU-based, while 1,039 companies are headquartered outside the European Union. At the country level, China and the United States host the largest number of companies, with 230 and 229 actors respectively.

A more detailed view emerges when combining geographic distribution with the functional roles of actors, as shown in **Figure 5**. Both EU and non-EU actors are predominantly concentrated in supplier roles, which represent a similar share of companies in each group (approximately three-quarters of actors). A limited number of EU-based actors are directly involved in the operation of automated mobility services. In addition, a significant share of EU actors falls into the category of supporting or ecosystem partners.

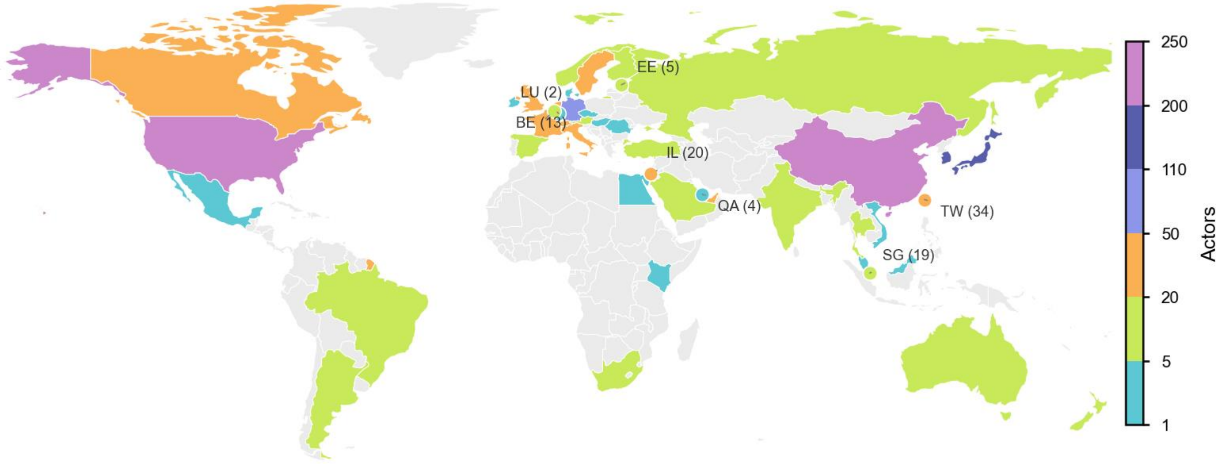
Figure 5. Distribution of actors across functional roles in the CCAM ecosystem, comparing EU and non-EU regions.



Source: JRC analysis.

Figure 6 presents the geographic distribution of companies in the dataset. China and the United States rank first, with 230 and 229 companies respectively. These two countries are followed by several Asian and European economies, including South Korea (146 companies), Japan (124), and Germany (108). Additional clusters of companies appear in countries such as France, Taiwan, Canada, Sweden and Switzerland, illustrating the broad geographic distribution of firms involved in the development of automated driving technologies.

Figure 6. Geographic distribution of AV industrial actors (n=1335 actors across 44 countries/territories).



Source: JRC analysis.

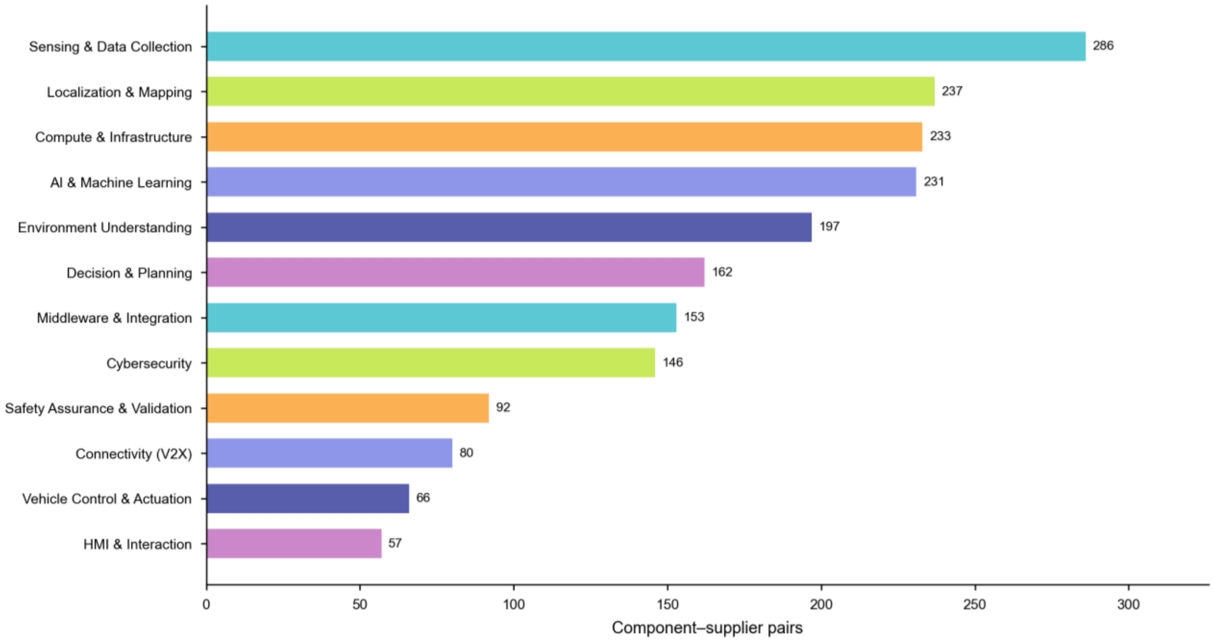
4.2. Supplier Landscape by Technology Domain

The supplier ecosystem in automated mobility spans a wide range of technology domains, from sensing hardware and computing platforms to software modules and infrastructure services. By analysing the full supplier–component dataset, it is possible to identify how many companies are active in each part of the technology stack and to assess the relative breadth of supplier participation across components.

4.2.1. Overall Supplier Base by Component

The CCAM supplier landscape encompasses 1,940 component–supplier pairs distributed across twelve distinct technology categories, reflecting the broad scope of enabling technologies required for connected, cooperative and automated mobility. As illustrated in **Figure 7**, Sensing & Data Collection constitutes the most densely populated category, followed by Compute & Infrastructure and AI & Machine Learning, underscoring the foundational role of hardware perception and processing capabilities in the current CCAM value chain. Categories associated with higher-level decisional and communicative functions, such as Decision & Planning and Connectivity (V2X), exhibit comparatively lower pair counts, suggesting that the supply base for software-intensive and protocol-specific technologies remains more concentrated.

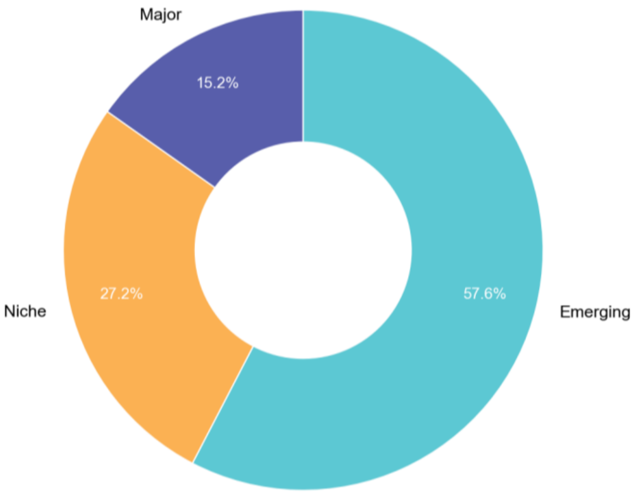
Figure 7. CCAM Component–supplier pairs by technology category (n = 1,940).



Source: JRC analysis.

Two distinct metrics are employed throughout this section and should be read in conjunction. Component–supplier pairs (n = 1,940) measure the total volume of commercial offerings, as a supplier may offer several distinct components, and reflect market activity and breadth of product coverage. Unique supplier counts measure the number of independent companies, regardless of how many component types each offers, and are the appropriate metric for assessing market concentration and the depth of the competitive base. Where the two metrics diverge materially, both are reported.

Figure 8. Provider tier distribution across all CCAM component–supplier pairs.

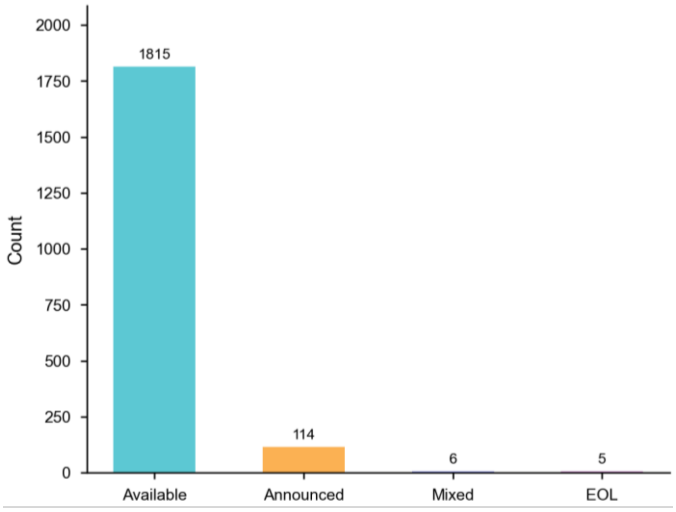


Source: JRC analysis.

Figure 8 presents an analysis of provider tier across the full dataset. Similarly to the services, suppliers are classified into tiers using a composite scoring framework (0–9) based on five dimensions: scale, geographic breadth, technological maturity, market adoption, and corporate strength. Based on this scoring, suppliers are grouped into three categories: Major (score ≥6 and meeting minimum maturity requirements), Emerging (score 3–5 or high score without sufficient maturity), and Niche (score 0–2). Emerging suppliers account for the majority of the recorded component–supplier pairs (approximately 57%), followed by Niche suppliers (27%) and Major-tier suppliers (15%). This distribution indicates that the global CCAM supply market is characterised predominantly by a large number of smaller, specialised, or recently established firms rather than by a compact group of dominant incumbents. The relatively low share of Major-tier suppliers reflects both the nascent state of certain technology segments and the ongoing market fragmentation inherent to a sector undergoing rapid technological transition.

From a European policy perspective, this finding carries a dual interpretation. On the one hand, the scarcity of Major-tier players raises concerns regarding Europe's capacity to anchor key CCAM value chains domestically and to ensure the long-term availability and resilience of critical components. On the other hand, the abundance of Emerging suppliers presents an opportunity for European start-ups and scale-ups to establish a competitive position before markets consolidate. Whether this window remains open long enough to be seized is, however, uncertain. Technology markets at an early stage may consolidate quickly once a dominant design emerges, and firms that cannot scale within that window risk being acquired or displaced rather than becoming lasting independent competitors.

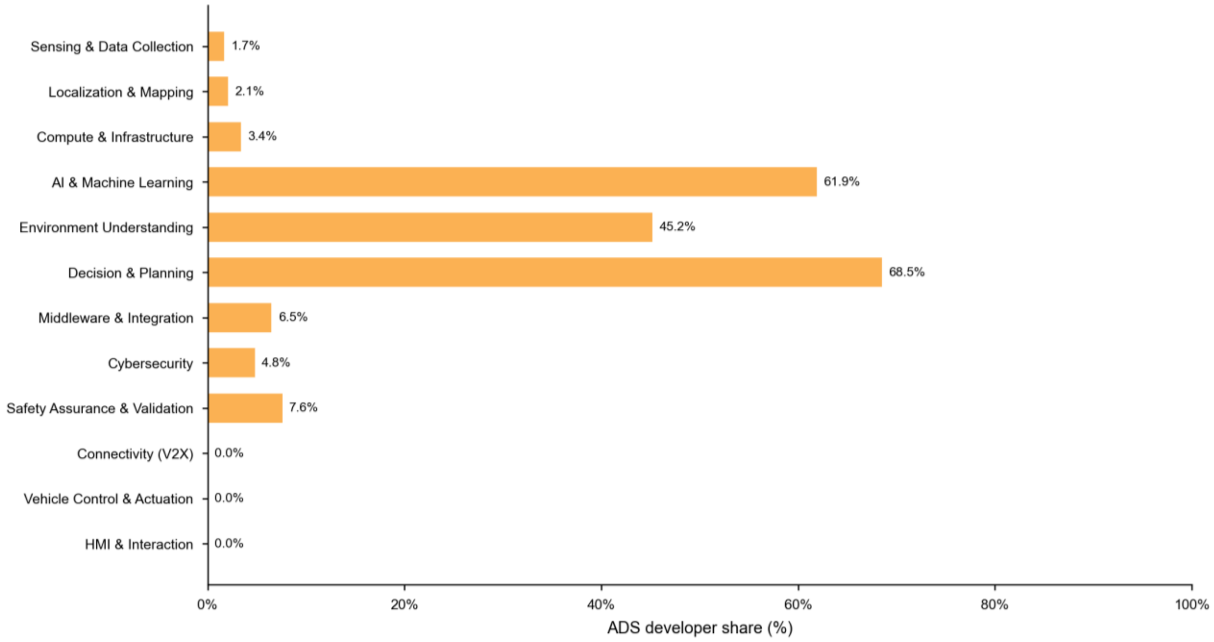
Figure 9. Offering status of CCAM components - distribution by technology category.



Source: JRC analysis.

The offering status of components across the dataset, presented in **Figure 9**, is strongly skewed towards commercially available products, with approximately 93.5% of all component–supplier pairs classified as Available. Announced products recorded in the database refer only to those that have been publicly disclosed and are not yet commercially accessible. These account for approximately 5.9% of component–supplier pairs. Mixed-status cases (i.e. components that are both available and announced in different variants) and End-of-Life (EOL) designations remain marginal. This high availability rate reflects the generally mature state of the surveyed supply base and confirms that the majority of the CCAM technology stack can, in principle, be procured from existing market offerings.

Figure 10. ADS developer share by technology category. Proportion of suppliers in each category that are themselves active automated driving system (ADS) developers.



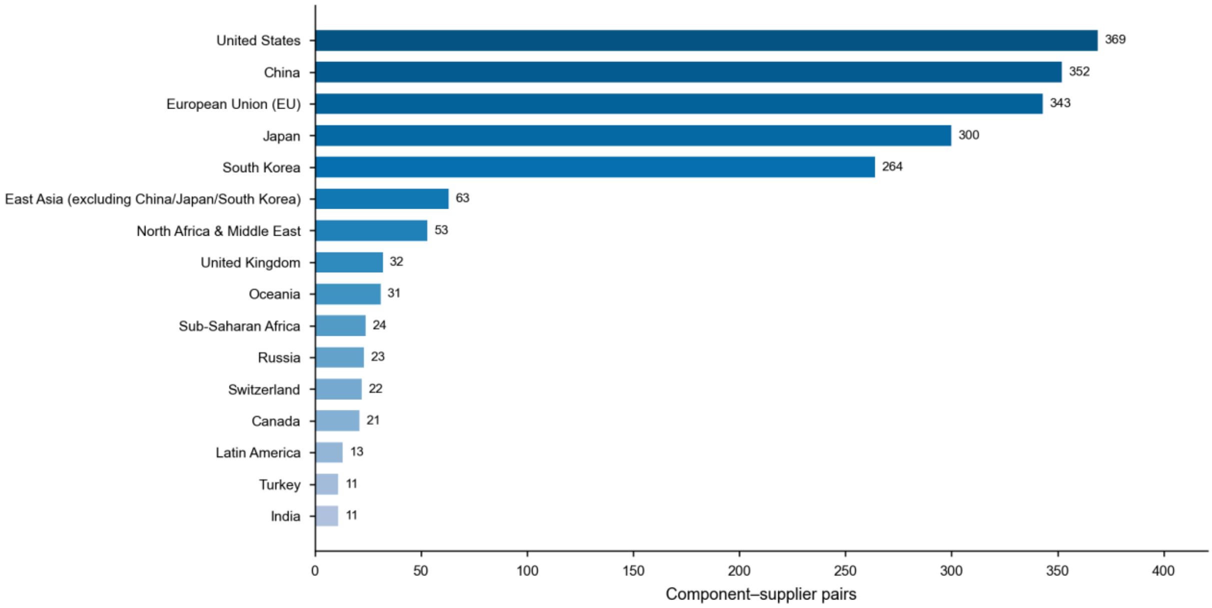
Source: JRC analysis.

The share of Automated Driving System (ADS) developers, suppliers that are themselves actively developing full autonomous driving stacks, varies substantially across technology categories, as shown in **Figure 10**. Decision & Planning and AI & Machine Learning exhibit the highest ADS developer concentrations, reflecting the central role of these technologies in automated vehicle architectures and the tendency of ADS developers to internalise capabilities in areas closest to the core algorithmic stack. Conversely, hardware-oriented categories such as Sensing & Data Collection and Vehicle Control & Actuation show minimal ADS developer presence, as these technologies are typically sourced from specialised component manufacturers rather than system integrators. The concentration of ADS developers in software and AI categories underscores the strategic importance of these segments for the future competitive landscape. Firms that combine ADS development with component supply are likely to exert disproportionate influence over system integration standards, safety frameworks and data governance norms.

4.2.2. Geographic Origin and Market Accessibility of CCAM Suppliers

The geographic origin of component–supplier pairs is presented in a decreasing order in **Figure 11**. It reveals a highly competitive multipolar structure at the global level. The United States (369 pairs), China (352 pairs) and the European Union (343 pairs) collectively account for approximately 54% of all recorded pairs, with Japan (300) and South Korea (264) constituting a second tier of major supply regions. This distribution reflects the established industrial capacities of these regions in automotive, electronics and software sectors, as well as their sustained investment in CCAM-related research and development. Expressed in unique supplier counts rather than pairs, the same regional ordering is broadly preserved, though the absolute figures differ: the EU's 343 pairs originate from approximately 165 unique suppliers, a ratio that reflects the breadth of portfolio coverage among larger European Tier 1 firms.

Figure 11. Component–supplier pairs by origin region.



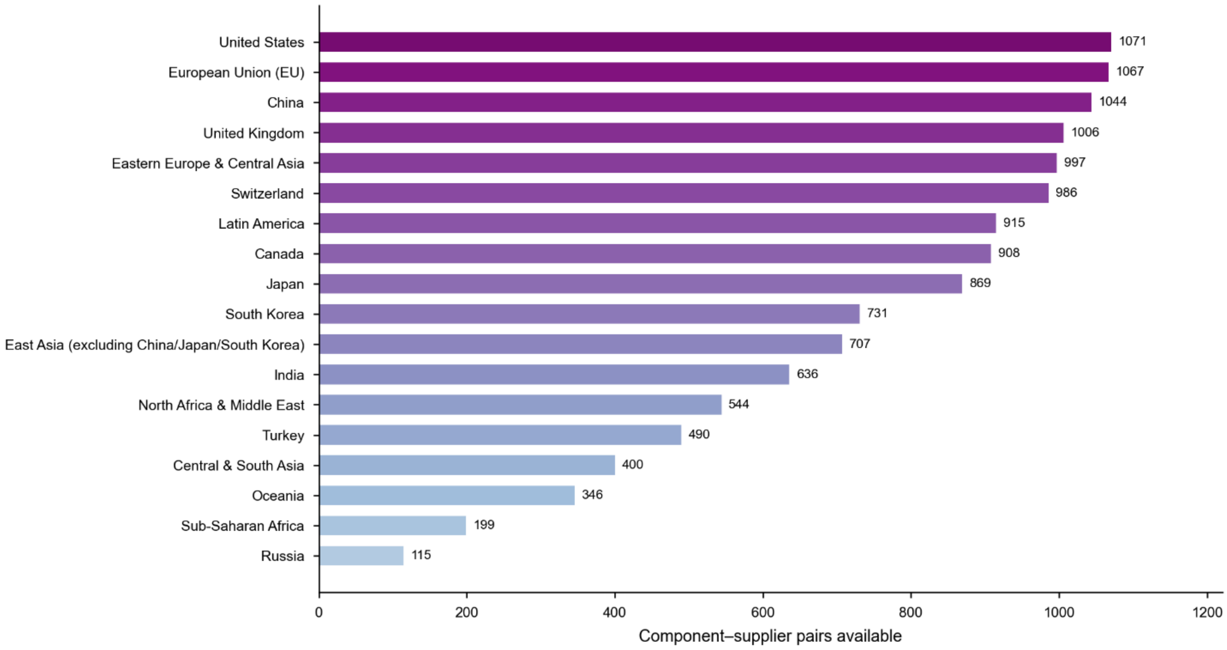
Source: JRC analysis.

The near-parity between the United States, China and the European Union at the aggregate level is, however, not fully reflective of differences in strategic positioning. Regional shares diverge substantially across technology categories, and the composition by provider tier differs markedly between regions. A more granular examination, presented in subsequent figures, reveals that the EU's aggregate contribution conceals a limitation in high-growth software categories and a reliance on Emerging-tier suppliers that may restrict its influence over future market standards and technology trajectories.

4.2.3. Provider Tier Structure Across Regions and Technology Domains

An assessment of the regions in which CCAM components are commercially available, in **Figure 12**, confirms that the European Union is among the most frequently served markets, alongside the United States and East Asian economies. The broad geographic availability of most components indicates that European procurers generally have access to the global supply portfolio.

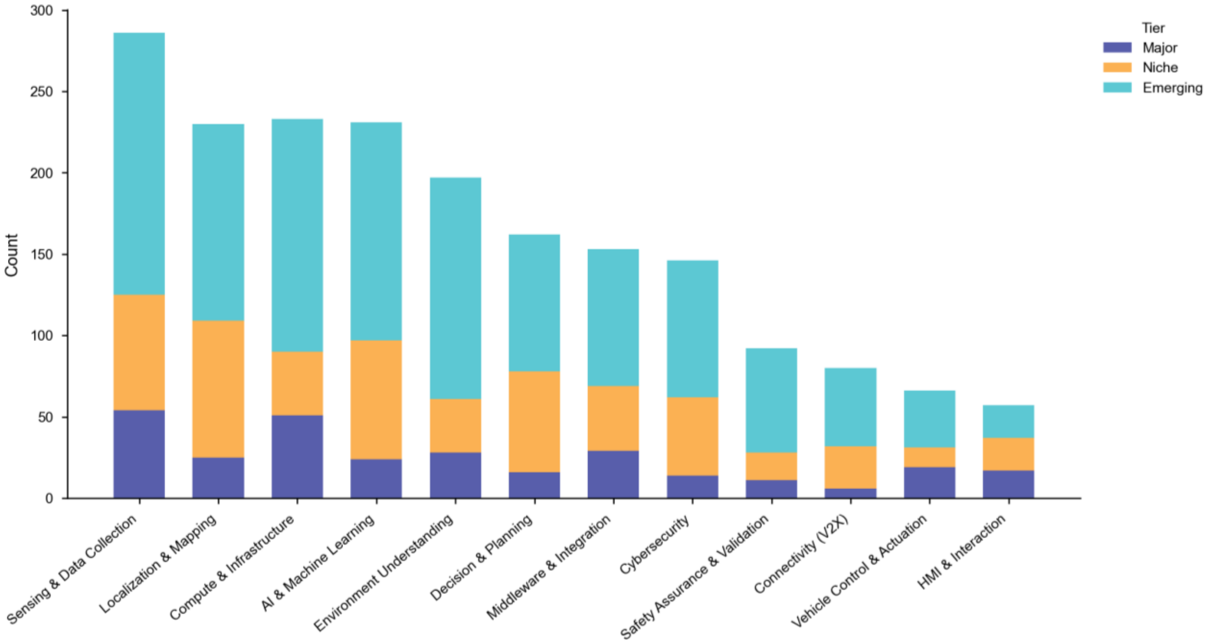
Figure 12. Component availability by target market region.



Source: JRC analysis.

The near-universal availability of components across major markets is consistent with the globalised nature of the CCAM supply chain. Nevertheless, geopolitical disruptions, export controls or trade restrictions could rapidly alter this picture. The EU's significant reliance on foreign-origin components that are currently available within its market represents a potential vulnerability, particularly for safety-critical and sovereignty-sensitive technology categories.

Figure 13. Provider tier composition by technology category. Stacked bars show the proportional share of Major, Niche and Emerging tier suppliers within each category.

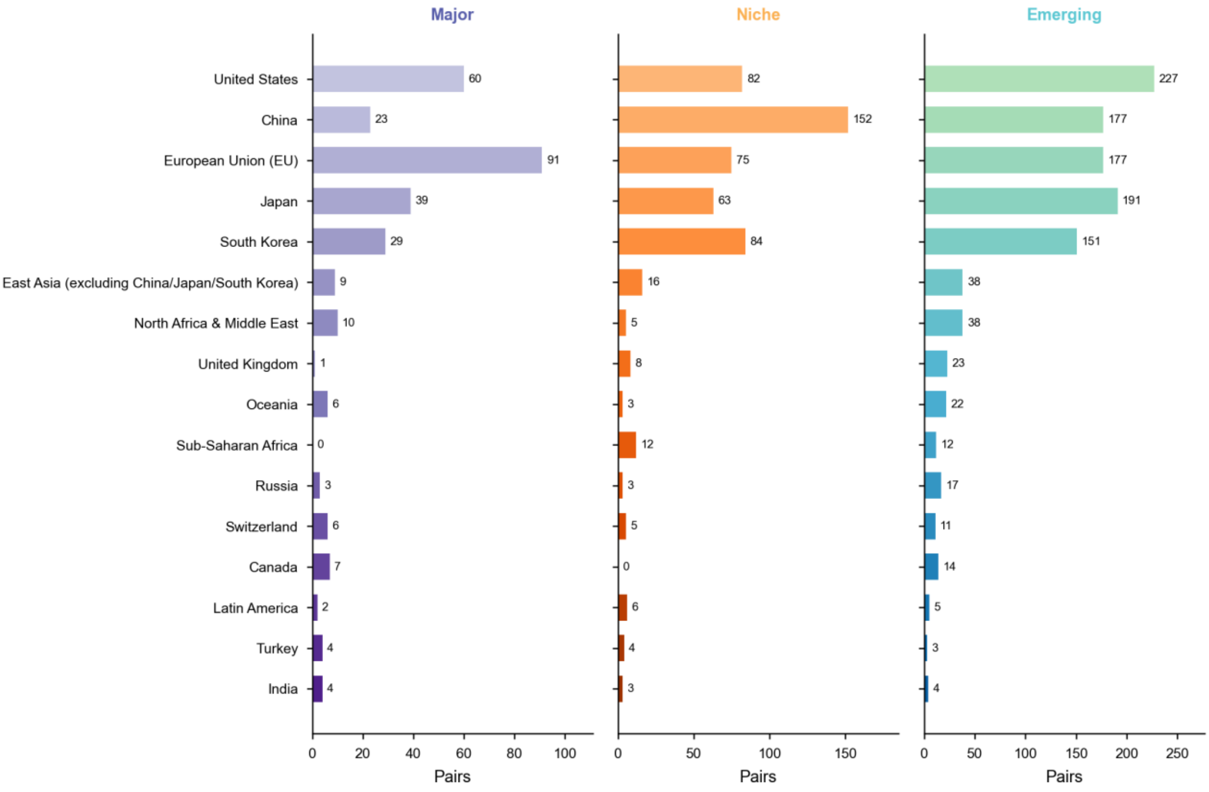


Source: JRC analysis.

In **Figure 13**, the decomposition of provider tier by technology category reveals considerable heterogeneity in market maturity across the CCAM value chain. Categories such as Vehicle Control & Actuation exhibit the highest proportions of Major-tier suppliers, reflecting decades of established automotive industry investment. Conversely, categories such as AI & Machine Learning, Decision & Planning and Environment Understanding are dominated by Emerging-tier suppliers, consistent with the relatively recent commercialisation of these technologies and the ongoing entry of new players.

This pattern has direct relevance for European industrial policy. The EU's comparative advantage lies predominantly in those categories where Major-tier suppliers are most prevalent, namely hardware-intensive and mechanically complex technologies, as will be presented in following figures. Conversely, European suppliers are underrepresented at the Major-tier level in the software-intensive categories that are growing most rapidly and that will increasingly define the competitive differentiation of CCAM systems. Targeted support for European firms seeking to scale in AI, perception fusion and autonomous decision-making represents an area where further assessment may be warranted.

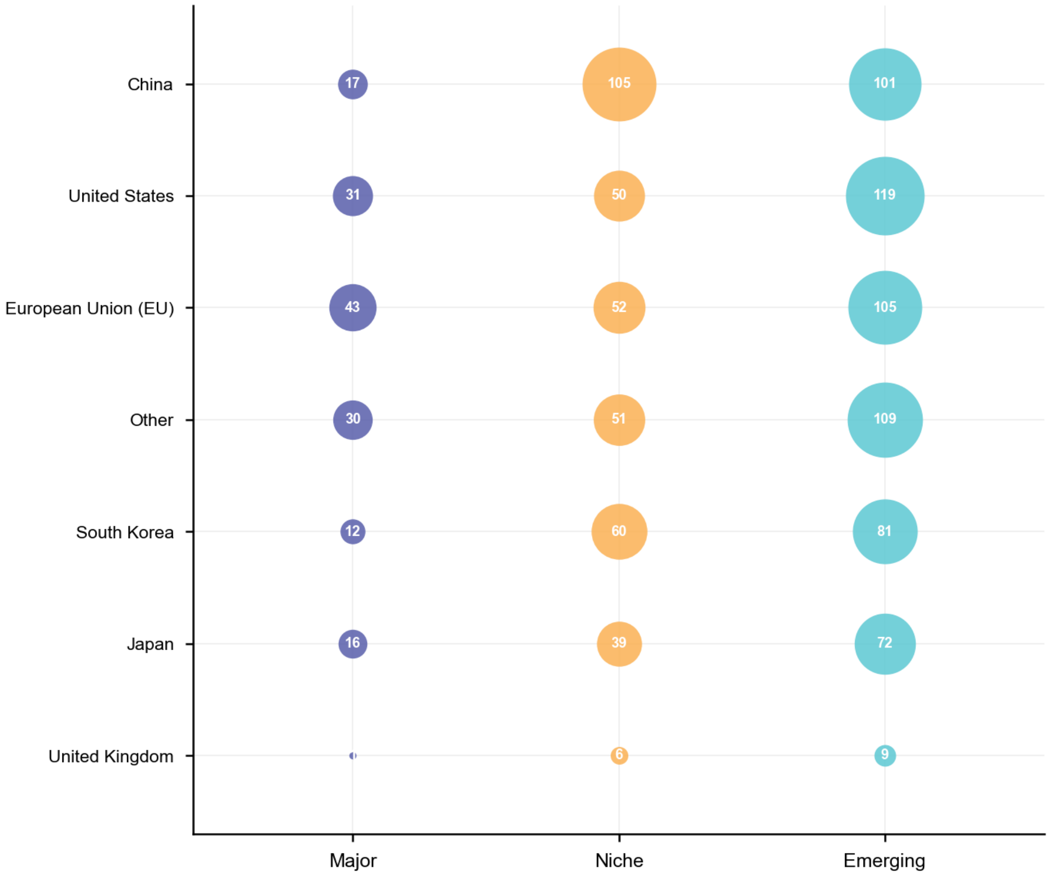
Figure 14. Component–supplier pairs by origin region and provider tier.



Source: JRC analysis.

Disaggregating origin region by provider tier, in **Figure 14**, reveals that the supply structure of each tier is geographically distinct. Among Major-tier suppliers, Japan and the United States account for a disproportionately large share, reflecting the long-standing industrial dominance of established automotive and electronics conglomerates in these regions. The European Union holds a strong Major-tier presence, particularly through German, French and Swedish firms. Among Niche-tier suppliers, South Korea and China feature more prominently, consistent with the strength of specialised electronics and sensor manufacturers in East Asia. The Emerging tier is the most geographically dispersed, with the United States, China and the EU each contributing substantially, alongside a wide range of smaller regions. Nevertheless, the EU does not hold a leading position in the Niche and Emerging tiers, the two segments most closely associated with the rapid innovation cycles of this developing technology sector.

Figure 15. Unique supplier counts by origin region and provider tier (bubble matrix). Bubble size is proportional to the number of unique suppliers; regions and tiers are shown on the two axes.



Source: JRC analysis.

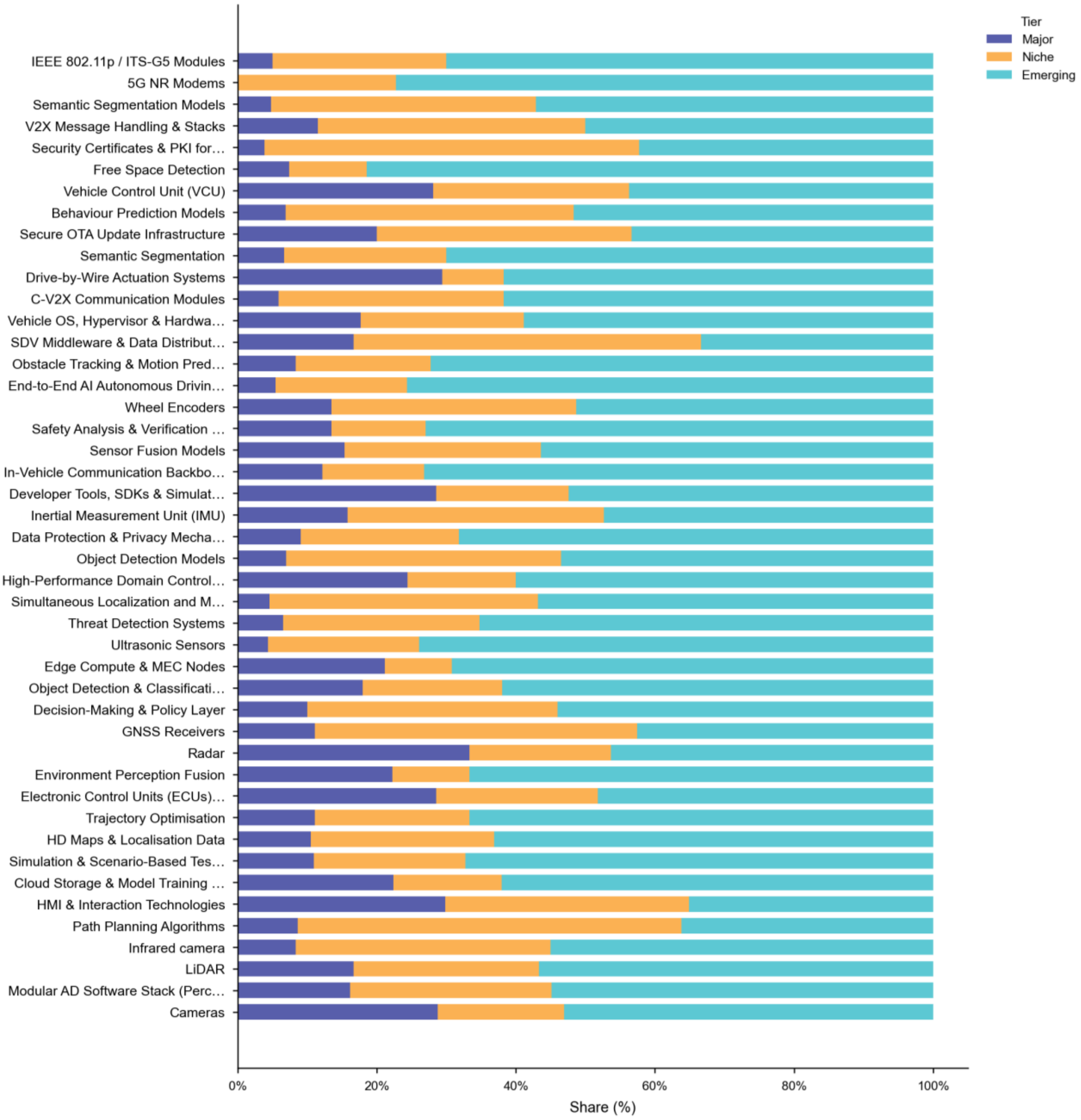
The bubble matrix, **Figure 15**, provides a compact representation of unique supplier counts across the six principal origin regions and the 'Other' aggregate, disaggregated by provider tier. The visualisation confirms that China dominates the Niche tier with 105 unique suppliers while the United States leads in the Emerging tier (119 suppliers), reflecting the depth of the US start-up and venture-backed CCAM ecosystem. The European Union holds the largest Major-tier supplier count (43 unique suppliers), surpassing both the United States (31) and China (17), which represents a relative structural strength. The stark contrast between the EU's Major-tier leadership and its comparatively modest position in the Emerging tier (105 suppliers, roughly on par with China and slightly behind the US) is a defining feature of the European CCAM supply landscape.

4.2.4. Component-Level Analysis

The 100% stacked horizontal bar chart, **Figure 16**, decomposing provider tier by component name reveals that the balance between Major, Niche and Emerging suppliers varies considerably across the technology portfolio. Components such as Radar, HMI & Interaction Technologies and Drive-by-

Wire Actuation Systems exhibit relatively high Major-tier shares, consistent with their roots in established automotive supply chains. In contrast, components such as Path Planning Algorithms, Simultaneous Localisation and Mapping (SLAM) Algorithms and Obstacle Tracking & Motion Prediction are almost entirely served by Emerging and Niche suppliers, reflecting the early-stage commercial maturity of these software-intensive technologies.

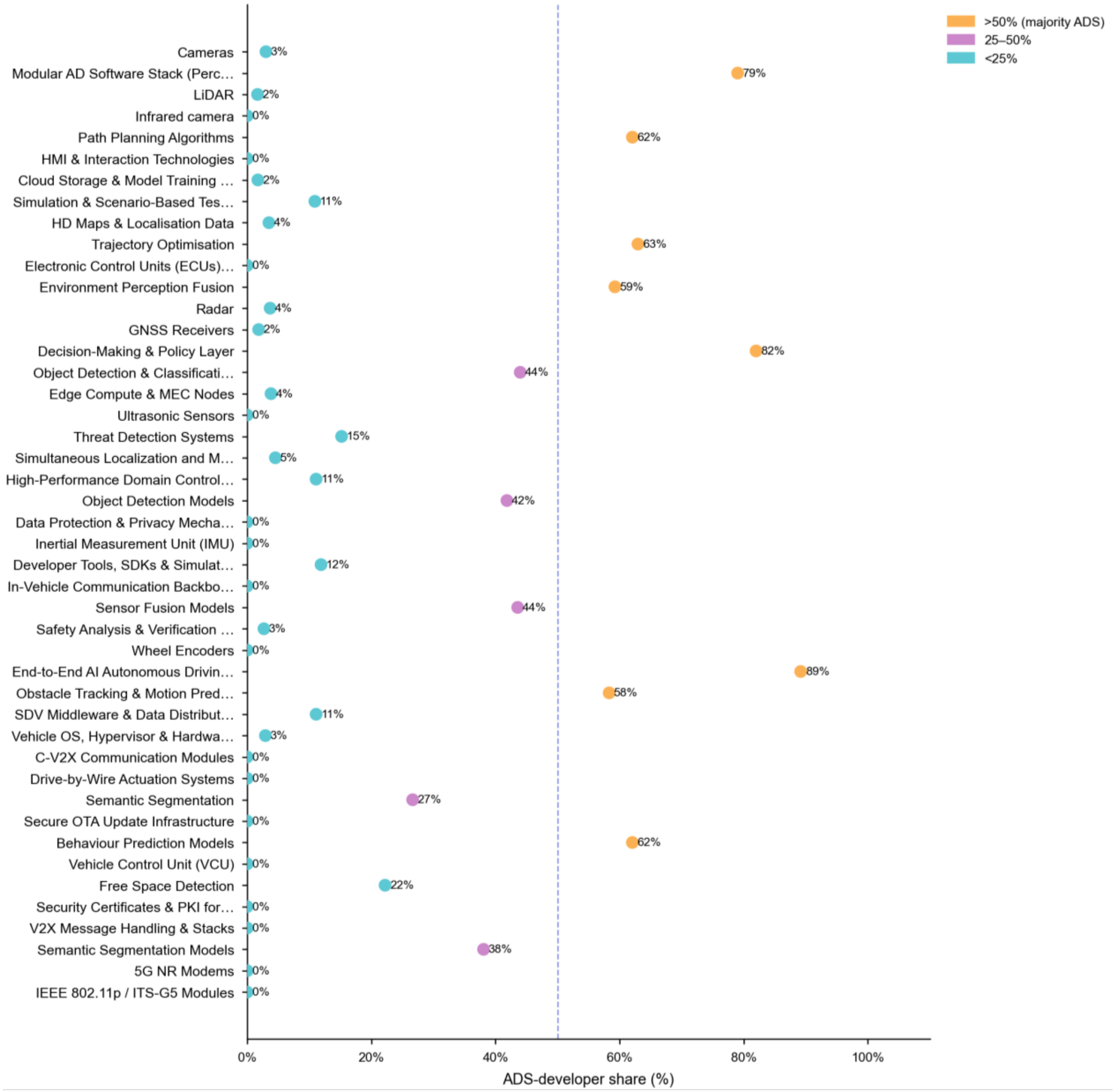
Figure 16. Provider tier composition by component name. Each bar represents the share of Major, Niche and Emerging tier suppliers for a given component type, ordered by total pair count.



Source: JRC analysis.

The dominance of Emerging-tier suppliers across the majority of component names underscores the degree to which the CCAM supply market remains in a formative phase. The competitive landscape in most software-defined components has not yet crystallised, leaving room for new firms to establish leadership positions.

Figure 17. ADS developer share by component name. Dot position indicates the proportion of suppliers in each component category that are themselves active ADS developers.



Source: JRC analysis.

In **Figure 17**, the dot plot of ADS developer share per component name highlights a strong concentration of autonomous driving system developers within specific software and algorithmic domains. Path Planning Algorithms, Decision-Making & Policy Layer and Modular AD Software Stacks exhibit ADS developer shares exceeding 50%, confirming that the firms most actively developing end-to-end autonomous systems are vertically integrating into the decisional core of the technology stack. Conversely, hardware-oriented components, including Radar, Cameras, GNSS Receivers and Wheel Encoders, register near-zero ADS developer participation, as these are predominantly supplied by specialised sensor and electronics manufacturers rather than system integrators.

The sharp gradient between ADS-developer-dense and ADS-developer-absent component segments reflects a broader architectural divide in the CCAM supply chain between the physical sensing and actuation layer and the computational intelligence layer. As will be presented in the following subchapter, European suppliers are well represented in the former but underrepresented in the latter, as reflected in the low ADS developer share among European firms in AI and planning categories identified in subchapter 4.2.1.

The concentration of ADS developers within the software-intensive categories of the CCAM supply chain reflects a broader dynamic of vertical integration. As ADS developers mature their stacks, they progressively internalise adjacent component categories, developing proprietary sensors, dedicated inference chips, and tightly coupled software modules optimised for their own architectures rather than sourcing these from independent specialists. This pattern, already observable in the strategies of leading ADS developers, may shift the boundary between system integrator and component supplier. The traditional Tier 1 / Tier 2 supply structure, in which component specialists supplied standardised parts to system integrators who in turn supplied OEMs, may be giving way to a model in which ADS developers simultaneously compete with and substitute for the conventional supply chain.

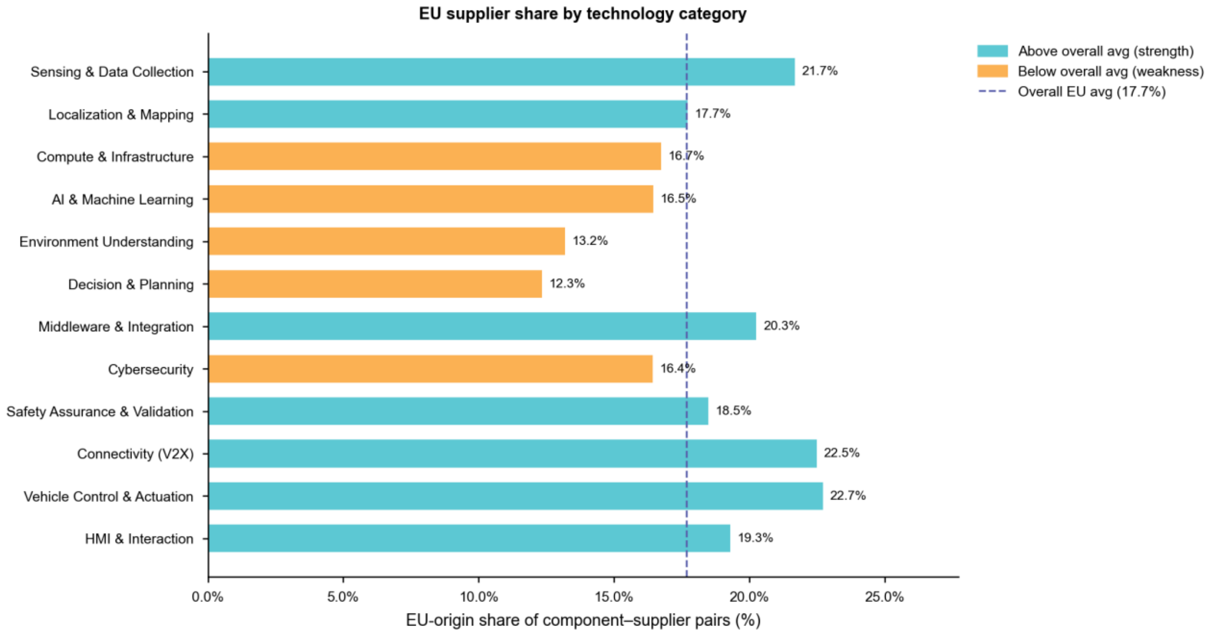
This dynamic has particular relevance for interpreting the present dataset. European suppliers hold a comparatively strong position in the hardware-intensive component categories that have historically been supplied through the conventional tier structure. However, the demand for these components is increasingly mediated by ADS developers who control system architecture decisions and specify the interface requirements that component suppliers must meet. Where ADS developers are predominantly non-European, as the data in this chapter indicates, European hardware suppliers are exposed to architectural decisions in which their direct involvement is limited. The degree to which this exposure translates into long-term supply chain displacement depends on how rapidly vertical integration accelerates and whether European hardware capabilities remain differentiated enough to resist substitution by in-house alternatives developed by ADS integrators.

4.2.5. European Union Positioning: Strengths, Gaps and Strategic Implications

The EU's share of component–supplier pairs, shown in **Figure 18**, varies from approximately 12% in Decision & Planning to nearly 23% in Vehicle Control & Actuation and Connectivity (V2X), against an overall EU average of 17.7%. Categories in which the EU exceeds its average share, like Vehicle Control & Actuation, Connectivity (V2X), Sensing & Data Collection and Middleware & Integration, represent domains of relative European competitive strength, rooted in established automotive manufacturing traditions. Categories below the average, most notably Decision & Planning, Environment Understanding and AI & Machine Learning, reveal the structural gaps in the European software and AI supply base. Comparing the data shown in **Figure 10**, it is evident that those are the categories most relevant to ADS developers.

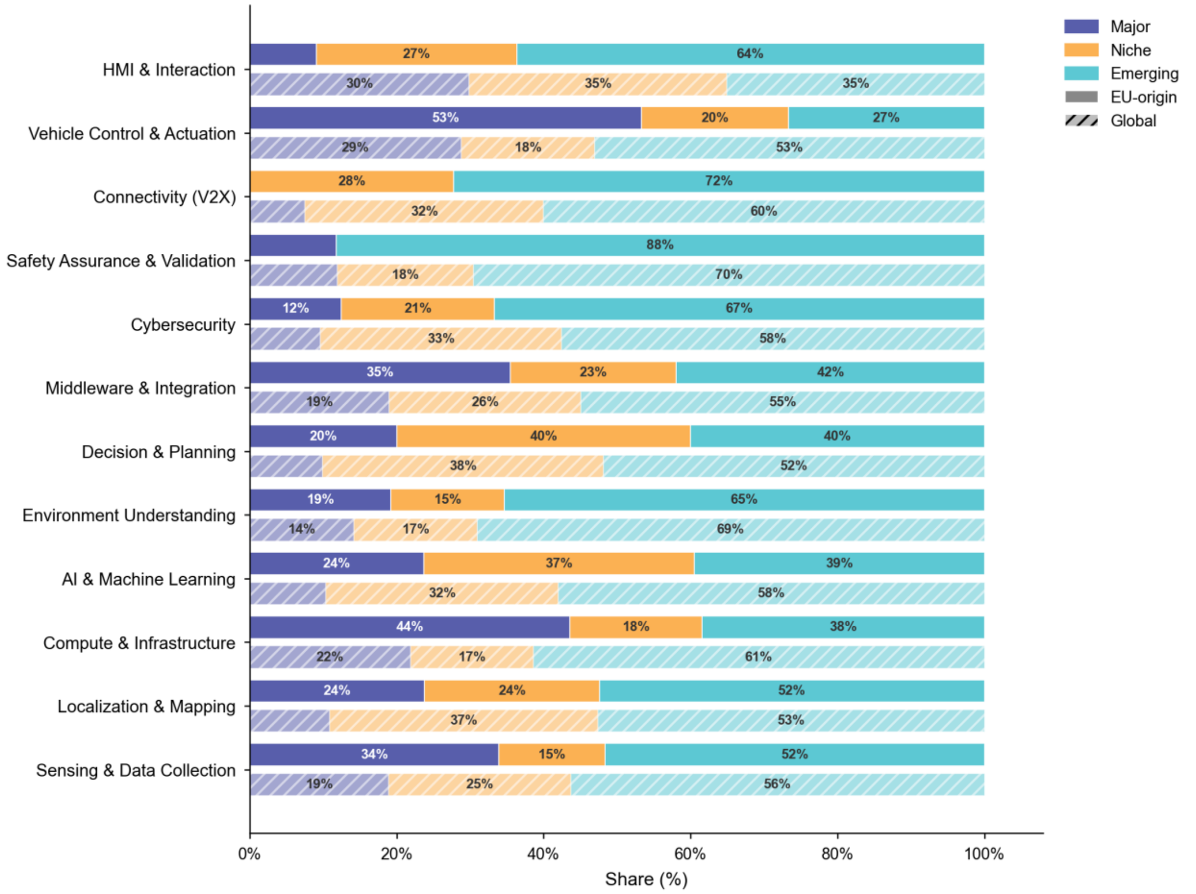
A direct comparison of the provider tier mix between EU-origin suppliers and the global supply base is presented in **Figure 19**. A consistent pattern is revealed, of EU over-representation at the Major tier across most technology categories. EU suppliers active in Vehicle Control & Actuation, Compute & Infrastructure and Sensing & Data Collection exhibit Major-tier shares substantially above the global averages for those categories, confirming the established industrial character of European CCAM hardware suppliers. The notable exception is HMI & Interaction, where the EU's Major-tier share falls well below the global average, reflecting the dominance of non-European consumer electronics and infotainment firms in that segment.

Figure 18. EU share of component–supplier pairs by technology category. The dashed vertical line marks the overall EU average (17.7%).



Source: JRC analysis.

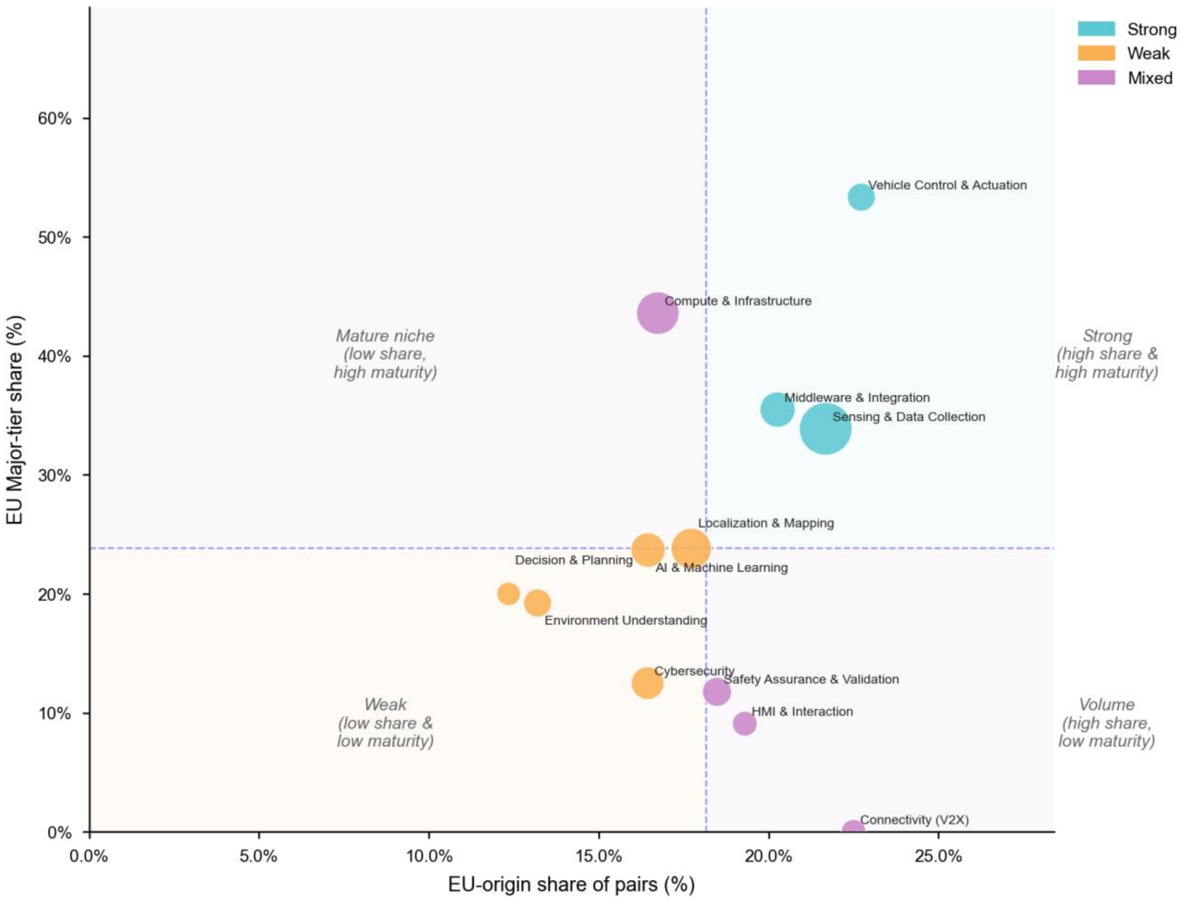
Figure 19. EU versus global provider tier composition by technology category. Paired bars compare the tier share of EU-origin suppliers against the global average for each category.



Source: JRC analysis.

The systematic EU premium in Major-tier representation is a double-edged finding. On the positive side, it indicates that European suppliers competing in the global CCAM market tend to operate at a higher maturity and scale than their global peers, suggesting a quality advantage. On the negative side, it may also reflect a relative absence of European Emerging-tier and Niche-tier activity, a thinness in the innovation pipeline that could leave the EU without successors to its current Major-tier base as technology cycles accelerate. This points to the importance of both maintaining existing Major-tier strengths and ensuring the continued renewal of the European CCAM supplier base.

Figure 20. EU competitive positioning quadrant by technology category. The horizontal axis shows EU origin share; the vertical axis shows EU Major-tier share. Dashed lines mark global averages, defining four strategic quadrants.



Source: JRC analysis.

The quadrant analysis of **Figure 20** provides a synthetic view of the EU's competitive position across all twelve technology categories, plotting each category on two axes that together capture both market presence (EU origin share of pairs) and supplier quality (EU Major-tier share). Categories falling in the upper-right quadrant combine an above-average EU market share with an above-average Major-tier supplier proportion, and can be characterised as genuine European strengths where domestic suppliers occupy an established and credible position. Categories in the lower-left quadrant, including Decision & Planning and Environment Understanding, exhibit both low EU market share and low EU Major-tier representation, identifying them as areas of structural weakness where European industry has yet to establish meaningful competitive presence.

The remaining categories fall into mixed positions that require nuanced interpretation. Compute & Infrastructure and Middleware & Integration exhibit high EU Major-tier shares but relatively modest overall EU presence, suggesting pockets of excellence within an otherwise thin domestic supply base. Conversely, Connectivity (V2X) shows an above-average EU share but near-zero Major-tier representation, a pattern of broad but immature involvement.

Taken together, the evidence presented in this section confirms that the European Union occupies a structurally asymmetric position in the global CCAM supply landscape. Its established industrial base in hardware-intensive domains provides a foundation of genuine competitive strength, yet the relative thinness of European presence in the software-intensive, AI-driven segments that are growing most rapidly represents a strategic vulnerability of increasing importance. Addressing this asymmetry may benefit from targeted policy attention that both protects existing Major-tier positions and actively stimulates the growth of European Emerging-tier suppliers in the categories where future market leadership will be decided.

4.3. Component Sourcing Based on Publicly Disclosed Information

This section analyses the sourcing of technological components in automated mobility services based on publicly disclosed information. As a result, the observations reflect only the components and supplier relationships that are visible in public sources and do not represent the full underlying technology stack.

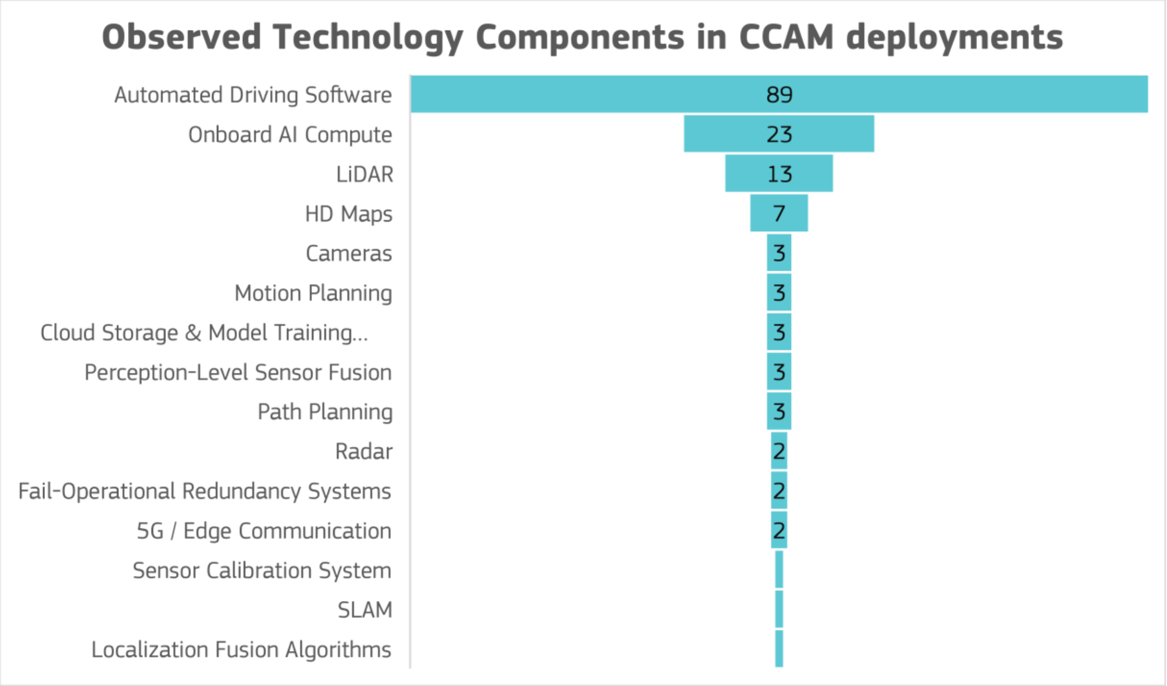
4.3.1. Technologies Used in Real Deployments

While the previous section describes the technological architecture of automated driving systems in conceptual terms, the Observatory database also makes it possible to examine which technologies are actually used in real-world service deployments. The database links automated mobility services with the technologies used in their deployments through the Service_Components table, which tracks relationships between services, technology components, and suppliers based on publicly available sources.

However, not all companies disclose detailed information on the technological components used in their deployments, and the results therefore reflect available evidence rather than a complete representation of all systems. Despite this limitation, the dataset allows for the identification of technologies most commonly used in real-world implementations and provides insights into how these components are combined within automated vehicle architectures.

Figure 21 illustrates the technologies most commonly observed in the services documented in the database. The results highlight the central role of automated driving software, defined as all software that directly enables perception, localisation, prediction, planning and control. Also significant is the role of high-performance computing platforms, which appear in a large share of the mapped deployments. Sensor technologies such as LiDAR and cameras also appear frequently, reflecting their importance in enabling reliable perception of the surrounding environment.

Figure 21. Most frequently observed technology components in mapped CCAM deployments.



Source: JRC analysis.

The deployment data confirm that perception technologies form the core of most automated mobility systems. Sensors such as cameras, LiDAR, and radar appear frequently across the services documented in the database. These technologies provide complementary sensing capabilities and are often combined through sensor fusion approaches in order to improve robustness and reliability. Cameras offer detailed visual information, LiDAR provides precise three-dimensional spatial measurements, and radar performs reliably under adverse weather conditions. The combination of multiple sensing modalities therefore represents a common design choice in automated vehicle architectures.

Localisation technologies also appear in deployment data, although less frequently disclosed. High-definition maps are identified in 7 services, while GNSS receivers and inertial measurement units play a critical role in ensuring that vehicles maintain accurate positioning within their operational environments. In many services, localisation technologies work together with perception systems to maintain consistent positioning even when satellite signals are degraded or when environmental conditions change.

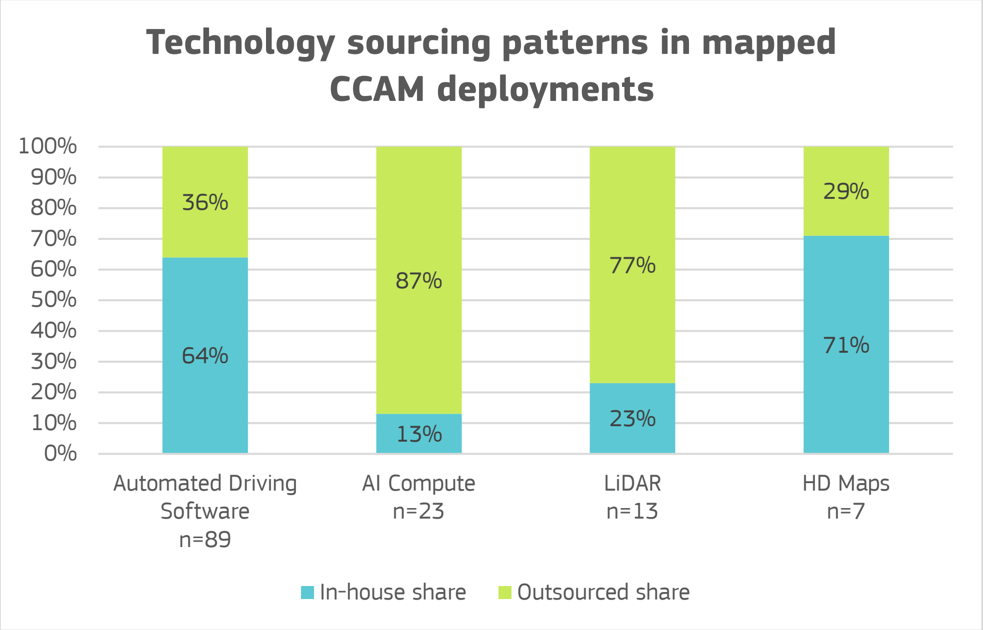
Another widely observed component of the technology stack is the presence of high-performance computing systems. Automated driving requires significant processing capacity in order to analyse sensor data, run machine learning models, and generate real-time driving decisions. As a result, many deployments rely on specialised computing platforms designed for AI workloads. The dataset identifies a relatively small group of suppliers in this segment, including NVIDIA, Ambarella Inc and Mobileye Global Inc. Unlike the ADS, which is often developed in-house, high-performance computing platforms are rarely built internally due to the high level of expertise required to develop and maintain them, as well as the industrial capabilities needed. As a result, service operators rely heavily on external suppliers for these components. The relatively limited number of providers also makes these partnerships more visible in public disclosures.

Important limitations affect what deployment data make visible. Publicly available information often refers to the automated driving stack at a general level, but much less frequently identifies the specific suppliers of individual components. In some cases, this information is simply not disclosed; in others, it may reflect the fact that key parts of the stack are developed in-house or are considered too strategic to be openly attributed to external suppliers. In certain deployments, outsourcing of core ADS capabilities may also be limited or not permitted.

In addition, not all technology domains are equally visible in deployment data. Technologies related to perception, localisation, and computing infrastructure are frequently mentioned in public documentation because they represent key technical features of automated vehicles. By contrast, some domains such as cybersecurity systems, validation tools, or cloud training infrastructure appear less frequently in the dataset. This does not necessarily mean that these technologies are absent from deployments; rather, it reflects the fact that detailed information about backend infrastructure or safety processes is often not disclosed publicly.

Beyond identifying the presence of technologies, the component links also provide insight into how operators organise their technology supply chains. Because the mapping relies mainly on publicly available information, the results reflect disclosed evidence rather than the full market. Even with this limitation, a clear make-versus-buy pattern can be observed. **Figure 22** illustrates the share of technology components that are developed in-house by service operators compared with those supplied by external providers.

Figure 22. In-house vs outsourced technologies in mapped CCAM deployments.



Source: JRC analysis.

The following observations draw on a limited number of disclosed component links (89 for automated driving software, 23 for computing, and 13 for LiDAR) and should be interpreted accordingly. The automated driving software is often developed internally by service operators: in the current dataset it appears in-house in about 64% of the 89 mapped ADS links. This means that, out of the 89 ADS-related links recorded in the dataset, approximately 57 correspond to in-house development, while around 32 involve externally supplied ADS solutions. By contrast, several hardware layers are mostly supplied by external companies. On-board AI compute platforms are outsourced in around 87% of the 23 mapped compute links, while LiDAR sensors are outsourced in roughly 77% of the 13 recorded LiDAR links. This shows that the roles are divided in the ecosystem: operators focus mainly on software development and system integration, while specialised suppliers provide key hardware components such as compute platforms and sensors.

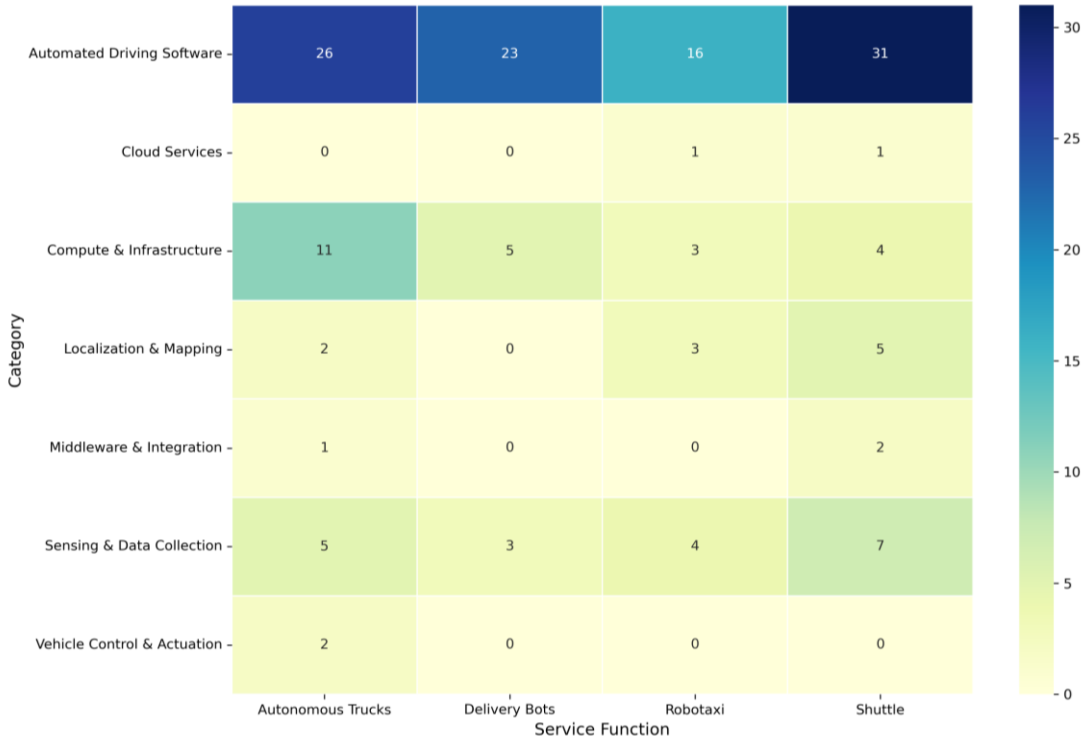
For clarity, **Figure 22** focuses only on the four technology components that appear most frequently in the dataset. These components have an sufficient number of recorded links across services to allow meaningful comparison between in-house development and external sourcing. Many of the remaining technologies appear only once or twice in the dataset, due to limited availability of publicly disclosed information for specific components and for this reason these technologies are not included in the visual comparison.

4.3.2. Technology Stack by Service Type

Automated mobility services operate in a variety of environments and use cases, ranging from urban passenger transport to long-distance freight logistics. As a result, the composition of the technology stack can vary depending on the operational context of the service. The Observatory database allows these differences to be examined by comparing the technologies used across four main service categories: robotaxis, autonomous trucks, automated shuttles, and delivery robots.

Figure 23 shows the distribution of technology domains across these service types. The heatmap shows how frequently different technology layers appear in the component links recorded for each category of automated mobility service. Notably, some categories appear low because of underreporting.

Figure 23. Technology stack across CCAM service types, derived from publicly available data. Some technologies may remain undisclosed.



Source: JRC analysis.

The figure shows several differences in the technological architecture of the four services. In particular, automated driving software components appear frequently across all service types, with 26 occurrences in autonomous trucking deployments, 31 in shuttle services, 16 in robotaxi services, and 23 in delivery robots. These components mainly correspond to the autonomous driving software stack and the systems that support its operation and ensure safe functioning.

Autonomous trucking services show a strong presence of automated driving software components (26) and compute and infrastructure technologies (11), which indicates the importance of processing capabilities and system performance in freight operations. Truck deployments also include sensing technologies (5) as well as smaller numbers of localisation and mapping (2) and vehicle control and actuation components (2), which help vehicles detect their surroundings and operate effectively on highways.

Delivery robot services show a slightly different technology setup. In these deployments, automated driving software components (23) and compute and infrastructure technologies (5) appear most often. Sensing technologies (3) are also present helping delivery robots detect objects, navigate their surroundings, and avoid obstacles in pedestrian areas where they operate.

Robotaxi services rely mainly on automated driving software components (16) together with sensing technologies (4) and localisation and mapping technologies (3). They also include compute and infrastructure components (3), which support processing and system performance. In addition, cloud services (1) appear in the dataset, highlighting the role of data connectivity and remote processing in supporting operations.

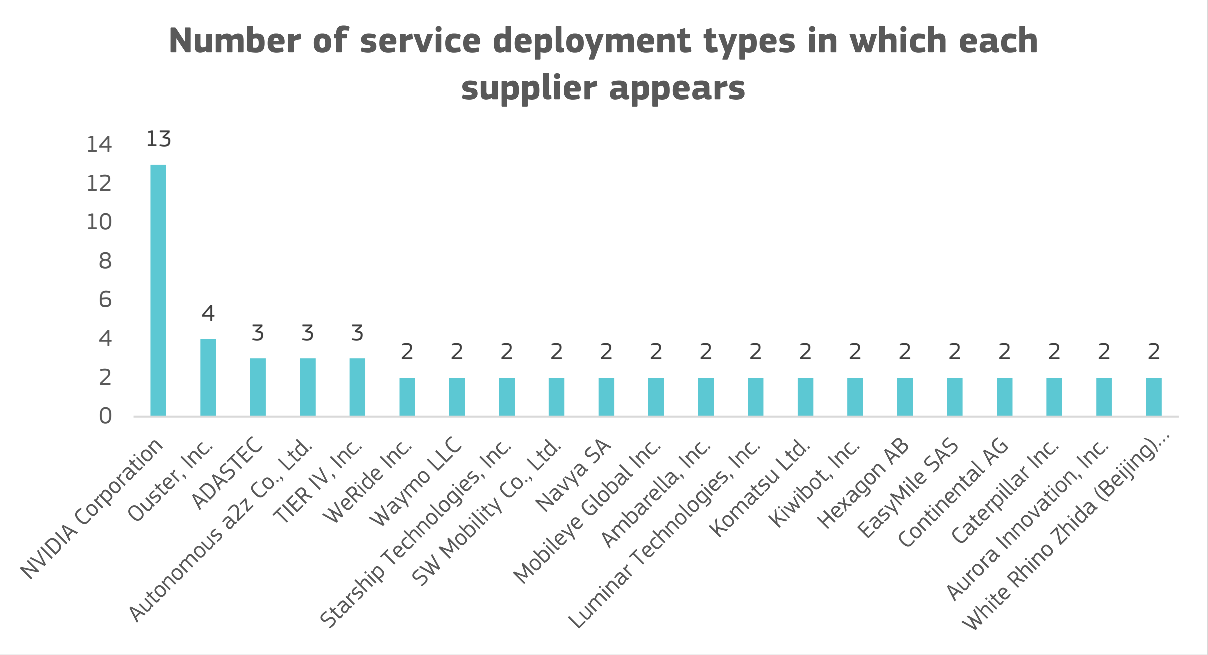
Automated shuttle services show the strongest overall presence of technology components in the dataset. These deployments include automated driving software components (31) along with sensing technologies (7), localisation and mapping (5), and compute and infrastructure technologies (4). Other elements include middleware and integration systems (2) as well as smaller numbers of cloud services (1). This combination reflects the role of shuttle services as integrated autonomous systems operating in relatively controlled environments such as campuses, airports, and residential districts.

4.3.3. Technology Supply Chains in Services

This subsection looks at how often suppliers appear across different services. **Figure 24** is a bar plot that visualises market reach by mapping individual supplier names against the number of unique service deployment types in which they appear. Each bar represents a company, and its height indicates how many different types of automated services are currently utilising that supplier’s technology, based on public information.

The data reveals a highly fragmented landscape characterised by a "long tail" distribution. This means that while a tiny handful of companies are widespread, the vast majority of suppliers appear only once in the dataset. This pattern suggests relatively low entry barriers for niche applications, while also indicating that competitive advantage is often based on specialization rather than broad market coverage. It also implies that the market remains only partially consolidated, with no single company controlling a dominant share of the value chain, except in AI compute.

Figure 24. Number of service deployments types associated with each supplier.



Source: JRC analysis.

NVIDIA stands as the primary exception to this fragmentation, reflecting its broad cross-sector presence. Because high-end autonomous driving requires massive computational power, NVIDIA has become a widely adopted hardware provider across the industry. By supplying its chips to multiple service operators, it appears repeatedly across the dataset, having an important role in the high-end automotive AI supply chain.

In contrast, some of the most successful companies, such as Waymo, show a much smaller footprint in this specific data because they pursue vertical integration. Instead of trying to dominate a market segment by selling their technology to competitors, they focus on building an end-to-end system for their own fleet. Because they do not act as a third-party supplier, they appear less frequently in a chart that measures how many different services a company supports.

The high concentration in the computing segment suggests that it is one of the few "bottlenecks" in the technology stack. While there are dozens of companies creating different sensors or software algorithms, high-performance onboard AI compute relies on a very small set of established platforms. This results in significant concentration within the hardware segment, while other vehicle technologies continue to support a more diverse set of competitors.

Finally, it is important to acknowledge that these findings may be affected by reporting bias. Public announcements and media coverage tend to emphasize highly visible components, such as the primary AI computing platform or autonomous driving software. In contrast, less visible infrastructure is seldom referenced in public disclosures. Consequently, firms operating in these areas may play a more significant role than the available data indicates, despite receiving comparatively limited attention.

5. European Stakeholder Presence

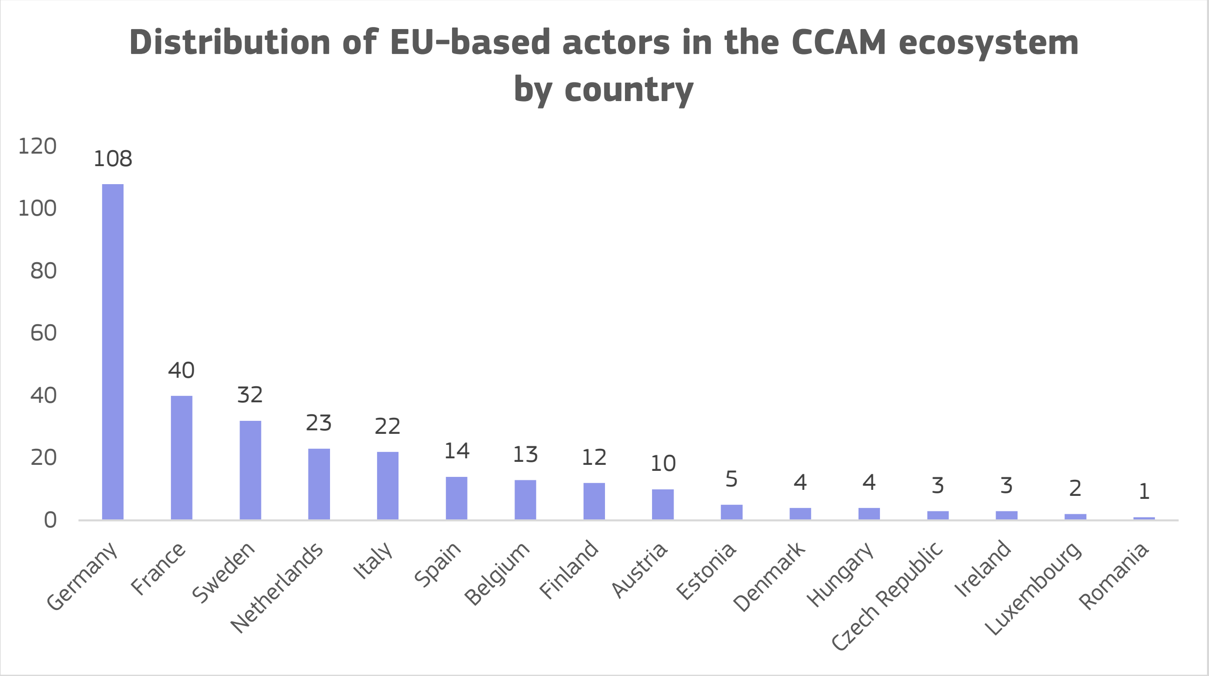
This section provides a more detailed examination of the role of European actors within the automated mobility ecosystem. Building on the global overview, it focuses specifically on the relative weight of EU-based companies, their position along the value chain, and their participation across key technology domains. Particular attention is given to the structure of the European ecosystem, including the balance between suppliers, service operators, and supporting actors. For the purposes of this analysis, European companies are defined as those having their headquarters in the European Union. The analysis also explores the contribution of startups and emerging innovators, offering insights into Europe's capacity for technological development and future growth in the sector.

5.1. European Companies in the Ecosystem

The actor dataset shows that European stakeholders are clearly present in the automated mobility ecosystem. Out of 1,335 actors included in the dataset, 296 are EU-based, corresponding to approximately 22.2% of the total, while 1,039 are non-EU-based. Given the global scope of the analysis, this share indicates a significant European presence within an international ecosystem, rather than a marginal role.

Within the European group, participation is also unevenly distributed across countries. As shown in **Figure 25**, Germany stands out by a wide margin, with 108 actors, followed by France (40), Sweden (32), the Netherlands (23), and Italy (22). A second group of countries, including Spain, Belgium, Finland, and Austria, also shows visible participation, although on a smaller scale. This pattern suggests that European activity is concentrated in a relatively limited number of countries with stronger automotive, industrial, and mobility technology ecosystems. It should be noted that the figure presents the number of actors, not their scale or market significance.

Figure 25. Number of EU-based actors included in the dataset by country (n = 296).



Source: JRC analysis.

The data also points to a clear role pattern. European actors are much more strongly represented on the supplier and enabling technology side than among service operators. Most EU-based actors in the dataset are identified as suppliers, while only a few are classified as service providers. This indicates that Europe's role in automated mobility is linked more closely to enabling technologies, components, software building blocks, and engineering capabilities than to the direct operation of automated mobility services.

5.2. European Supplier Participation Across Technology Domains

A more detailed picture of Europe's position in the ecosystem emerges when looking specifically at supplier participation across individual technology domains. The supplier-component dataset shows that, based on the EU/non-EU classification recorded in the actor database, European suppliers are not evenly distributed across the stack, but are instead more frequently represented in a number of specific component categories.

As detailed in **Table 3**, European suppliers are particularly active across several key technology domains. The highest number of EU-based suppliers is observed in Radar (17 suppliers), followed by Cameras (15) and LiDAR (14). A similarly high presence can be observed in Simulation & Scenario-Based Testing Platforms (13 suppliers). Cloud Storage & Model Training Infrastructure, HMI & Interaction Technologies, and Modular AD Software Stack (Perception–Planning–Control) each include 12 EU-based suppliers, while Wheel Encoders account for 11. Finally, Developer Tools, Drive-by-wire systems, Edge Compute, and ECUs & Microcontrollers each include 10 EU-based suppliers.

Table 3. EU-based suppliers by technology domain in the automated mobility ecosystem, based on the CCAM Observatory database.

Technology	EU-based Suppliers
Radar	ZF Friedrichshafen, Continental AG, Robert Bosch GmbH, Aptiv PLC, FORVIA HELLA, Infineon Technologies, NXP Semiconductors, smartmicro, Valeo, Acconeer, ECHOES, Elettronica Aster, Gapwaves, Inxpect, Rheinmetall Italia, TRUESENSE
Cameras	Robert Bosch GmbH, Continental AG, Valeo, ZF Friedrichshafen, Aptiv PLC, FORVIA HELLA, STMicroelectronics, Infineon Technologies, NXP Semiconductors, Elektrobit, Veoneer, Marelli Europe, Ficosa, Smart Eye
LiDAR	Valeo, Robert Bosch GmbH, ZF Friedrichshafen, AUMOVIO, Innoviz Technologies Europe, Ibeo Automotive Systems, AEye Europe, Blickfeld, Opsys Tech Europe, Ouster Europe, Hesai Europe, RoboSense Europe, Quanergy Europe
Simulation & Scenario-Based Testing Platforms	dSPACE, AVL, Siemens, Hexagon, IPG Automotive, Cognata Europe, Foretellix Europe, Applied Intuition Europe, VIRES Simulationstechnologie, rFpro, Claytex, TASS International, Dynisma
Cloud Storage & Model Training Infrastructure	SAP, Siemens, Atos, OVHcloud, Deutsche Telekom, Orange, Ericsson, Nokia, T-Systems, Capgemini, Dassault Systèmes, Reply
HMI & Interaction Technologies	Robert Bosch GmbH, Continental AG, Valeo, Elektrobit, ZF Friedrichshafen, Aptiv PLC, FORVIA HELLA, Marelli, Visteon Europe, Preh, Faurecia, Luxoft
Modular AD Software Stack (Perception–Planning–Control)	Elektrobit, Robert Bosch GmbH, Continental AG, ZF Friedrichshafen, Aptiv PLC, Valeo, TTTech Auto, KPIT Europe, dSPACE, AVL, Siemens, Oxbotica

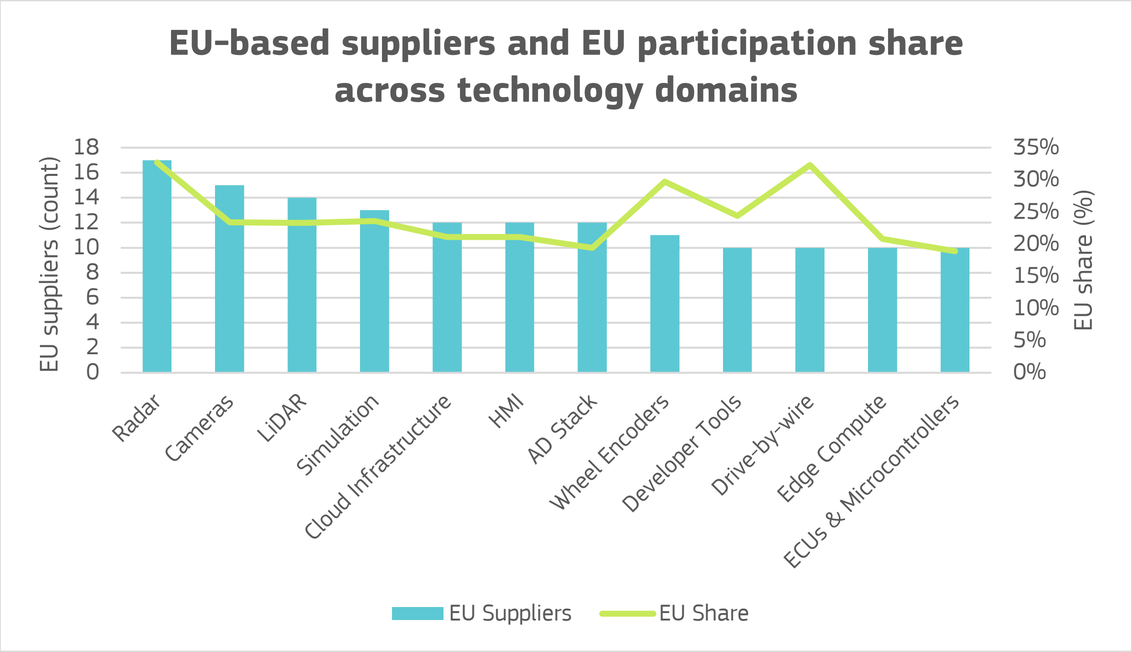
Wheel Encoders	Robert Bosch GmbH, Continental AG, ZF Friedrichshafen, Valeo, Aptiv PLC, FORVIA HELLA, Infineon Technologies, NXP Semiconductors, SKF, Schaeffler, Sensata Europe
Developer Tools, SDKs & Simulation Frameworks	dSPACE, Siemens, Elektrobit, AVL, Dassault Systèmes, MathWorks Europe, Hexagon, IPG Automotive, VIRES, Claytex
Drive-by-Wire Actuation Systems	ZF Friedrichshafen, Robert Bosch GmbH, Continental AG, Valeo, Aptiv PLC, FORVIA HELLA, Nexteer Europe, Schaeffler, SKF, TTTech Auto
Edge Compute & MEC Nodes	Robert Bosch GmbH, Continental AG, NXP Semiconductors, Infineon Technologies, STMicroelectronics, Siemens, Kontron, Advantech Europe, Eurotech, AAEON Europe
ECUs & Microcontrollers	NXP Semiconductors, Infineon Technologies, STMicroelectronics, Robert Bosch GmbH, Continental AG, Valeo, ZF Friedrichshafen, Aptiv PLC, FORVIA HELLA, TTTech Auto

Source: JRC analysis.

The number of suppliers can also be used to approximate the relative distribution of market participation across technology domains as shown in **Figure 26**. By comparing the number of EU-based suppliers with the total number of actors in each category, it is possible to derive a participation-based measure of market share. This analysis shows that European suppliers account for approximately one-fifth to one-third of actors across most domains, with stronger representation in hardware-intensive areas such as radar and drive-by-wire systems (around 30% of suppliers), and comparatively lower shares in software-oriented domains such as modular AD stacks and computing infrastructure (around 20%).

At the same time, these results should be interpreted with caution. The analysis reflects the number of suppliers identified in each category within the dataset, which provides an indication of the distribution of actors across technology domains. While this allows for an approximation of participation-based market share, it does not capture the economic weight or technological leadership of individual companies. Crucially, the number of companies in a given segment should not be interpreted as a proxy for actual market share, which is typically highly concentrated among a limited number of leading players. As a result, a higher number of suppliers does not necessarily imply a stronger competitive position, but may also reflect differences in market structure, such as the presence of a larger number of smaller or more specialised firms.

Figure 26. Number of EU-based suppliers and participation-based EU share across technology domains in the automated mobility ecosystem.



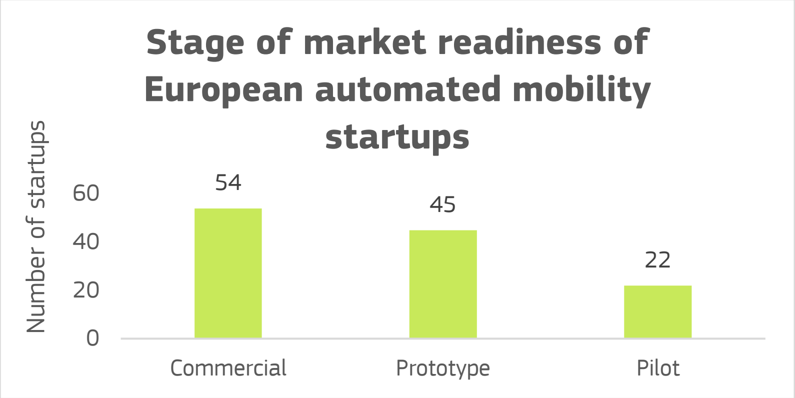
Source: JRC analysis.

5.3. Startups and Emerging Innovators

The startup dataset adds a useful perspective by highlighting the presence of younger and more specialised European companies within the ecosystem. In total, the dataset includes 121 European startup and emerging company profiles, indicating that Europe's role in automated mobility is not limited to established industrial players, but also includes a visible layer of newer entrants.

A first indication of this landscape is provided by **Figure 27**, which shows the distribution of startups according to their stage of market readiness. The sample includes 54 companies classified as commercial, 45 at prototype stage, and 22 at pilot stage. This suggests that the European startup ecosystem is not confined to very early experimentation, but already includes a meaningful number of firms that have progressed towards market-facing activity.

Figure 27. Distribution of European startups in automated mobility by stage of market readiness.



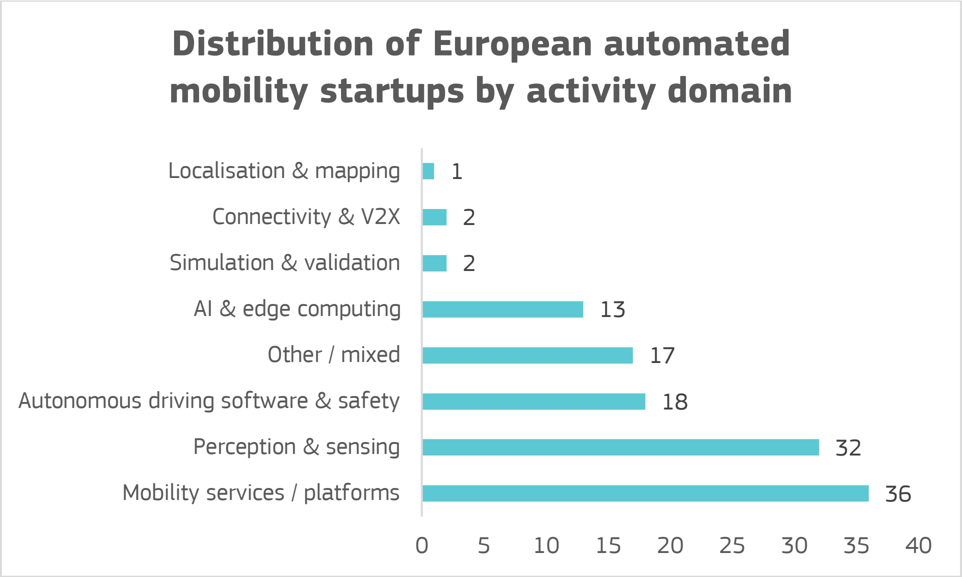
Source: JRC analysis.

Funding data are available for a subset of the sample and point to a non-negligible level of investment activity. Out of the 121 companies, 35 have disclosed funding values, with a combined total of approximately EUR 1.21 billion. Among those with available figures, the median reported funding level is approximately EUR 17.1 million. This suggests that while some better-capitalised firms are present, a large part of the ecosystem remains composed of relatively modestly funded specialist players.

The data also indicate that public support is visible in part of the startup landscape. 15 companies in the sample are marked as having received EU-related funding, suggesting that institutional and public funding mechanisms continue to play a role in supporting emerging innovation in the sector.

A more detailed analysis of startup activities shows that this innovation base is primarily concentrated in enabling technologies rather than end-user mobility services. As illustrated in **Figure 28**, a large share of companies focus on areas such as perception and sensing systems, artificial intelligence and edge computing, as well as autonomous driving software and safety solutions. Additional clusters include simulation and validation platforms, connectivity and V2X technologies, and localisation and mapping systems. By contrast, a notable number of startups are active in operating mobility services or developing integrated transport platforms, although these represent a comparatively smaller share of the overall ecosystem.

Figure 28. Number of startups by primary activity domain (n = 121).



Source: JRC analysis.

These results should be interpreted with some caution. The classification of companies by activity domain is based on the primary focus identified in company descriptions within the dataset, and some firms operate across multiple technological areas. As a result, each company is assigned to a dominant category for analytical purposes, which may not fully capture the breadth of its activities.

Overall, the startup data suggest that Europe has a technically active and relatively diverse innovation base in automated mobility, but one that remains largely concentrated in specialised enabling technologies rather than in large-scale integrated platform development.

6. Partnerships and Ecosystem Collaboration

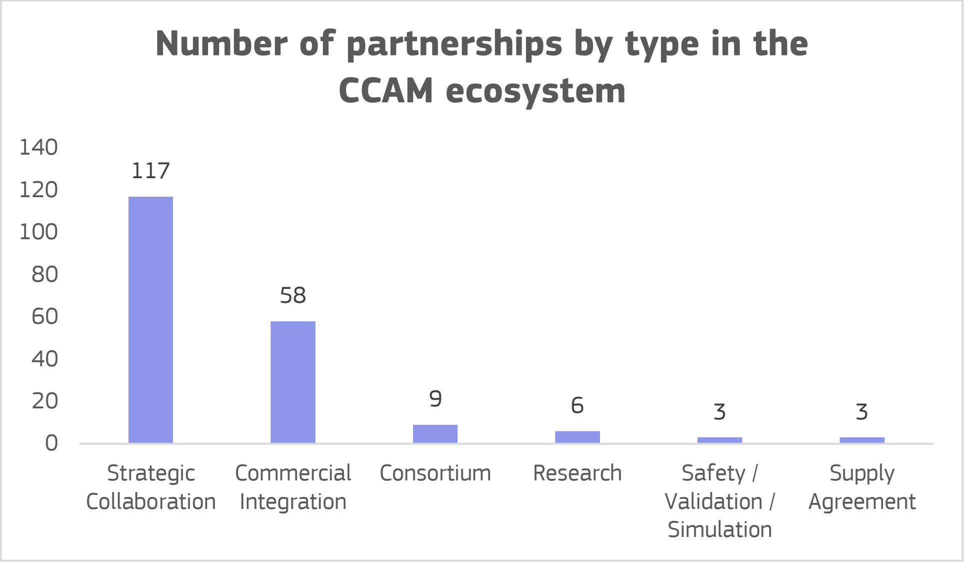
This section examines partnership activity within the CCAM ecosystem, focusing on how actors collaborate across technologies, services, and regions. It analyses the types of collaborations recorded in the Observatory database, their geographic distribution, and the companies that occupy central positions in the partnership network. Supply Agreements are recorded as partnerships only when the supplier relationship is publicly announced and strategically relevant, for example where it is exclusive or preferred, long-term, linked to a specific deployment, production programme, or scale-up activity. Generic supplier–customer relationships or ordinary component use are not counted as partnerships.

6.1. Collaboration Patterns and Geographic Distribution

Partnerships are identified based on publicly announced collaborations and include bilateral agreements as well as multi-partner initiatives. The following subsections examine these collaborations in more detail, focusing on the types of partnerships and the structure of collaboration networks. The CCAM Observatory database records a total of 196 partnerships between organisations active in the automated mobility ecosystem. All partnerships included in the dataset are currently active, reflecting the focus on ongoing collaborations and recently established agreements.

The distribution of partnerships across different types of collaboration is shown in **Figure 29**. The results indicate a strong concentration in strategic collaborations, which account for 117 cases. These are followed by commercial integration agreements (58 partnerships), indicating a significant level of activity related to the deployment and integration of technologies into operational services. Other forms of collaboration appear less frequently, including consortia (9 partnerships), research collaborations (6), and a small number of supply agreements and safety or validation partnerships (3 each). However, this distribution should be interpreted with caution, as supply-side relationships are less frequently disclosed, leading to a structural underrepresentation of these partnerships in the dataset.

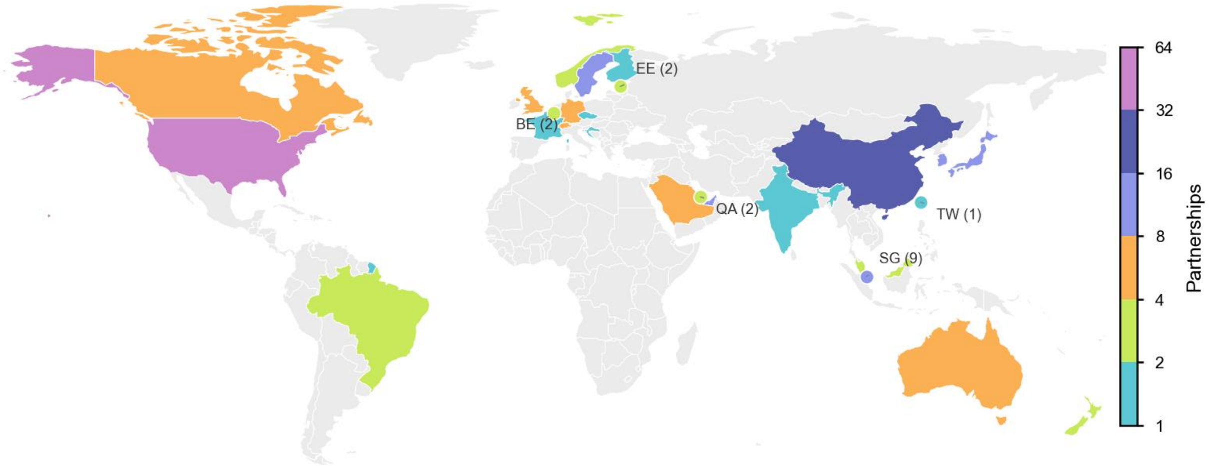
Figure 29. Distribution of partnerships by collaboration type based on the “type” field in the Observatory database.



Source: JRC analysis.

From a geographic perspective, partnerships are not evenly distributed across countries. **Figure 30** presents the countries with the highest number of recorded collaborations in the dataset.

Figure 30. Geographic distribution of partnerships by country (n=196 partnerships across 26 countries/territories).



Source: JRC analysis.

The strong presence of partnerships in the United States and China highlights the role of these countries as leading centres for technological development and large-scale deployment. At the same time, the presence of partnerships across a wider range of countries indicates that collaboration in the sector is not confined to a single region but takes place across multiple international markets.

The choropleth map provides a spatial representation of partnership activity, making it possible to identify geographic patterns that are less visible in tabular data. The map clearly shows a strong concentration of partnerships in a limited number of countries, with the United States representing the most prominent location (61 cases).

A second cluster of activity is visible in East Asia, particularly in China (22), Japan (10), and South Korea (11). Although none of these countries reaches the same level as the United States, their combined numbers create a distinct regional concentration of partnerships. This indicates that the Asia-Pacific region represents a major area of activity in the development and deployment of automated mobility solutions.

The map also highlights the role of selected smaller but highly active markets. Countries such as the United Arab Emirates (15) and Singapore (9) appear relatively prominent despite their size. EU-related partnership activity is present but relatively limited in the dataset. Based on the geographic scope assigned to the partnerships, 22 out of 196 cases are associated with EU countries or Europe more broadly. Sweden accounts for the highest number of cases (8), followed by Germany (4), while Belgium and Estonia each appear in 2 cases. France, Finland, Czechia, and Croatia are each represented once.

Finally, large regions such as Africa and parts of Latin America remain almost absent, suggesting that partnership activity is still concentrated in a relatively limited set of markets.

6.2. Types of Collaboration

While the previous section presents the distribution of partnerships, a more detailed examination of their types helps to better understand how actors collaborate in practice within the automated and connected mobility ecosystem.

In this report, partnerships refer specifically to active collaborations involving at least one actor engaged in automated, connected, or cooperative mobility within the selected vehicle category. These include AV service operators, OEMs, technology suppliers, telecom and cloud providers, infrastructure operators, and public authorities. The analysis focuses on operational and technology-oriented collaborations, excluding purely financial investments or generic agreements without clear relevance to automated mobility.

The large number of strategic collaborations and framework agreements suggests that many companies favour flexible and long-term forms of cooperation. These partnerships are typically broad in scope and may cover multiple activities, including technology development, testing, deployment preparation, and market entry. Their flexibility allows partners to adapt their roles over time as technologies evolve and business models mature.

At the same time, the presence of commercial integrations and service launch agreements indicates that a significant share of partnerships is already linked to real-world deployment. These collaborations are more targeted and operational, often involving the integration of specific technologies, systems, or services into concrete applications such as AV services or logistics operations. This reflects a shift in the sector from experimentation towards implementation.

Other types of partnerships appear less frequently but remain important. Supply agreements and technology licensing or integration deals are relatively limited in the dataset, possibly because they are often embedded within broader strategic collaborations rather than reported as standalone partnerships. Joint ventures and co-owned platforms also represent a smaller share but signal deeper, long-term commitments between partners.

In addition, consortia, testbeds, living labs, and large-scale pilot projects highlight the role of collaborative experimentation environments, often involving multiple stakeholders such as cities, infrastructure operators, and research organisations. These initiatives are particularly relevant for testing technologies and validating use cases in real-world conditions. Similarly, safety, testing, and simulation collaborations contribute to ensuring system reliability and regulatory compliance, although they are less visible in the overall distribution.

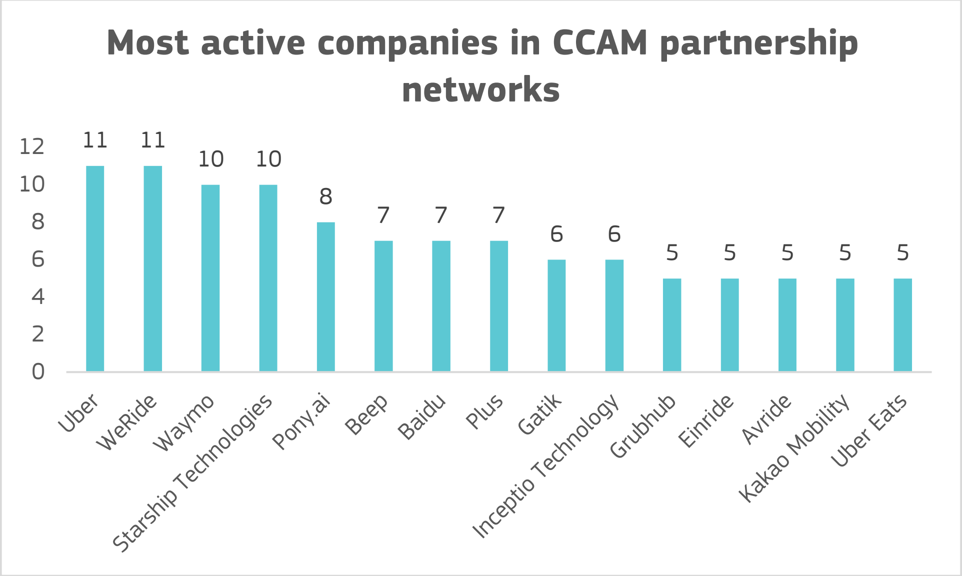
6.3. Key Actors in Partnerships

The structure of partnerships allows to identify the companies that play a central role in the collaboration network. By counting how often each company appears across recorded partnerships, it is possible to highlight the actors that are most actively involved in collaborative activities.

The results show that participation in partnerships is not evenly distributed. A small number of companies appear repeatedly across different collaborations, while most actors are involved in only a limited number of partnerships. This indicates that the ecosystem is structured around a core group of highly connected companies.

Figure 31 presents the companies that appear most frequently in the dataset. Uber and WeRide are the most active actors, each appearing in 11 partnerships. They are followed by Waymo and Starship Technologies, both with 10 partnerships, and Pony.ai, with 8 recorded collaborations. Other companies with a notable presence include Beep, Baidu, and Plus, each appearing in 7 partnerships, as well as Gatik AI and Inceptio Technology, with 6 partnerships. Companies such as Grubhub, Einride, Avride, Kakao Mobility, and Uber Eats also show a visible presence, each appearing in 5 partnerships.

Figure 31. Number of partnerships in which each company appears, based on the CCAM Observatory database.



Source: JRC analysis.

This distribution also reflects the type and geographic origin of the most connected actors. The companies that appear most frequently are predominantly automated vehicle developers and mobility service providers, rather than component suppliers. Moreover, they are largely concentrated in the United States and China, with only a limited presence of European actors, highlighting the leading role of these regions in structuring collaboration networks within the CCAM ecosystem.

This pattern suggests that certain companies act as central nodes within the ecosystem, connecting multiple partners across different projects and markets. These actors are often involved in several types of collaboration, ranging from technology development to service deployment, which increases their visibility and influence within the network.

A more detailed view of participation levels further clarifies this structure. Approximately 75.7% of companies appear only once in the dataset, while only 11.8% are involved in three or more partnerships. This distribution indicates a clear core–periphery structure, where a central group of highly connected actors coexists with a larger number of more specialised participants.

The data also show that most collaborations occur only once between a given set of actors. When all pairwise relationships within partnerships are considered, around 95.7% of links correspond to unique collaborations, while repeated links account for approximately 4.3%. This suggests that a large share of the ecosystem is still characterised by exploratory, project-based interactions, with only a limited number of stable collaboration relationships emerging over time.

At the same time, the presence of companies from different segments — including technology developers, service operators, and platform providers — indicates that centrality is not limited to a single type of actor. Instead, collaboration networks are built through interactions between different parts of the value chain.

The results also indicate that a significant share of collaborations extends beyond national boundaries. Nearly half of the partnerships with known headquarters involve actors located in different countries, suggesting that automated mobility deployments often rely on capabilities distributed across multiple geographic areas. At the same time, domestic collaborations remain present, particularly in more mature markets where both service operators and technology providers are well established.

The structure of partnerships also varies in terms of the number of participating organisations. The majority of collaborations involve two actors, accounting for approximately 67.9% of the total, while 32.1% involve three or more partners. Taken together, these patterns suggest that the partnership landscape combines a broad base of exploratory collaborations with a more limited set of recurring relationships and central actors, reflecting a sector that is still evolving while gradually consolidating.

7. Technology Maturity and Market Trends

This section analyses the maturity of technologies across the automated mobility stack and the main market signals associated with their development. The assessment is based on the market trends dataset compiled for this report, which includes technology status classifications, reported growth rates, and selected market size indicators. Together, these elements provide an overview of how different parts of the stack are evolving and where the strongest development dynamics are observed.

7.1. Technology Maturity Across the Stack

To make the maturity picture easier to read, the analysis was carried out at the level of individual technology components. Each component was assigned the maturity stage that appeared most frequently across the trend entries in the dataset.

Overall, most technologies fall into the improving category (27 components), while a smaller group can be considered mature (9 components). Only a few are classified as emerging (4) or innovating (1). This suggests that much of the automated mobility stack has already moved beyond the purely experimental phase, but many technologies are still developing quickly and have not yet fully stabilised.

The more mature technologies are mainly found in the sensing and core system layers. These include cameras, radar, ultrasonic sensors, GNSS, IMU, and in-vehicle communication backbone technologies. In general, these components already have a more established industrial base and are more widely integrated into vehicle systems. Compared with other parts of the stack, they appear to be evolving more incrementally.

Most of the stack, however, sits in the improving category. This is especially the case for technologies linked to perception, planning, control, and software infrastructure, such as object detection and tracking, semantic segmentation, behaviour prediction, motion and path planning, sensor fusion, onboard AI compute, and secure OTA update infrastructure. These technologies are already being used in practical applications, but they are still advancing rapidly in terms of performance, system integration, and scalability.

A smaller group remains at an earlier stage of development. Technologies such as AI model architecture and optimisation, data protection and privacy mechanisms, infrared sensing, V2V/V2X connectivity, and 5G/edge communication appear less consolidated and are still more dependent on factors such as infrastructure availability, deployment conditions, and broader ecosystem readiness.

7.2. Market Growth and Industry Signals

The market trends dataset also provides an indication of how different technologies across the stack are evolving in terms of growth and market relevance. The reported growth rates vary significantly between components, reflecting differences in how close they are to large-scale deployment, as well as their role within the overall system.

Some of the strongest growth signals are associated with technologies that are central to perception, connectivity, and data processing. For example, LiDAR shows one of the highest reported growth rates at around 60%, suggesting a continued expansion as sensing capabilities become more advanced and costs gradually decrease. Similarly, V2V/V2X connectivity (around 45%), multi-modal fusion models (around 42%), and 5G/edge communication (around 33%) also stand out, pointing to the increasing importance of connected and integrated system architectures.

Strong growth is also visible in technologies related to AI and data infrastructure. Deep learning models (around 31.8%), cloud storage and model training infrastructure (around 29.8%), and AI model architecture and optimisation (around 22.7%) all show clear upward momentum. In addition, onboard AI compute (around 21%) reflects the growing need for higher processing capabilities directly within the vehicle.

Other technologies show more moderate, but still consistent, growth patterns. HD maps (around 24.1%) and SLAM (around 23.1%) continue to play an important role in localisation, while secure OTA update infrastructure (around 18.4%) and threat detection systems (around 16.8%) highlight the increasing relevance of cybersecurity as systems become more complex and interconnected.

Looking at market size signals, the dataset suggests that some of the largest reported values are linked to enabling infrastructure. For instance, cloud storage and model training infrastructure is associated with a reported market size of approximately USD 35.6 billion in 2024, while onboard AI compute is linked to around USD 7.4 billion in the same year. Although these figures are not directly comparable across all technologies, they indicate the scale of investment in data processing and compute capabilities.

8. Conclusions

The Observatory database documents a substantial and rapidly growing global CCAM ecosystem spanning services, suppliers and enabling technologies. Service launches have accelerated sharply in recent years, yet the majority of deployments remain at the late-stage pilot phase rather than full commercial operation. The sector is clearly in transition, not yet at maturity. This formative character extends to the supply side. Emerging-tier firms account for the majority of all component–supplier pairs, and most technology components are classified as improving rather than mature. Competitive positions have therefore not yet consolidated, and the window within which new entrants can establish durable market positions remains open. The pace of development, however, implies that this window may narrow as dominant designs and platform architectures begin to crystallise.

At the aggregate level, the United States, China and the European Union each account for roughly comparable shares of the global supply base. However, this apparent parity dissolves upon closer inspection. Service deployments are heavily concentrated in the United States and China, where large-scale robotaxi, trucking and delivery operations are already commercially active, whereas European deployments are characterised by smaller-scale shuttle and pilot projects distributed across multiple national programmes. The geographic distribution of key industry actors reinforces this asymmetry, with EU-based actors predominantly concentrated in supplier and enabling roles rather than in service operation or vertically integrated business models. Aggregate supply-side presence does not translate directly into deployment leadership or ecosystem centrality. This heterogeneity is also reflected in the types of services being deployed.

Within the service landscape, a further differentiation emerges across operational models. Freight and logistics applications account for a slightly larger share of deployments than passenger services, with autonomous trucking representing the most commercially advanced segment. This is driven by strong economic incentives and comparatively simpler operational environments. By contrast, robotaxi services, despite their high visibility, face greater technical and regulatory complexity, resulting in comparatively slower deployment progress.

The analysis reveals a defining structural asymmetry in the EU's position within the global CCAM supply landscape. The EU holds the largest Major-tier supplier count of any region, and this strength is concentrated in hardware-intensive technology categories such as Vehicle Control & Actuation, Sensing & Data Collection and Compute & Infrastructure, where EU Major-tier shares substantially exceed global averages. Conversely, the EU is structurally underrepresented in the software-intensive categories that are growing most rapidly: Decision & Planning, Environment Understanding and AI & Machine Learning. These are precisely the domains in which ADS developer concentration is highest and in which future system integration standards will be shaped. Europe's competitive foundation has not yet fully established comparable depth in the layers that are emerging as the primary locus of value creation.

The EU's Major-tier leadership coexists with a comparatively thin pipeline of Emerging-tier suppliers, raising concerns about long-term succession. The Emerging tier represents the primary source of future Major-tier incumbents, and European representation in this segment trails that of the United States.

The European startup dataset reinforces this observation. While a meaningful number of startups have reached commercial stage, their activities are concentrated overwhelmingly in specialised enabling technologies such as perception, sensing, simulation, edge computing, rather than in integrated platform development or large-scale service operation. The relative absence of European firms pursuing vertically integrated models suggests that the EU's innovation base, while technically diverse, may not be generating the type of companies best positioned to capture architectural control in the next phase of market development.

ADS developers are progressively internalising adjacent component categories, developing proprietary sensors, dedicated inference chips, and tightly coupled software modules optimised for their own architectures. The deployment data confirm this: while hardware layers remain predominantly outsourced, the ADS stack itself is developed in-house in the majority of recorded cases. Hardware procurement may remain open, but the architectural decisions governing how components are specified and integrated are increasingly made by the software platform owner. This trend could reduce the strategic role of standalone component suppliers, particularly those focused on hardware. As many of these actors are EU-based, there is a risk that Europe's relative position in the value chain may weaken as system-level control becomes increasingly concentrated among vertically integrated, currently predominantly non-EU developers.

The EU market is broadly served by the global supply base, with components available at rates comparable to those in the United States and East Asia. However, this accessibility should not be equated with strategic autonomy. In every technology category examined, non-EU suppliers selling into the EU substantially outnumber EU-origin suppliers, with import dependency highest in the software-intensive domains where European alternatives are thinnest. Several categories also exhibit high geographic concentration of supply, where a single non-EU region holds a dominant share. While market openness supports competitive pricing and access to global innovation, it simultaneously exposes the EU to risks arising from geopolitical disruption, export controls and regulatory divergence.

Sensing technologies are already classified as mature, reflecting established industrial bases and incremental performance improvements. The growth frontier lies in the domains that remain at improving or emerging stages: LiDAR, V2X connectivity, multi-modal fusion, 5G and edge communication, and deep learning models all show strong upward momentum. Market size indicators further underscore the scale of investment flowing into AI compute and cloud training infrastructure. Critically, the categories exhibiting the highest growth rates closely overlap with those in which the EU's competitive position is weakest. The fastest-expanding market segments are precisely those where European supply is thinnest and where the distance to leading non-EU competitors is greatest. This convergence of growth opportunity and competitive deficit suggests that targeted European investment in these domains may warrant priority attention and could prove strategically consequential.

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List of Abbreviations and Definitions

Abbreviations	**Definitions**
ADAS	Advanced Driver Assistance Systems
ADS	Automated Driving System
AI	Artificial Intelligence
AV	Automated Vehicle
CCAM	Connected, Cooperative and Automated Mobility
CI/CD	Continuous Integration / Continuous Deployment
DG RTD	Directorate-General for Research and Innovation
E2E	End-to-End
EOL	End of Life
EU	European Union
5G NR	Fifth-Generation New Radio
GNSS	Global Navigation Satellite System
HAL	Hardware Abstraction Layer
HD	High Definition
HMI	Human-Machine Interface
IEEE	Institute of Electrical and Electronics Engineers
IMU	Inertial Measurement Unit
ITS	Intelligent Transport Systems
ITS-G5	ITS at 5 GHz (dedicated short-range communication standard)
JRC	Joint Research Centre
LiDAR	Light Detection and Ranging
MEC	Multi-access Edge Computing
OEM	Original Equipment Manufacturer
OS	Operating System
OTA	Over-the-Air
PKI	Public Key Infrastructure
RTOS	Real-Time Operating System
SAE	Society of Automotive Engineers
SDV	Software-Defined Vehicle

SLAM	Simultaneous Localisation and Mapping
TSN	Time-Sensitive Networking
UAE	United Arab Emirates
V2V	Vehicle-to-Vehicle
V2X	Vehicle-to-Everything
VCU	Vehicle Control Unit

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