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The Big Tech in Auto & Mobility Report

How Google, Amazon, Microsoft, and Apple are betting on automotive and transportation

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Big tech | Auto & Mobility

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Analyzing Ford's growth strategy: How the automaker is preparing for the future of transportation

The Future of the Fleet: How electrified roads, digital twins, and driverless vehicles are making fleets more autonomous, sustainable, and efficient

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Summary of findings

Overview of big tech's activities in auto and mobility

Big tech companies are leveraging their strengths in software development, AI, and cloud computing to reshape the future of auto & transportation…

- Google, Amazon, Microsoft, and Apple's automotive investments have focused on the in-vehicle experience, autonomous driving, vehicle electrification, and connected vehicle infrastructure.
- Since 2017, Google has led big tech in auto & mobility investments (15) while Amazon leads in acquisitions (4). Big tech companies have increased their investments in auto & mobility in 2022 with 11 total deals so far, compared to 6 in 2021 and 3 in 2020.

… and they're doubling down on connected, autonomous vehicle technology given the market opportunity.

- Google, Amazon, Microsoft, and Apple have collectively acquired or invested in 13 companies in autonomous driving tech and 4 companies in connected vehicle tech since 2017, which amounts to over 40% of all their automotive investment activity.
- While Google, Amazon, and Microsoft are focused on partnerships with auto manufacturers to deploy their technology, Apple is looking to own the entirety of vehicle development and develop cars itself.

What's next?

Watch for Amazon, Google, Microsoft, and Apple to vie for leadership positions in in-vehicle software and infotainment. Big tech companies will continue to prioritize connectivity and in-vehicle software as they work to gain share in the cloud market and drive stickiness on their digital platforms. As automakers look to improve the in-vehicle experience, they will likely rely heavily on big tech companies for infotainment, in-vehicle operating systems, and cloud computing.

Expect big tech companies to use their electronics expertise to improve charging infrastructure. A lack of widespread and quick charging options is one of the main hurdles to electric vehicles' market adoption. Big tech companies can leverage tech currently used for charging other devices to improve charging infrastructure.

Safety and regulatory hurdles pose a major challenge for autonomous vehicle commercialization. Because autonomous vehicles do not have drivers, they don't fit into current automotive regulation frameworks. Without updated regulation, autonomous driving cannot achieve commercialization. Federal governments are slowly addressing this, but the pace of change inhibits industry growth.

As concerns around a potential recession build, look for big tech companies to refocus their investments on less speculative projects. Big tech companies will likely pivot away from testing autonomous delivery robots or drones, focusing instead on software-driven connected vehicle technologies.

Where big tech is making moves

How big tech is transforming auto & mobility

Google	Google's self-driving subsidiary, Waymo, is the first autonomous vehicle developer to deploy a commercial fleet of AVs. Meanwhile, Google's cloud computing and mapping capabilities continue to spur partnerships across the auto space to improve vehicle connectivity and shared mobility.
amazon	Amazon has made significant moves in the auto and mobility space in recent years. For example, it invested in electric vehicle company Rivian in 2019 and 2020. In the autonomous driving space, Amazon acquired Zoox and invested in Aurora. These investments are essential for Amazon to reach its goal of net-zero carbon emissions in its operations by 2040. The company is also building out its presence in the connected ecosystem by developing ways to integrate its voice assistant Alexa into the vehicle.
Microsoft	Microsoft's auto initiatives remain focused on connectivity, where the company has capitalized on its expertise in cloud and edge computing. Microsoft's other efforts in auto and mobility include deploying mixed reality, which can help auto giants improve efficiencies and safety. The company expects to partner with an automotive company to build a vehicle that will house its autonomous and connected vehicle tech.
	Apple first launched its car project, Project Titan, in 2014 with ambitions to build an electric, self-driving car from the ground up. The company already had a presence in the car with CarPlay, a platform similar to Google's Android Auto, which integrates with a vehicle's infotainment system. Looking ahead, Apple expects to launch its autonomous car by 2025.

What’s driving big tech activity in auto & mobility?

Digitization of the automotive industry

As vehicles become more connected, big tech companies are leveraging their capabilities in software development and cloud computing to tap into new market opportunities and further integrate their operating system into the consumer’s connected device suite.

The race to autonomous driving commercialization

Big tech companies have the expertise and data needed to improve autonomous features, but regulatory and safety hurdles have slowed commercialization.

Rising pressure to electrify vehicles

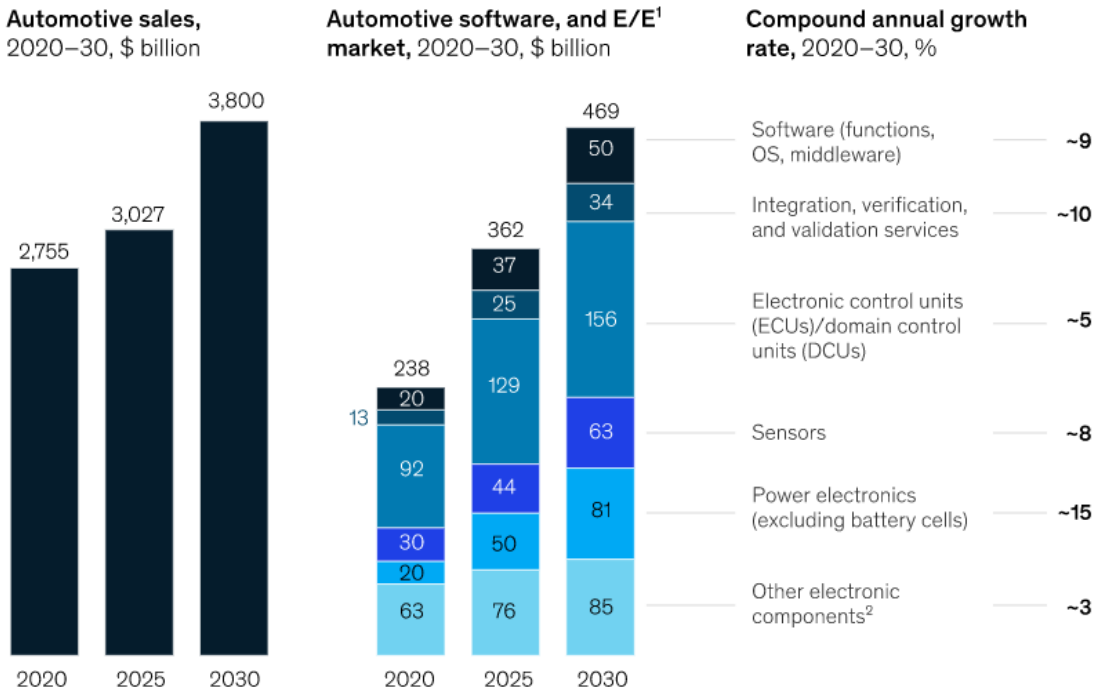
With regulations requiring all new car sales to be electric on the horizon, big tech companies have an opportunity to leverage their electronics expertise to gain market share in a competitive space.

Connected vehicles open doors for big tech to integrate cloud computing and software

Big tech companies are exploring ways to incorporate their expertise in software development and cloud computing capabilities (in the cases of Google, Amazon, and Microsoft) to further integrate their operating system into the consumer's connected device suite and capitalize on new market opportunities in the automotive space.

The companies can also leverage their current software, smart phone applications, and cloud computing leadership to expand in-vehicle infotainment and in-vehicle operating systems.

The automotive electronic and software market will see a strong growth through 2030, driven by power electronics, software, ECUs, and DCUs.



Note: Figures may not sum, because of rounding.
[1]Electrical and electronic components.
[2]For example, harnesses, controls, switches, displays.
Source: IHS; McKinsey analysis

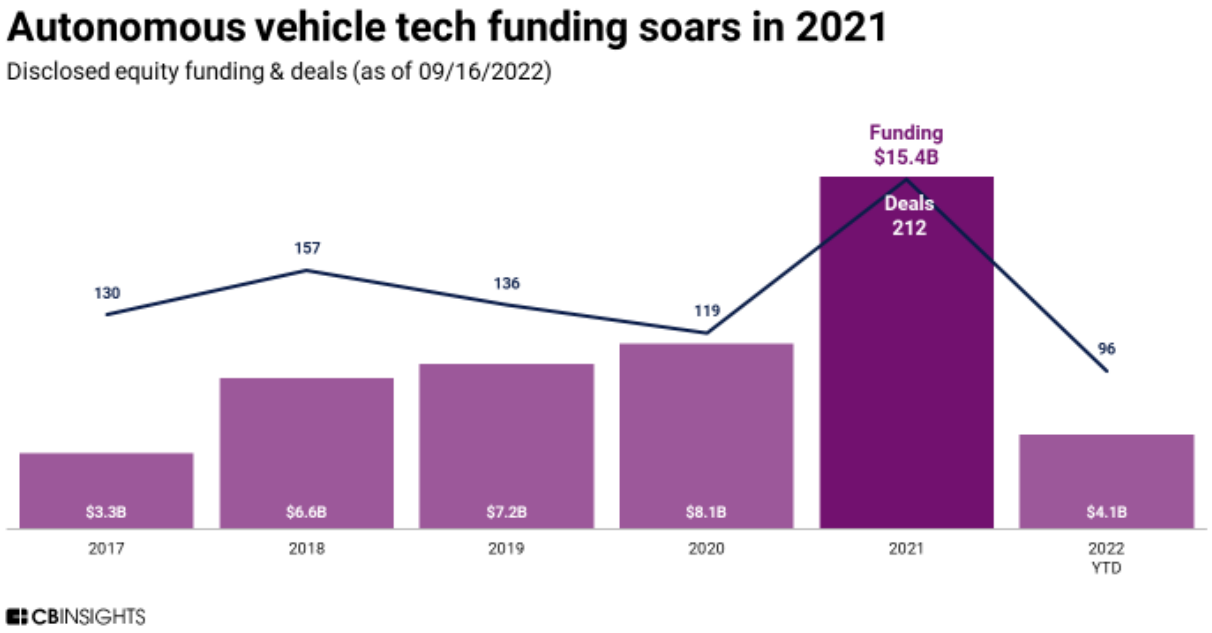
Source: CNBC

Big tech is heavily focused on autonomous driving technology

Autonomous driving has seen robust interest from investors, especially with the emergence of new applications such as logistics and off-road vehicles.

Big tech leaders including Google, Amazon, and Apple are leveraging their expertise in AI and machine learning to develop the most sophisticated autonomous driving technology.

Microsoft is also focused on autonomous driving, providing the computing infrastructure to support the rise of autonomous vehicles.



Big tech explores EV tech as the transportation sector looks to decarbonize

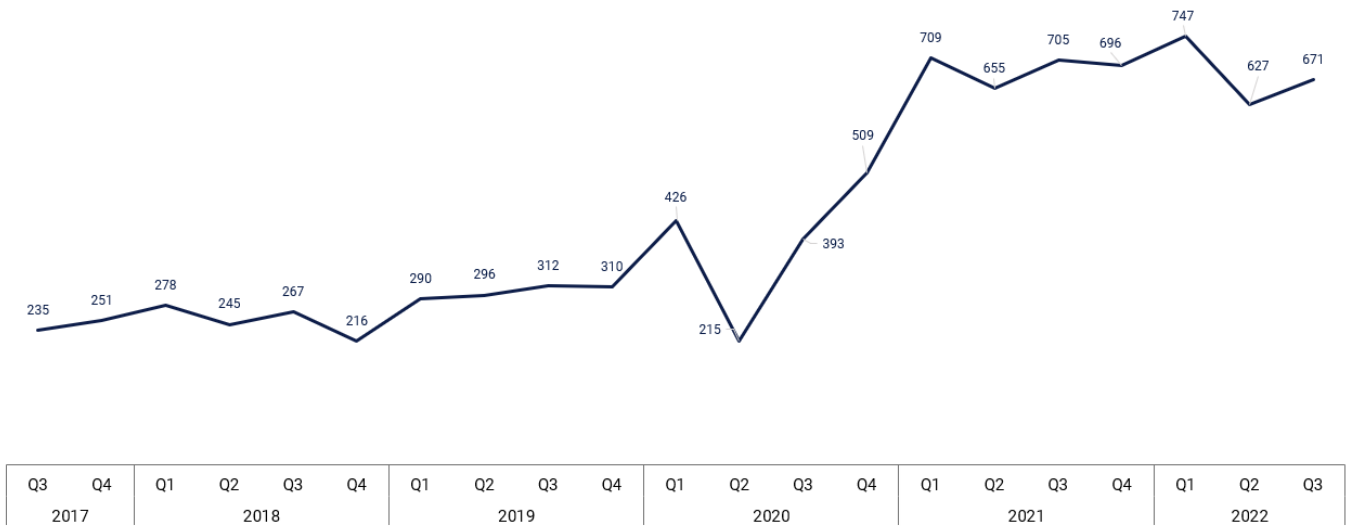
Vehicle electrification is coming into focus as an area of investment for big tech companies, as new regulations and rising pressure from investors spur EV adoption.

Amazon is looking to decarbonize its logistics operations by transitioning to fully electric delivery fleets. It is partnering with EV auto maker Rivian to purpose-build EV delivery vehicles.

Apple is looking to leverage its battery development expertise to bring a battery-electric passenger car to market, attempting to capture a share of a substantial market opportunity.

Corporates are increasingly focused on electric vehicles

Earnings call mentions of electric vehicle, Q3'17 – Q3'22



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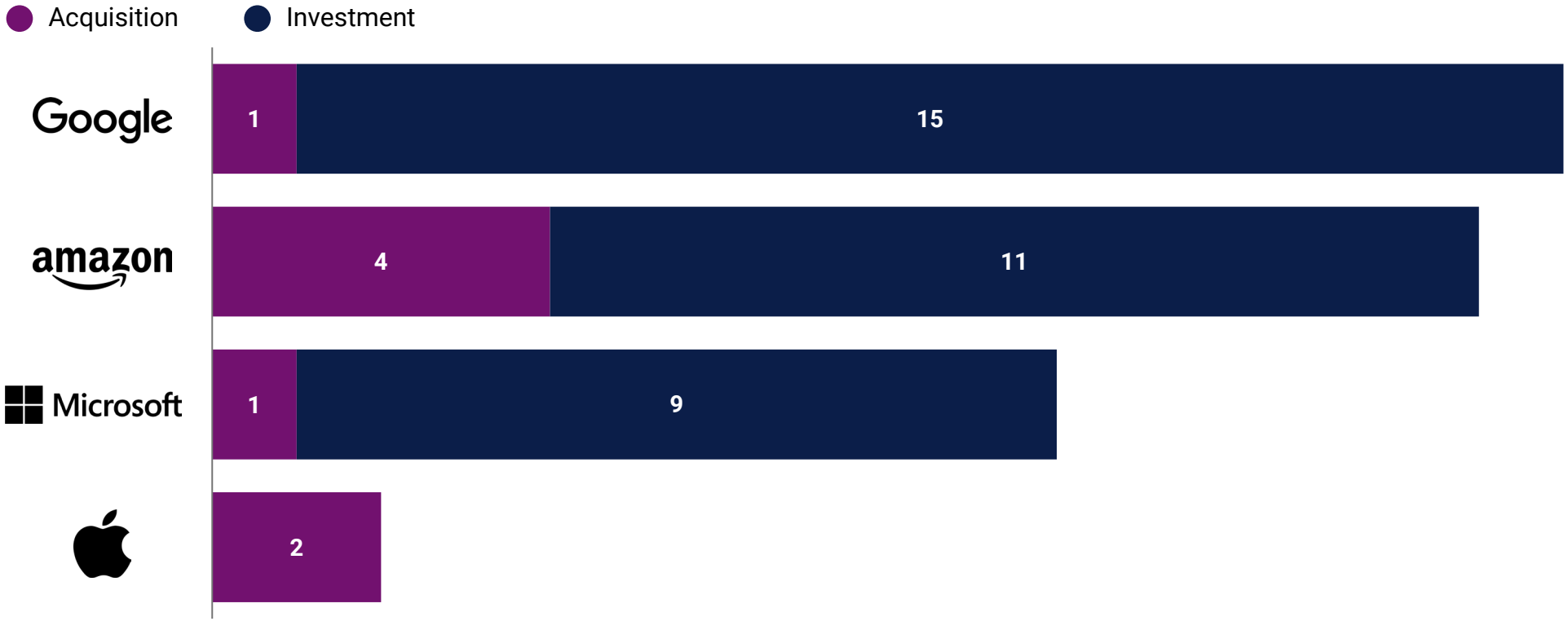
Source: Statista

Google leads in auto investments with Amazon close behind

2017 – 2022 (as of 9/15/2022)



Source: CB Insights | These designations are not exhaustive of Big Tech's investment and partnership activity in the analyzed period.

Big tech's largest investments target electric and autonomous vehicles

Company	Amount raised Deal date	Total disclosed funding	Select investors	Description
RIVIAN	**$2.5B** 07/23/21 + add'l rounds	$11.2B	**Amazon**, **The Climate Pledge**, Soros Fund Management, Ford Motor Company	Rivian develops an integrated portfolio of electric vehicles, technologies, and services with a focus on developing an all-electric pickup truck.
WAYMO	**$2.5B** 06/16/2021 + add'l rounds	$5.7B	**Alphabet**, Andreessen Horowitz, Fidelity Investments, Tiger Global Management	Waymo is a self-driving company with a mission to make it safer and easier for people and things to move around.
nuro	**$600M** 11/2/2021	$2.1B	**Google Ventures**, Fidelity Investments, Tiger Global Management	Nuro is a robotics company transforming local commerce through driverless delivery.
Aurora	**$520M** 02/07/2019 + add'l rounds	$1.1B	**Amazon**, Greylock Partners, Sequoia Capital, Shell Ventures	Aurora designs and develops hardware and software for self-driving cars.

Google

Where Google is focusing

Setting the pace for autonomous driving

Google is leading autonomous driving development through its self-driving subsidiary, Waymo, in an effort to introduce automated driving technology across a wide variety of applications.

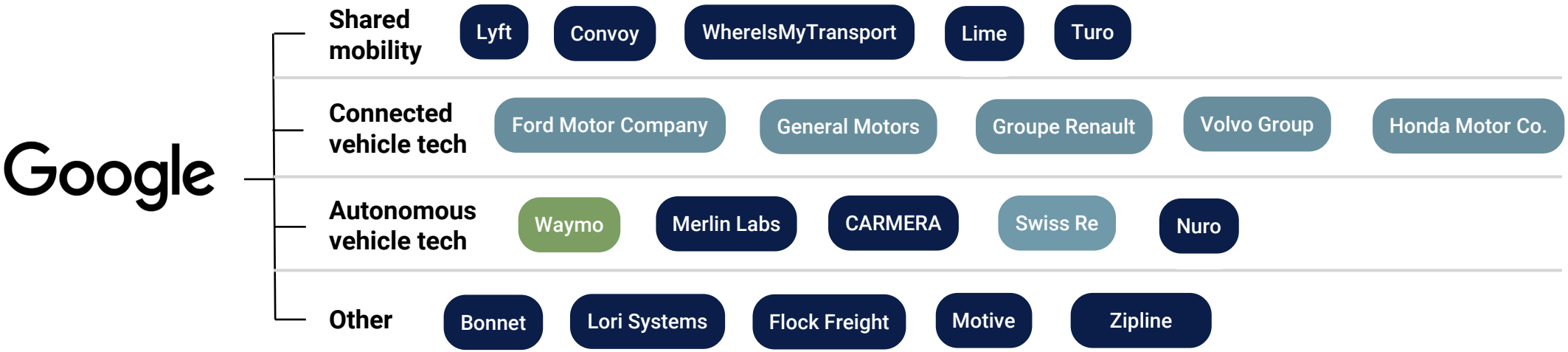
Reshaping in-vehicle connectivity

Google is increasingly integrating into the connected vehicle with its in-vehicle operating system and cloud computing solutions for automotive.

Google's strategic priorities in auto & mobility

2017 – 2022 (as of 09/16/2022)

● Investment ● Partnership ● Subsidiary



Source: CB Insights | These designations are not exhaustive of Google's investment and partnership activity in the analyzed period.

Theme 1:

Google is setting the pace for autonomous vehicles

Google looks to deploy the first fleet of autonomous vehicles

Google's subsidiary Waymo is considered an industry leader in autonomous driving technology given its tenure — and its access to parent company Alphabet's deep pockets.

The self-driving arm's main product is Waymo Driver, a full stack autonomous driving solution. The company is looking to deploy it in production vehicles through partnerships with automakers such as Geely, Jaguar, and Nissan.

Waymo is also working on an accompanying ride-hailing service, Waymo One, that leverages its autonomous driving tech. The company recently announced that it was expanding its portfolio into logistics applications, developing its tech in autonomous Class 8 trucks and delivery vans.

WAYMO ONE WAYMO VIA

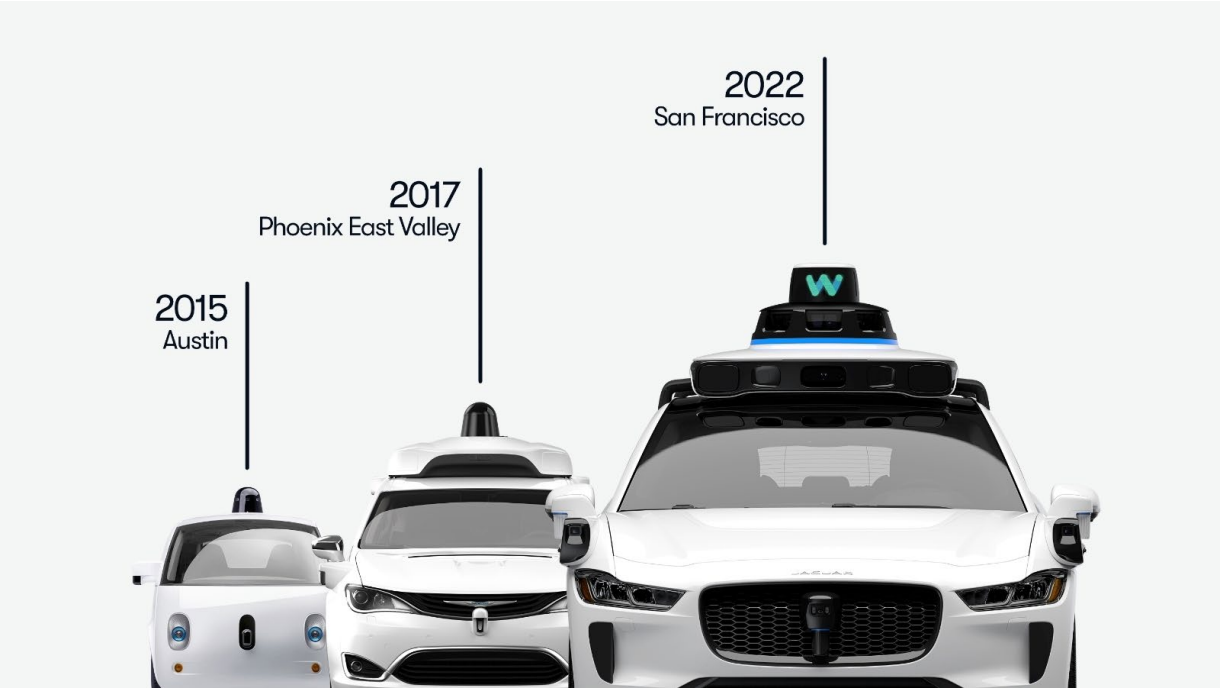
Waymo is deploying its tech across a variety of vehicle types and applications

Source: Waymo

Waymo is well-positioned to lead the self-driving industry

One of Waymo's most substantial competitive advantages in the self-driving space is its tenure. Google launched the self-driving unit in 2009, years before its competitors. Tenure is especially important in the autonomous driving space, given the amount of time self-driving systems require to train and experience situations in simulation and on public roads. Waymo has driven a whopping 20B test miles, well above its peers.

Waymo also has access to Alphabet's deep pockets and key technologies from Alphabet's subsidiaries. It trains its neural networks using tensor processing units (TPUs) from Google's open-source software platform, TensorFlow. By building out its own software and sensors, Waymo also has limited dependency on outside suppliers, which is more efficient and improves integration capabilities.



Waymo expands its self-driving car trials

Source: Waymo

Theme 2:

Google is reshaping in-vehicle connectivity

Google is leveraging its mobile strength for in-vehicle infotainment

Google has integrated its Android mobile platform Google Assistant into the vehicle with Android Auto. The goal is to help Google maintain platform stickiness across connected devices to combat rising competition from Apple and Amazon. Android Auto is currently available in more than 400 car models from brands such as GM, Hyundai, and Volvo.

Google hopes to expand its relationship with these brands and add Android Automotive, its vehicular operating system that's installed in the vehicle itself. Unlike Android Auto, Android Automotive controls the built-in infotainment system rather than showing a version of a phone's screen. It can also gather data on speed, battery status, heating and air conditioning, and more.

Source: Google

Google partners with leading auto manufacturers to deploy connectivity solutions

Ford and Google sign six-year deal for in-car connectivity and cloud services

February 1, 2021 | CNBC

New Honda models will have built-in Google features starting in 2022

September 29, 2021 | MOTOR TREND

Google Home, YouTube integrate with Volvo cars

January 5, 2022 | TechCrunch

Google partners with Renault-Nissan-Mitsubishi to put Android into millions of vehicles

September 18, 2018 | TechCrunch

Google's plans point to key trends for 2022

	Setting the pace for autonomous driving	Reshaping in-vehicle connectivity
Summary	Google is currently one of the leading developers of autonomous driving technology. Through its subsidiary Waymo, it has partnered with some of the leading automakers to deploy self-driving tech. Waymo has a long list of competitive advantages, most notably its tenure and its ability to leverage the resources and tech expertise within its parent company, Alphabet.	Google has made concerted efforts to integrate its mobile platform, Android Auto, and its cloud computing capabilities into existing and future production vehicles.
Implications	Watch for Waymo to launch its self-driving cars on public roads in new cities. A growing operating network signals more favorable regulation as well as more data to continue honing the technology. Expect Waymo to pursue additional automaker partnerships to widen its autonomous driving solution portfolio.	Google continues to gain automaker partnerships due to its software leadership and infotainment operating system installed into the vehicle. Look for further integration of Google's apps — like Maps and Assistant — into vehicle software for its growing partner list.

Amazon

Where Amazon is focusing

Building an all-electric logistics ecosystem

As Amazon works toward its decarbonization goals, it's exploring opportunities to electrify its delivery fleet and logistics operations.

Exploring autonomous driving applications

Though Amazon was initially focused on autonomous driving for commercial applications, it has recently made moves in automating passenger mobility.

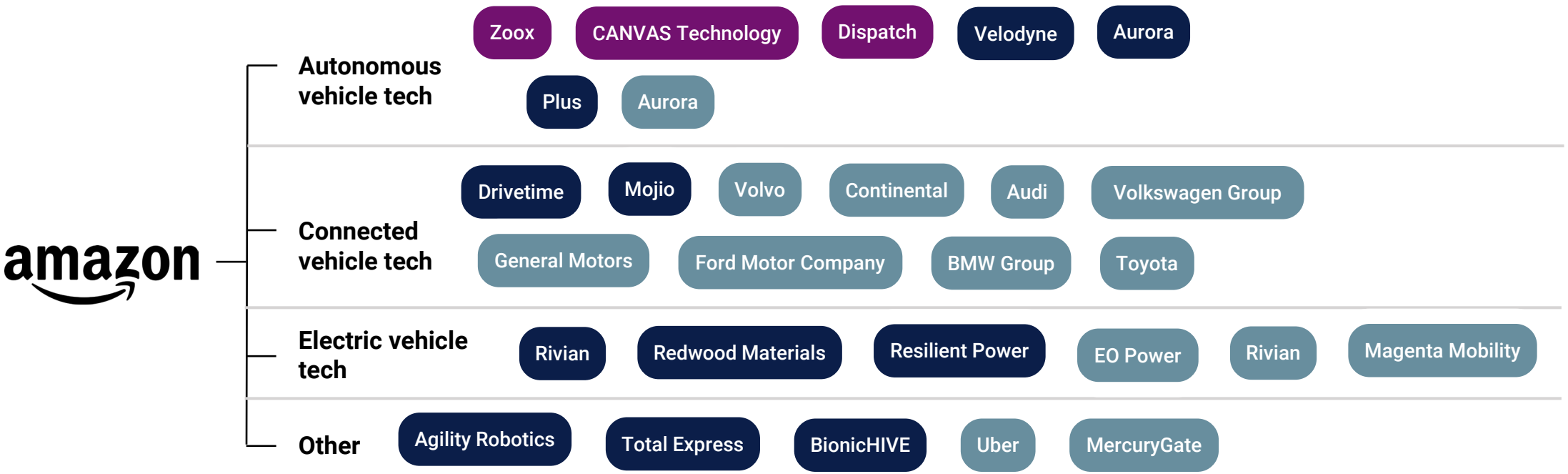
Leveraging Alexa and AWS in connected vehicles

Amazon is looking to create more surface area for its digital assistant Alexa and to use its cloud capabilities to accelerate the automotive industry's digital transformation.

Amazon's strategic priorities in auto & mobility

2017 – 2022 (as of 09/16/2022)

● Acquisition ● Investment ● Partnership



Source: CB Insights | These designations are not exhaustive of Amazon's investment and partnership activity in the analyzed period.

Theme 1:

Amazon is building an all-electric logistics ecosystem

Vehicle electrification is essential for Amazon to reach carbon neutrality by 2040

In 2020, Amazon launched its $2B Climate Pledge Fund to invest in companies that can help facilitate its transition carbon neutrality by 2040.

Amazon has been working closely with EV startup Rivian, which has raised $11.2B in funding and went public in 2021. Amazon participated in multiple funding rounds to the startup, including a $2.5B round in July 2020. Through the Climate Pledge Fund, Amazon participated in a $2.7B investment in January 2021 and a $2.5B investment in July 2021.

The two companies co-developed a purpose-built electric delivery vehicle with Alexa capabilities and advanced safety features. Amazon ordered 100,00 of the vehicles, which are expected to be delivered by 2030.

	EDV 500	EDV 700	EDV 900
Range	Up to 150 miles	Up to 150 miles	Up to 120 miles
Wheelbase	157 in.	187 in.	205 in.
Length	248 in.	277 in.	321 in.
Storage	500 cu. ft.	660 cu. ft.	840 cu. ft.
GVWR	9,350 lbs.	9,350 lbs.	14,000 lbs.

GVWR = gross vehicle weight rating

Amazon and Rivian's suite of delivery vehicles. As of September 2022, only the EDV 700 is available for Amazon to order.

Source: Amazon

Amazon is building an ecosystem of partnerships across charging and battery lifecycle

RESILIENT POWER

Bridging the Gap in EV Charging Infrastructure

Latest Round: Seed VC (10/27/2021)

Amount: $5M

About: Resilient Power is working on converting power from the grid into effective charging stations for EVs.

REDWOOD MATERIALS

Latest Round: Series C (7/28/2021)

Amount: $700M

About: Redwood is creating a closed-loop supply chain for electric vehicles and energy products, improving sustainability and continuing to drive down the costs for batteries.

eo CHARGING

Latest Round: Seed VC ((9/26/2018)

Amount: $17M

About: Amazon partners with EO Charging to charge its fleet of Mercedes electric delivery vehicles in Europe. Amazon installed 800 chargers to support its of close to 2,000 zero-emission delivery vehicles.

Theme 2:

Amazon is developing a suite of autonomous vehicles

Amazon focuses on passenger AVs and logistics

Amazon is investing in and building out an ecosystem of autonomous vehicles for logistics and passenger applications.

Its investments in the space include autonomous long-haul trucking companies like Plus and Aurora. Amazon is also working on autonomous last-mile delivery through its autonomous vehicle projects Prime Air and Scout.

In June 2020, Amazon acquired self-driving vehicle developer Zoox. Recently, Zoox achieved a key autonomous driving milestone where its passenger vehicle operated with no driver, chase vehicle, or emergency stop on an open, private road with non-Zoox pedestrians, cyclists, and trucks.

Source: Amazon; Zoox

Amazon’s cloud platform provides a foundation for autonomous mobility

Amazon’s cloud computing solution, AWS, offers an Autonomous Mobility platform that helps self-driving tech developers accelerate AV development with purpose-built AWS services and solutions. These include map development, algorithm and model development, verification and validation, and deep learning frameworks. TuSimple, Lyft, Toyota, and WeRide are among the platform’s users.

AWS IoT FleetWise

AWS IoT FleetWise makes it easy and cost effective for automakers to collect, transform, and transfer vehicle data to the cloud in near-real time and use it to build applications with analytics and machine learning that improve vehicle quality, safety, and autonomy.

Learn more »

Autonomous Vehicle Data Lake on AWS

Delivers highly scalable storage and compute services and advanced deep learning frameworks that allow for the collection, ingestion, storage, and analysis of autonomous vehicle data to support full-scale autonomous vehicle development.

Learn more »

DXC and AWS Robotic Drive Cloud

Provides the tools, services, and base backend platform on AWS to accelerate the build of autonomous driving functions and software by enriching AWS services optimized for autonomous driving-specific workloads.

Learn more »

Capgemini Driving Automation System Validation

Helps OEMs rapidly adopt the underlying architecture and technologies of autonomous driving.

Learn more »

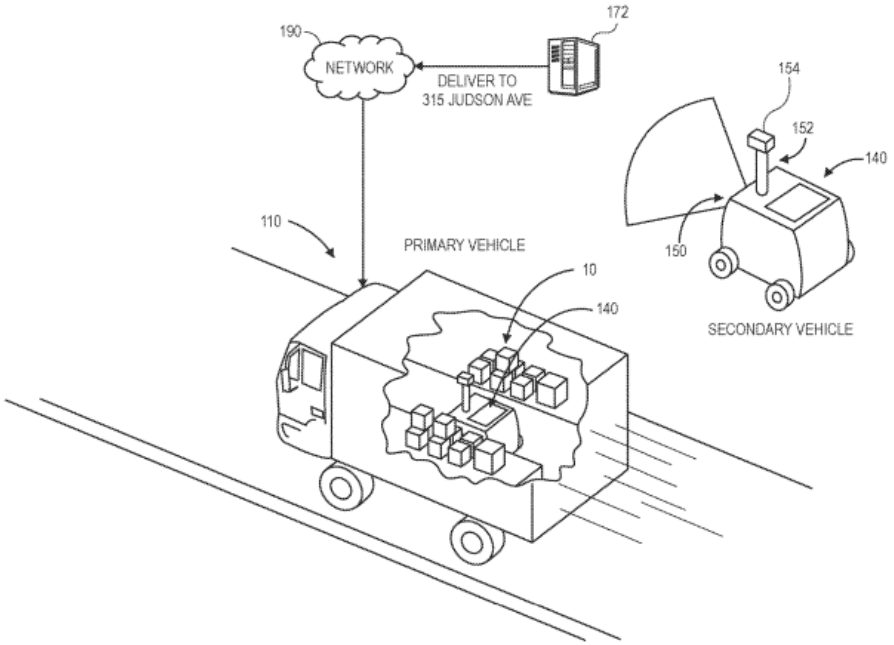
Source: AWS

Amazon’s patents signal plans for autonomous vehicle fleets

Before acquiring Zoox, Amazon’s autonomous driving patents focused on automated delivery solutions like driverless delivery vans and drones, driverless pickup lockers, and robotic courier delivery.

Amazon significantly strengthened its autonomous driving tech portfolio after acquiring Zoox and its 154 patent families. These patent families include:

- Vehicle components
- Navigation
- Image processing
- Driving assistance



Directing secondary vehicles using primary delivery vehicles: Primary vehicle has cameras and sensors to generate and transmit instructions for secondary vehicles (usually personal delivery devices).

Source: US Patent and Trademark Office

Theme 3:

Amazon is leveraging AWS and Alexa in connected vehicles

Amazon changes how voice assistance integrates in vehicles

Historically, in-vehicle voice assistants had to be built into cars at the point of manufacture. Amazon changed this in September 2018 when it released the Echo Auto, an aftermarket device for voice control.

Unlike Google's Android Auto or Apple's CarPlay, Echo Auto is compatible with any phone and can be installed in any vehicle.

In 2021, Amazon launched Alexa Custom Assistant, which allows automakers to build their own digital voice assistants using Alexa's voice-enabled technology. Alexa Custom Assistant can be added via software updates or built into the vehicle. It offers Amazon an additional touchpoint in the vehicle, improving the in-vehicle experience, reducing friction, and providing more stickiness for the company.

In September, BMW announced that it is leveraging Alexa Custom Assistant to build a custom voice assistant into select vehicle models in coming years.

Source: Amazon

AWS is accelerating the auto industry's digital transformation

AWS' cloud capabilities are essential for manufacturers working on connected vehicles. AWS is supporting the auto industry's digital transformation with AI/ML, IoT, high performance computing (HPC), and data lakes, as well as a global network of Amazon and AWS Partners with robust industry expertise.

VOLVO
VOLVO GROUP

Volvo Group Accelerates Time to Market for Connected Services Using AWS

Volvo migrated to the AWS Cloud in 2015 with the goal of driving faster time to market and scalability. Since 2015, most of Volvo's services are built on AWS, and the AWS Cloud is the foundation for Volvo Group to deliver connected services to more than 800,000 trucks, buses, and machines.

HONDA
The Power of Dreams

Honda Builds Serverless Connected Car Platform for Millions of Cars on AWS

Honda, a leading manufacturer of motorcycles, automobiles, and power products, engaged AWS Professional Services and used AWS CloudFormation to quickly launch a new serverless connected car platform.

BMW GROUP

BMW Group Uses AWS-Based Data Lake to Unlock the Power of Data

BMW Group uses AWS to process 10 TB of data daily from 1.2 million vehicles, create a voice-activated personal in-vehicle assistant, and derive real-time insights from vehicle and customer telemetry data. The organization, based in Germany, is a leading manufacturer of premium automobiles and motorcycles. BMW Group runs its Cloud Data Hub on AWS, using Amazon SageMaker to train models for predictive analysis.

Source: AWS

Amazon's plans point to key trends for 2022

	Building an all-electric logistics ecosystem	Developing a suite of autonomous vehicles	Leveraging Alexa and AWS in connected vehicles
Summary	Amazon is building out connections across the electric vehicle ecosystem, including EV manufacturers, charging providers, and battery recycling tech, as the company works to reach carbon neutrality across its logistics operations.	Amazon is also exploring opportunities in autonomous driving tech, leveraging partnerships and investments to build out capabilities across applications from long-haul trucking to last-mile delivery to passenger mobility.	Amazon's investments and partnerships suggest it is looking to create more surface area for its digital assistant Alexa and to use its cloud capabilities to accelerate the automotive industry's digital transformation.
Implications	Watch for Amazon to continue investing across different areas of the EV ecosystem, from passenger vehicles to delivery vehicles of all sizes. As Amazon receives electric vehicles for its fleet from Rivian, anticipate an increased focus on charging infrastructure.	With its focus on delivery, especially the last mile, watch for Amazon to continue testing drone and robot delivery. Expect a slower rollout of autonomous passenger vehicles.	As it faces increasing competition from Google in in-vehicle software and cloud computing, expect Amazon to further its efforts in vehicle connectivity.

Microsoft

Where Microsoft is focusing

Providing cloud computing for autonomous driving companies

Microsoft is leveraging its cloud computing expertise to partner with hardware providers in an effort to commercialize a fleet of autonomous vehicles.

Tapping into connected vehicle monetization opportunities

Microsoft continues to look for new ways to leverage connected vehicle data and shape the in-vehicle experience for drivers.

Addressing growth opportunities in aerial autonomy

Microsoft aims to expand the use cases for autonomous drones through its Project AirSim and partnership with Volocoptor.

Microsoft's strategic priorities in auto & mobility

2017 – 2022 (as of 09/16/2022)

● Investment ● Partnership

Source: CB Insights | These designations are not exhaustive of Microsoft's investment and partnership activity in the analyzed period.

Theme 1:

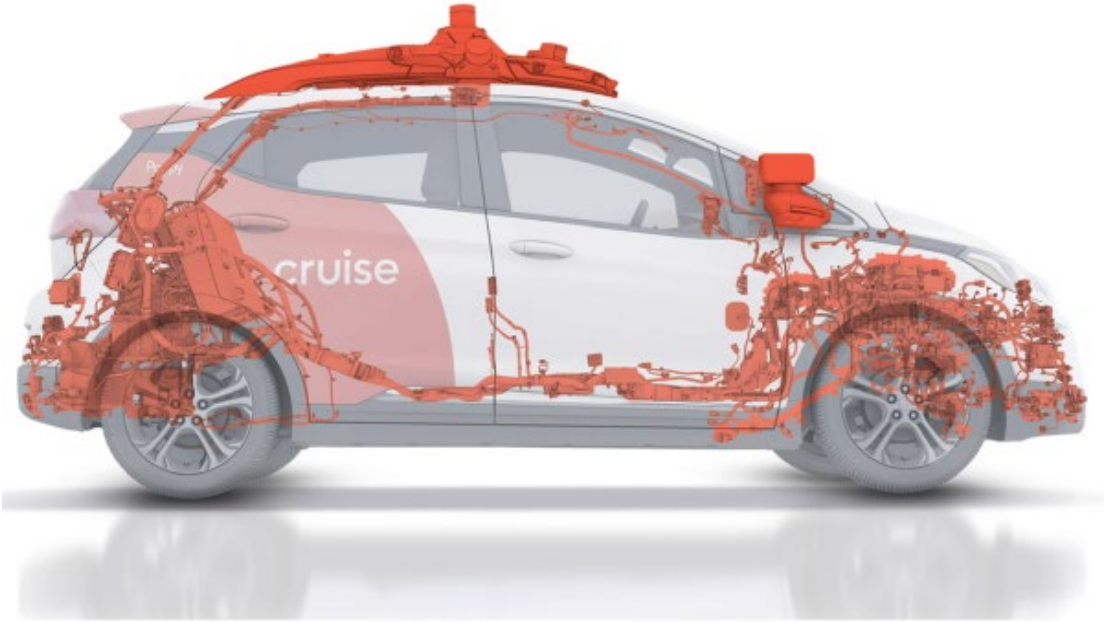
Microsoft provides cloud computing for autonomous driving companies

Microsoft fuels self-driving tech development with cloud computing and software support

In the race to commercialize autonomous vehicles, Microsoft is sticking to its strength as a software provider and partnering with auto industry experts like GM and its self-driving subsidiary Cruise for the physical vehicle.

Microsoft will be Cruise's preferred cloud provider, while Cruise leverages Microsoft's cloud platform to accelerate its self-driving technology development and robo-taxi service rollout. Microsoft also contributed to Cruise's $2B funding round in January, along with GM and Honda.

Cruise uses Microsoft's Azure AI stack to commercialize its autonomous vehicle solutions at scale.



Our mission to bring safer, better, and more affordable transportation to everyone isn't just a tech race—it's also a trust race. Microsoft, as the gold standard in the trustworthy democratization of technology, will be a force multiplier for us as we commercialize our fleet of self-driving, all-electric, shared vehicles.

—Cruise CEO Dan Ammann

Source: Cruise

Microsoft’s self-driving car strategy hinges on partnerships

Through its Microsoft for Startups Founders Hub platform, Microsoft provides autonomous driving startups with engineering support and discounted cloud service access. The hub also provides the tech giant with a pool of potential partners. By partnering rather than acquiring, Microsoft is more shielded from the emerging industry’s volatility and rapidly changing environment than its peers.

WAYVE

Wayve builds machine learning technology. Instead of relying on the traditional AV stack, HD maps, and hand-coded rules, Wayve is focused on building a data-driven learned driver that can scale, adapt, and generalize its driving intelligence to new places.

Wayve uses Microsoft Azure to increase the scale of its machine learning with data from fleets of connected vehicles across the world.

DEEPROUTE.Ai

Deeproute.ai provides L4 self-driving solutions and develops sensors, high-precision mapping, control, hardware, infrastructure, cloud computing and storage, and other self-driving technologies.

Its partnership with Microsoft aims to push forward DeepRoute.ai’s global deployment and accelerate the mass production of Level 4 autonomous vehicles while boosting the safety of its self-driving systems outside of China.

Theme 2:

Microsoft is tapping into connected vehicle monetization opportunities

Microsoft's connected vehicle ecosystem provides valuable data for automakers

The Microsoft Azure Mobility Team launched the Microsoft Connected Vehicle Platform (MCVP) at the Consumer Electronics Show in 2017. Microsoft does the software-heavy work of ingesting mass amounts of sensor and usage data from connected vehicles. It then puts the data on the MCVP to help manufacturers address priorities like predictive maintenance, advanced navigation, and building autonomous driving capabilities, opening the door for potential partnerships.

MCVP users

ZF, cerence, Volkswagen, ERICSSON, LG Electronics

Source: CB Insights; Neowin

Microsoft leverages connected vehicle data to improve mapping capabilities

Data from autonomous, electric, and connected vehicles is becoming prolific as cars become more connected. Microsoft partnered with connected vehicle data platform Wejo to build Wejo's data assets onto Microsoft's cloud platform, Azure. The partnership provides Wejo with real-time data exchange capabilities and gives Microsoft access to Wejo's 12T+ points of data, allowing the company to improve its mapping services.

Microsoft can also use this data to help auto companies and OEMs scale solutions. A recent extension of the partnership supports Microsoft Maps with intelligent routing, route optimization, identifying parking spaces, and more.

Real-time traffic data that will improve decision-making

Wejo have recently launched their brand new Real-Time Traffic Intelligence tool, which provides timely, up-to-date traffic data that will allow business to enhance their decision-making capabilities; with accurate insights into congestion and road safety incidents, businesses have the ability to measure their impact, while also furthering the cause of mobility powered by data

Source: Wejo

Microsoft and VW shape the in-vehicle experience with HoloLens

Microsoft is also looking for ways to shape the in-vehicle experience for drivers using its AR glasses, HoloLens. Along with early AR tech adopter Volkswagen, Microsoft has improved the HoloLens so that it can now be used in a moving platform. Previous iterations lost sensor tracking when used in moving vehicles.

HoloLens can be used to project navigation and traffic information in front of vehicles, train drivers on handling challenging road conditions, and for new user experience in autonomous vehicles.

HoloLens' moving platform is currently used in large ships, but to improve in-vehicle platform stickiness, Microsoft plans to roll the headset out to passenger and commercial vehicles.

HoloLens alerting a driver to an upcoming pedestrian crossing. Image: Microsoft

Source: Microsoft

Theme 3:

Microsoft pursues growth opportunities with aerial autonomy

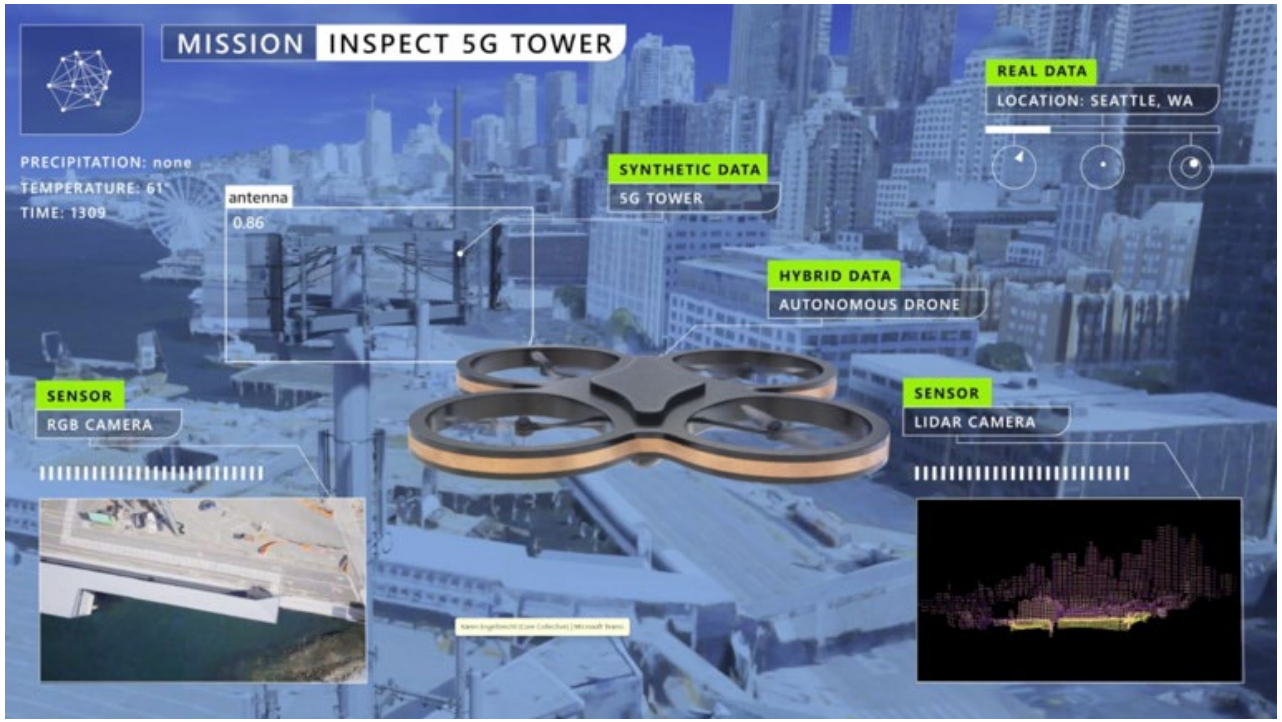
Microsoft is working on aerial autonomy for multiple use cases

Microsoft is using its expertise in AI to help train autonomous drones and flying taxis through Project AirSim, an end-to-end platform for creating, training, and validating autonomous agents through simulation.

Use cases for Project AirSim include infrastructure inspection, last-mile delivery, and urban air mobility. Project AirSim leverages Microsoft AI models that can detect and avoid obstacles while in flight.

Autonomous drones and flying taxis represent substantial opportunities for Microsoft's technology, with drone delivery automating one of the most expensive parts of the supply chain, and flying taxis offering the potential to optimize urban transportation and reduce fuel usage.

Microsoft has also invested in several other companies in the aerial mobility space, including Airtonomy and Airobotics.



Project AirSim generates large volumes of synthetic labeled data to speed up AI model training. These easy-to-use data sets in the cloud enhance autonomy models.

Source: Microsoft

Microsoft is helping pioneer autonomous flying taxis

In May 2022, Microsoft announced a partnership with urban air mobility (UAM) manufacturer Volocopter to develop an aerospace cloud system in Azure. The system will address the nascent cloud computing requirements for electric vertical takeoff and landing (eVTOL) aircrafts.

Volocopter's flying taxi, called the VoloCity, will have the technical capability to be flown with remote piloting and then autonomously once fully commercialized. Microsoft Azure will support the Volocopter's operating system, VoloIQ, as it transitions to fully autonomous operations.

Source: Volocopter

Microsoft's plans point to key trends for 2022

	Providing cloud computing for autonomous driving startups	Tapping into connected vehicle monetization opportunities	Addressing growth opportunities with aerial autonomy
Summary	Microsoft is seeking out opportunities to deploy its cloud computing solutions to help both automakers and smaller upstarts accelerate autonomous driving.	Microsoft continues to look for new ways to leverage connected vehicle data and shape the in-vehicle experience for drivers.	Through Project AirSim and its partnership with Volocoptor, Microsoft's technology will help improve training efficiencies for these vehicles, leading to faster commercialization.
Implications	Watch for Microsoft to continue partnering with auto manufacturers and autonomous driving startups and provide cloud computing solutions.	Look for Microsoft to expand its connected vehicle opportunities by designing solutions that automakers and startups can implement into connected and autonomous vehicles.	Microsoft is in the early stages of using the Azure platform to provide a secure cloud for applications like UAM. Expect an increase in initiatives where Microsoft leverages its cloud security and safety for UAM application.

Apple

Where Apple is focusing

Increasing its CarPlay footprint

Apple continues deepening integration within the vehicle, focusing on increasing personalization and enabling multi-screen control.

Building an autonomous, electric vehicle

Though Apple has historically been discrete about its plans to develop a full vehicle, the company's recent activity suggests that it's looking to build a car that can compete with industry leaders like Tesla.

Theme 1

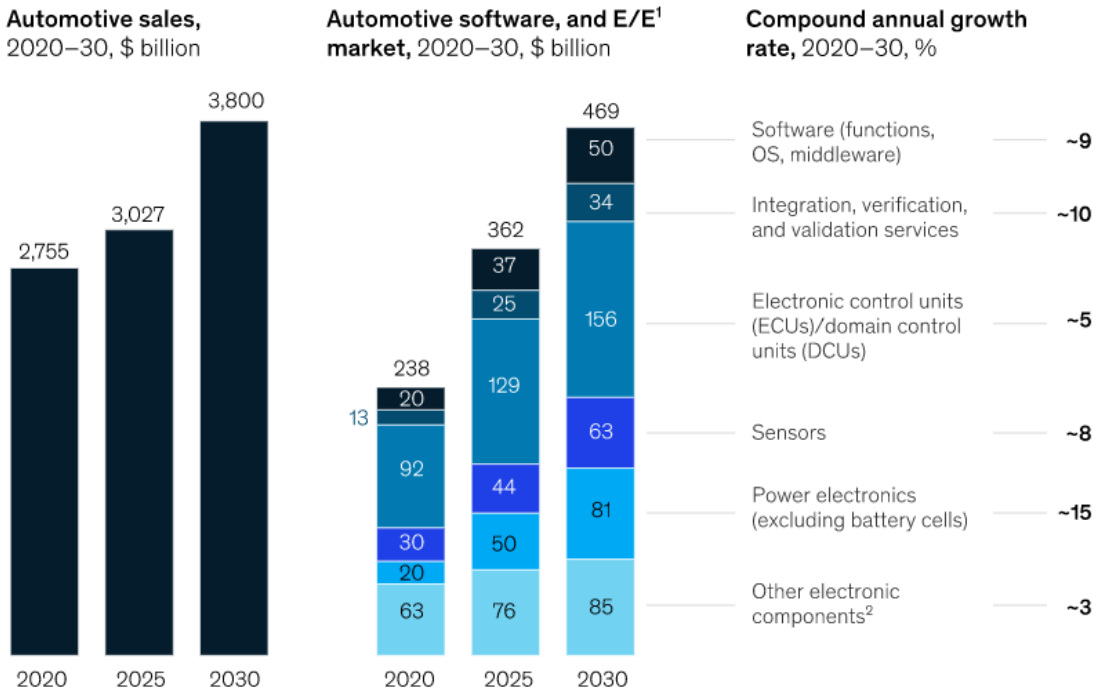
Apple CarPlay is increasing its CarPlay footprint

Apple uses its software expertise to make inroads in the automotive industry

Apple's CarPlay first launched in 2014 as a way for iPhone users to access and interact with navigation, music, messaging, and calls on their car's dashboard touch screen. Apple now reports that 98% of new cars in the US come with CarPlay installed, and that 80% of car buyers say they would only purchase a car with CarPlay.

The car software market is poised to grow 9% annually through 2030, accounting for up to $50B in sales. To capture as much of this market as possible, Apple wants to convince auto manufacturers that developing their own infotainment software is too expensive and that they should give Apple control over their in-car experience instead. Apple can then build on these relationships and expand its offerings from infotainment to other connected vehicle software.

The automotive electronic and software market will see a strong growth through 2030, driven by power electronics, software, ECUs, and DCUs.



Note: Figures may not sum, because of rounding.
[1]Electrical and electronic components.
[2]For example, harnesses, controls, switches, displays.
Source: IHS; McKinsey analysis

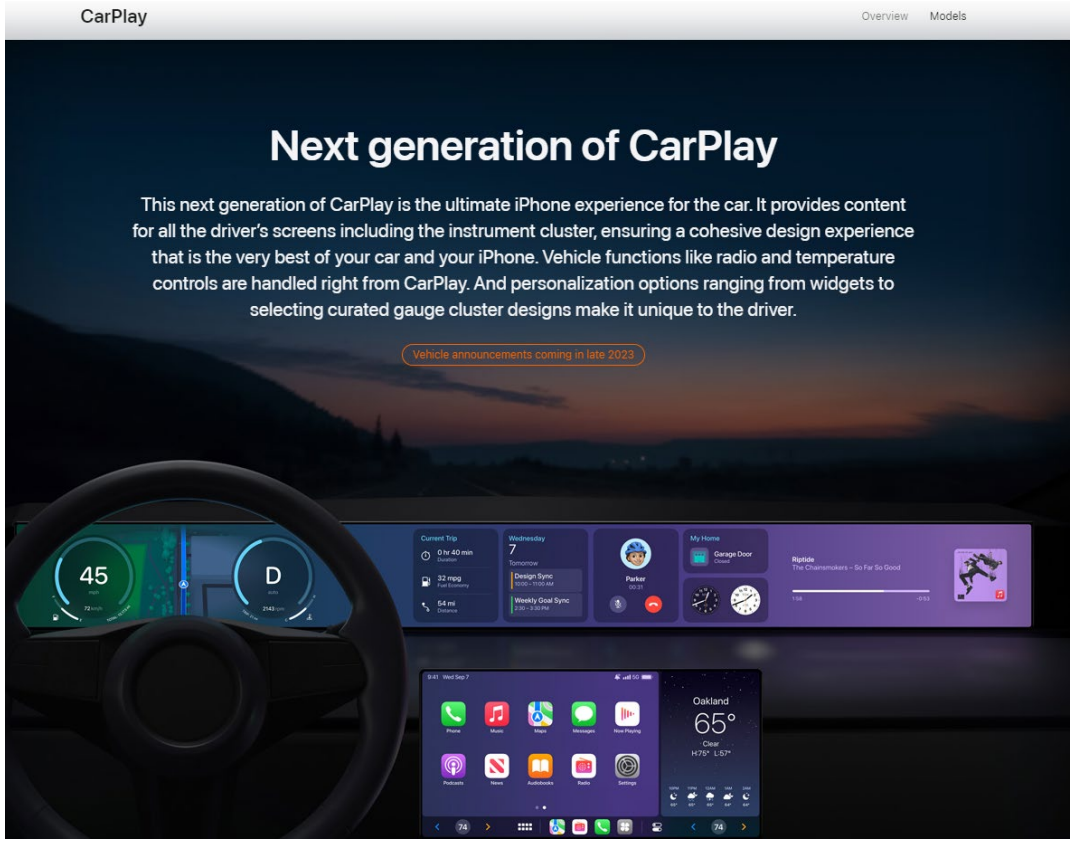
Source: CNBC

Apple's sights are set beyond infotainment

The new 2022 CarPlay release allows Apple to collect high-level data about how people use their vehicles. With Apple Maps, the company can gain insight into traffic and what routes are most used during different times of day.

To shift more vehicles' software from the manufacturer to Apple, the company is expanding its interface to include vehicle controls, such as air conditioning.

The company can also track which CarPlay apps are downloaded the most. This data provides valuable insights that Apple can use to develop infotainment for its autonomous vehicle.



Source: Apple

Apple wants to takeover your car's software

Apple's new car software could be a trojan horse into the automotive industry

July 22, 2022 | CNBC

Apple's new CarPlay is the foreshock to releasing its own vehicle

June 12, 2022 | Bloomberg

Apple's massive success with CarPlay paves the way for automotive ambitions

May 29, 2021 | CNBC

Apple seeks more control of vehicle software with CarPlay's new features

August 1, 2022 | MARKETPLACE

Theme 2

Apple is developing an autonomous, electric vehicle

Project Titan: Apple's unit focused on auto tech

Though Apple launched Project Titan in 2014, it has yet to make a formal announcement regarding its automotive ambitions. Apple's vehicle will likely be electric and self-driving. Automakers Hyundai, Kia Corporation, and Nissan, along with US-based EV startup Canoo, have all been tied to Apple's car efforts. However, as of September 2022, Apple is still searching for an auto manufacturing partner.

Because building a complete vehicle may be ambitious, Apple could prioritize its software capabilities on the self-driving front. The company has been testing a fleet of self-driving cars in California for several years, and it acquired self-driving technology developer Drive.ai in June 2019 before the startup shut down.

Source: Trending Tens

Apple leverages battery and software prowess to compete with EV leaders

Internal expertise: battery tech and software tech

Apple is well-positioned for EV battery development given its efforts to improve batteries in its existing products. Sources have said that the company is exploring a “monocell” battery design that frees up space in the battery pack by eliminating pouches and modules that hold the battery materials. This could increase the vehicle’s range substantially.

External expertise: automotive manufacturing and additional battery tech development

Apple is making strategic industry hires to advance its automotive development. Since the launch of Project Titan, Apple has been hiring its team from auto, battery, and technology leaders like Tesla, Mercedes-Benz, Porsche, Ford, Panasonic, and Johnson Controls.

Poached from	Former role	Area of expertise
Lamborghini	Head of Chassis and Vehicle Dynamics	Vehicle handling, suspension, steering, breaks, and rims
Porsche	VP of Chassis Development	Chassis for EVs
Ford	Director of Safety Engineering	Safety for EV and self-driving; strategy development; safety compliance
A123 Systems (5 employees)*	Battery technology research & development	EV battery tech

*resulted in a lawsuit which was settled

Source: CB Insights

Apple has applied for 248 car-related patents

Apple has patents for automotive-related hardware and software.

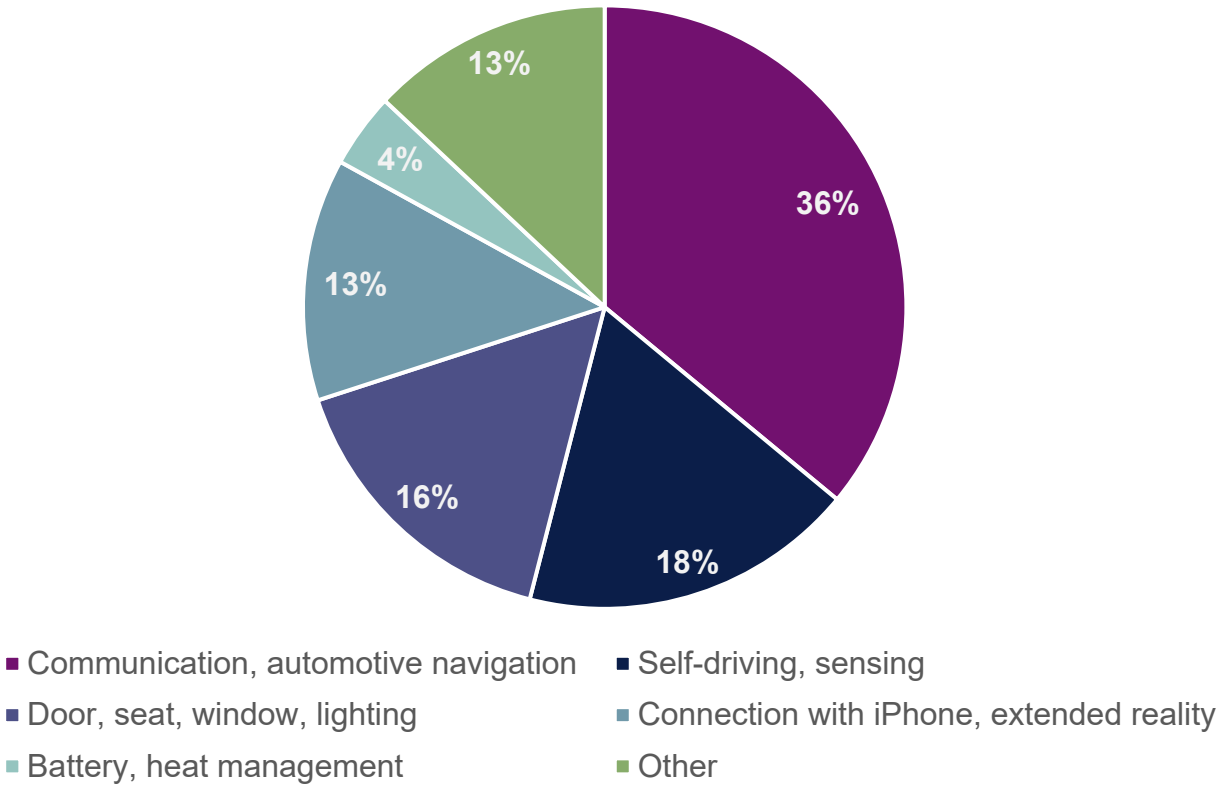
Hardware patents:

- System and method for dynamic privacy and window tinting
- Door and roof configuration for vehicles
- Active suspension system
- Charging station with passive alignment mechanism

Software patents:

- Augmented virtual display
- Guidance of autonomous vehicles in destination vicinities using intent signals
- Evaluating varying-sized action spaces using reinforcement learning
- Enabling lidar detection

Apple's auto-related patents since 2000



Source: Patently Apple

Apple's plans for becoming an automotive industry leader

	Increasing its CarPlay footprint	Building a fully autonomous, electric vehicle
Summary	Apple continues to develop its car software to deepen integration within the vehicle, increasing personalization and enabling multi-screen control.	Apple's recent activity suggests the company is looking to build a fully autonomous electric vehicle to compete with industry leaders like Tesla.
Implications	Watch for Apple to expand its software beyond infotainment, integrating additional vehicle controls like air conditioning and display for speed, RPM, and charge status. Apple's in-vehicle software development capabilities will also be useful for its future car.	Monitor partnerships and patents to see if Apple plans to develop the entire vehicle in-house or if the company will partner with an auto manufacturing expert.