Chinese autonomous vehicle industry faces geopolitical headwinds

China boosts support for AV sector amid significant market, technological, and external challenges

PREPARED BY EURASIA GROUP

MARCH 2021

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Key findings

- Beijing is making targeted investments in technologies such as 5G networks, data centers, electric vehicles (EVs), autonomous vehicles (AVs), and charging infrastructure as part of the coronavirus stimulus spending under the so-called New Infrastructure Initiative (NII). The NII, which was unveiled last May, includes approximately USD 1.4 trillion of government funding over five years.
- The pandemic has also helped encourage the development of commercial use cases for AVs, ranging from autonomous delivery services to robotaxis, and has boosted demand for contactless technologies.
- China's coordinated and ecosystem-centric approach to industry guidance and standards could help fast-track the deployment of self-driving cars. Meanwhile, in the US, there is growing industry concern that overlap between federal and state authorities is contributing to heightened uncertainty and confusion in the market.
- Since the Beijing provincial government issued the country's first local AV regulations in 2017, a growing number of provincial and municipal governments have followed suit. Local officials are vying to attract AV industry leaders and startups by removing regulatory barriers, offering subsidies, and building out 5G network infrastructure.
- Despite high-level assistance from both central and municipal governments, the wide-scale deployment of self-driving vehicles in China will face some of the same regulatory and technological challenges that exist in other markets, such as the US and the EU, though these will affect domestic and foreign AV producers in different ways. Chinese firms will grapple with an array of issues, including talent shortages, legal battles among industry leaders, and "the last mile" technical challenge.
- In addition, US President Joe Biden's administration is conducting a comprehensive review of China policy, including the previous administration's last-minute actions targeting Chinese tech companies—some with AV industry ties. While US trade officials have not focused on the AV sector, it could assume a more prominent role for issues such as forced technology transfer if and when trade talks resume between the two countries.
- Chinese industrial planning ministries will likewise face new challenges in 2021 as the complexity of AV supply chains becomes more apparent. These supply chains will also come under new pressure from US-China tensions and continuing shortages, particularly for auto-related semiconductors, caused by the pandemic.

Overview

The Ministry of Industry and Information Technology (MIIT) in mid-January published draft "Management Standards for Road Testing and Demonstration Application of Intelligent Connected Vehicles (Test)." The policy document is part of a government effort to increase regulatory support for AVs and the broader new energy vehicle (NEV) sector. Given the priority Chinese industrial planners are placing on developing a robust domestic EV/AV technology ecosystem, the sector achieved a major expansion in 2020, with a host of private and state-owned players—both car manufacturers and technology companies—ramping up offerings. They are partnering to deploy more advanced systems and positioning themselves to compete in the EV/AV market.

This report analyzes China's efforts to fast-track the development and deployment of AVs such as self-driving delivery vehicles and robotaxis. It describes how policies aimed at boosting the sector and spurring related infrastructure investment have taken on new urgency during the Covid-19 pandemic, as the government works to mitigate the virus's economic impact. It also describes how the US-China technology and trade confrontation—including US export restrictions on some key tech components—could pose difficulties for Chinese companies operating in the sector (please see Eurasia Group report: China/Geo-technology: Chinese AV ambitions at risk amid trade war, 9 July 2019).

Key definitions and terminology

Autonomous vehicles (AVs)	Refers to self-driving cars, which are equipped with technology that allows them to drive without the active control or monitoring of a person. There are varying levels of autonomy, ranging from basic driver assistance, such as adaptive cruise control with forward collision avoidance that automatically slows cars when they encounter obstacles, to fully autonomous driving involving no human input.
Interconnected vehicles (ICVs)	Describes vehicles that are connected to the internet, generally through their own wireless local area network (LAN). This enables them to communicate with the driver, other vehicles, and connected infrastructure (V2X).
Electric vehicles (EVs)	Refers to vehicles, also known as plug-in electric vehicles, that derive all or part of their power from electricity supplied by the electric grid. EVs are widely considered the most compatible with automated driving systems and consequently key to AVs.
Smart vehicles	Refers to "intelligent cars," which are characterized by advanced electronic features but are not necessarily fully autonomous.
New energy vehicles (NEVs)	Refers to vehicles with new-type power systems that are completely or mainly driven by new energy sources, such as EVs.
Cellular vehicle-to-everything technology (C-V2X)	Describes a 3GPP-supported cellular standard helping a technology to achieve V2X communications. Supports active safety and improves situational awareness by identifying and communicating information using low-latency direct transmission in the 5.9-gigahertz Intelligent Transportation System band.

Source: Eurasia Group

Beijing seeks to stimulate post-pandemic economy via new infrastructure investments

Beijing is pursuing targeted investment in high-tech sectors, such as 5G networks, data centers, and EV/AVs and charging infrastructure, as part of a coronavirus-related stimulus package outlined in the so-called New Infrastructure Initiative (NII). The pandemic has also helped focus thinking on commercial use cases for AVs, ranging from autonomous delivery services to robotaxis, and has lent momentum to consumer demand for contactless technologies.

Industry leaders, including Alibaba-backed AutoX, have touted the pandemic's role in demonstrating the superior safety of robotaxis and robodelivery services relative to traditional transportation, especially to reduce the risk of infection. For example, e-commerce leader JD.com

last February launched its first delivery of coronavirus-related medical aid transported via AV in Wuhan—the epicenter of the country's initial outbreak.

Authorities fast-track regulatory support for the rapidly growing tech sector ...

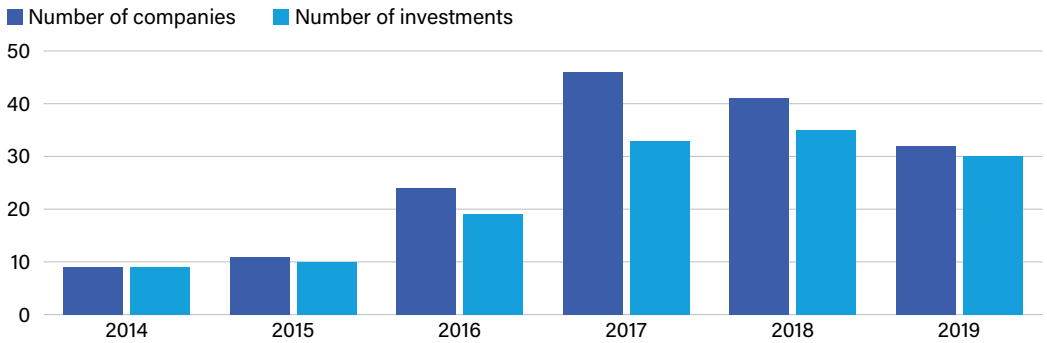
Last May, Beijing unveiled a major push for investment in "new infrastructure" as part of its evolving high-tech industrial policy. The NII includes an estimated USD 1.4 trillion of government funding over the next five years for targeted investment in a wide array of emerging technologies, including next-generation networks, data centers, charging infrastructure, and autonomous and interconnected vehicles. The two areas are linked, since next-generation networks will enable certain autonomous and interconnected vehicle applications.

The NII is among the government's latest support for new energy and smart vehicles, which are highlighted as strategic priorities under the Made in China 2025 (MIC 2025) industrial policy and the National Artificial Intelligence Development Plan (2018). The central government founded more than 300 active state-backed investment funds under MIC 2025 to support high-tech sectors, including AVs and NEVs. These funds reportedly possess more than USD 200 billion of assets and have gradually ramped up investment in the AV industry, with an average state-owned enterprise (SOE) investment of USD 4 billion between 2016 and 2019, according to one estimate.

This injection of fresh capital has been used to invigorate the industry, including by upgrading production lines, as well as tools and machinery used to manufacture both vehicle hardware and software. Government ministries, along with AV developers, media, communications, and other related companies, are eager to stake out a share in the country's AV sector. The market is expected to reach 1.5 million units by 2025 and grow at a compound annual growth rate of approximately 28%. This is likely a low estimate, though, given increased funding allocated under the banner of the NII, including local government financing vehicles such as special bonds and large state-backed funds. Guangdong's provincial government, for example, unveiled plans last year to invest USD 154.6 billion (CNY 1 trillion) in digital infrastructure as part of plans to implement the NII, such as 180,000 charging points for NEVs and 220,000 5G base stations by the end of 2022.

Investment in Chinese autonomous vehicle companies

Venture capital and private equity investments in Chinese AV companies have gained momentum over the past five years, with total private equity investment in the bourgeoning sector climbing to USD 91.64 billion in 2019. The number of companies receiving investments in self-driving vehicles more than tripled between 2014 and 2019, while the number of investments grew 233% over the same period. Given that the number of investments appears to be relatively steady over the past four years, investors seem to be increasingly selective in identifying target companies.



Source: Eurasia Group, Yiou Research and Qingke Research

China's central government has demonstrated a sustained commitment to allocating resources and providing high-level support to the sector. In February 2020, the National Development and Reform Commission (NDRC) and ten other central government departments jointly issued the Strategy for Innovation and Development of Intelligent Vehicles. The policy document builds upon the draft released in late 2018 and provides a policy blueprint for boosting the development of AVs over the next three decades. It also outlines the following target benchmarks:

- **2025:** Establish the standards underpinning smart vehicle technology innovation, the industry ecosystem, and foundational infrastructure; construct the wireless networks for full coverage of LTE-V2X and 5G-enabled V2X in main cities
- **2035-2050:** Construct and fully deploy a standard smart car system throughout the country to promote green transportation and improve safety as well as efficiency

The strategy is emblematic of China's evolving regulatory approach. With nearly a dozen central government departments involved, the high-level interagency coordination reflects agreement that a cross-cutting approach is necessary to grapple with the regulatory and industry impacts of the suite of technologies that will enable AVs. In addition, the document places particular importance on establishing a big data cloud platform for national smart vehicles and devising standards to support the industry.

Indeed, industry standards are at the forefront of regulatory efforts. The MIIT in March 2020, for example, released standards and technical requirements for different levels of autonomous driving. The ministry highlighted the following benchmarks for the industry:

- **2020:**
    - Further develop an ICV standards system underpinning driving assistance and low-level autonomous driving
    - Conduct research and assessment for the requirements of national standards, industry standards, and social organization standards, as well as enhance the ICV standard system
    - Chart a course for the standardization of the function and application of automotive networking
- **2022:**
    - Complete research on basic technologies and develop more than 20 essential standards to support the registration, management, identification, etc. of intelligent and interconnected vehicles; provide support for IoVs

China's coordinated and ecosystem-centric approach to crafting industry guidance and standards could help fast-track the development and deployment of self-driving cars. Meanwhile, in the US, there is growing concern within industry that overlap between federal and state authorities is contributing to heightened uncertainty and confusion in the market.

Both SOEs and the private sector are responding to Beijing's high-level push and ramping up investment in the EV and AV sectors. State-run automaker FAW Group, for example, announced plans in October to partner with Germany's Audi AG to establish a joint venture to manufacture premium EVs. While Audi AG and its parent company Volkswagen will own a 60% stake in the future joint venture, FAW will own the remainder and the company will be based in the northeastern city of Changchun. Starting in 2024, the joint venture will focus on the local production of completely electric vehicles. Meanwhile, Audi AG also plans to produce vehicles with the Shanghai-based, state-owned SAIC Motor.

The planned joint ventures mark the latest between SOEs and private sector players, underscoring rising interest in China's growing EV sector and highlighting the appeal of the sector's relatively low investment barriers. In 2018, the NDRC removed joint-venture requirements for NEVs and announced that the removal of foreign ownership restrictions for commercial vehicles and passenger cars would be phased out by 2022.

Snapshot: High-level government efforts to promote AV development (December 2018 to present)

Beijing is coordinating interagency efforts to devise the regulatory framework underpinning the AV ecosystem. The high-level push reflects broader efforts to reduce regulatory uncertainty for AV makers in China. The move contrasts with the situation in the US, which has seen a proliferation of patchwork state-level legislation in the absence of an overarching federal approach.

Date released	Regulation/official statement	Relevant ministries
January 2021	Management Standards for Road Testing and Demonstration Application of Intelligent Connected Vehicles (Test), draft for public comment	Ministry of Transportation (MoT), Ministry of Industry and Information Technology (MIIT), Ministry of Public Security
January 2021	Interpretation of "Guiding Opinions on Advancing the Development and Application of Autonomous Driving Technology for On-the-road Transportation"	MIIT
November 2020	New energy automotive industry development plan (2021-2035)	State Council
November 2020	Statement in support of pilot projects for next-generation transportation, such as autonomous driving and smart roads in Beijing, Shanghai, and Hebei province	MoT
October 2020	Statement on speeding up the transformation and upgrading of key expressways (5G+ Internet of Vehicles Ecological Development Summit Forum at the China International Information and Communication Exhibition)	MIIT
June 2020	Statement on accelerating the advancement of smart and interconnected vehicle development	MIIT
April 2020	Draft document on general technical specifications for highway auxiliary facilities adapted to automated driving	MoT
Date released	**Regulation/official statement**	**Relevant ministries**
March 2020	Work Priorities for Standards of Intelligent Connected Vehicles (ICT) in 2020	MIIT
February 2020	Strategy for Innovation and Development of Intelligent Vehicles	National Development and Reform Commission (NDRC) and 10 central government departments
January 2018	Draft Strategy for Innovation and Development of Intelligent Vehicles	NDRC and 10 central government departments
January 2018	Three-Year Action Plan to Enhance Core Competitiveness in the Manufacturing Industry (2018-2020)	NDRC
December 2017	Guidelines for Development of National Internet of Vehicles Industry Standards System (Intelligent and Connected Vehicles) (2018)	MIIT
July 2017	National Artificial Intelligence Development Plan	State Council

Source: Eurasia Group, Xinhua

… as local governments pave the way for wide-scale deployment

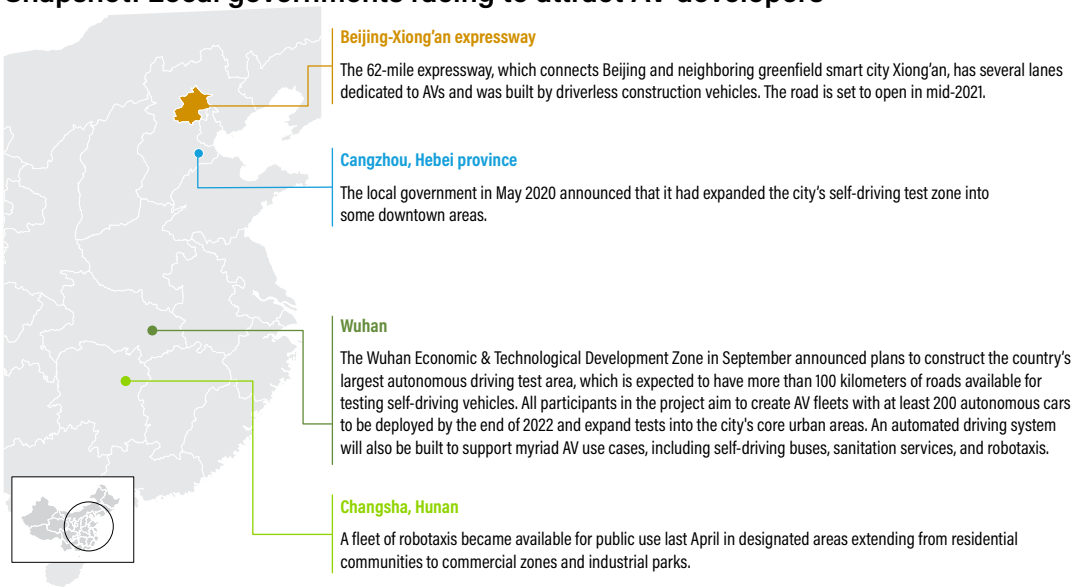
Since the Beijing provincial government issued the country's first local AV regulations in 2017, a growing number of provincial and municipal governments have followed suit. Local officials are vying to attract AV industry leaders and startups by removing regulatory barriers, offering subsidies, and building out 5G network infrastructure. Last April, for example, Baidu received approval from the Hunan government to deploy robotaxi services to the public in Changsha. Baidu also launched the Apollo Go Robotaxi service in Cangzhou, Hebei province, marking the first time robotaxi coverage extended to the downtown area of a Chinese city.

Meanwhile, in early September, Wuhan authorities announced plans to construct the country's largest AV testbed, expanding the test roads in the National Intelligent Connected Vehicle (Wuhan) Pilot Zone by 78 kilometers and bringing it to a total of more than 100 kilometers. Chinese AV developers, including the domestic auto giant Dongfeng, plan to expand the AV fleet with more than 200 autonomous cars to be deployed by the end of 2022, while also extending the demonstration zone to the city's main urban areas. In addition, the Hefei government in September 2020 issued licenses permitting ride-hailing company Didi Chuxing to conduct road tests for AVs, while Guangzhou approved Baidu's request to deploy connected autonomous vehicles (CAVs) and develop an intelligent transportation network in the city, ranging from robotaxi operations to 5G-enabled robobuses.

As of 2019, China had approved more than 200 license plates for dozens of companies for AV testing in an expanding number of cities. The number has almost certainly grown substantially since then, highlighting the country's intensifying push to promote AV testing. These local regulations are a key pillar in the central government's regulatory efforts as they influence the high-level rulemaking efforts of the MIIT, the transport ministry, and other ministries.

This has translated to significant policy support for and industry progress in AV development, with AutoX in December announcing plans to remove safety drivers and deploy a fleet of 25 AVs in downtown Shenzhen. This represents the first time AVs have been tested in China on public roads with neither safety drivers nor remote operators, and it paves the way for other AV developers to follow suit.

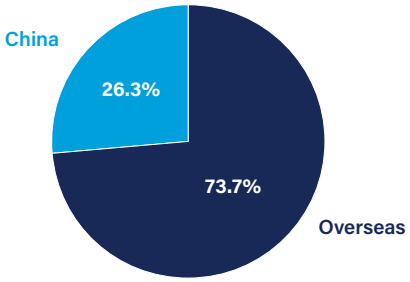
Snapshot: Local governments racing to attract AV developers



Source: Xinhua, Eurasia Group

Potential roadblocks loom

Current location of China-educated AI scientists*



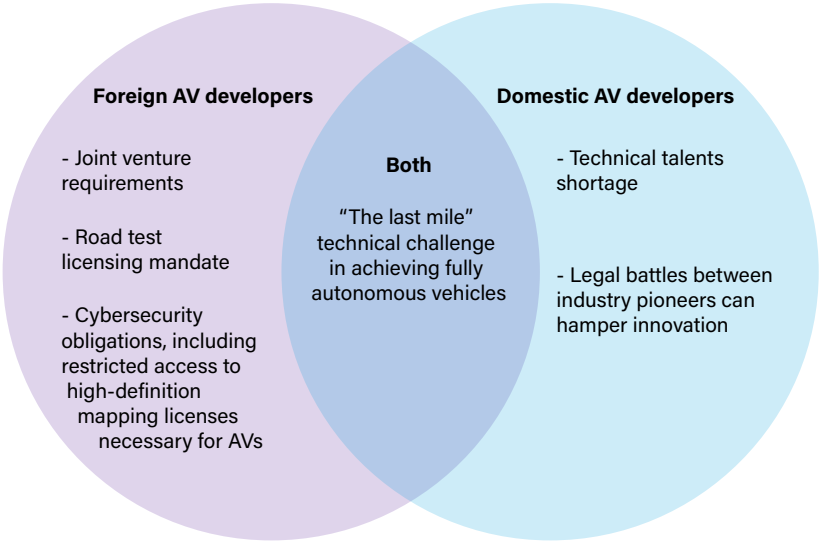
*The data are calculated according to Chinese AI scientists accepted to the NeurIPS conference, a renowned global AI conference that represents the pool of top global AI talent.
Sources: NeurIPS and Macro Polo

Despite high-level assistance from both central and municipal governments, the wide-scale deployment of self-driving vehicles in China will face some of the same regulatory and technological challenges that exist in other markets, such as the US and the EU, though these will manifest differently for domestic and foreign AV producers. Chinese firms will grapple with an array of issues, including limited talent pools. Although China's AI talent base has grown roughly ten-fold over the past decade, the country struggles to retain AI talent. More than 70% of China-educated, highly skilled AI scientists pursue employment overseas, according to one estimate. This has exacerbated concerns about shallow talent pools for highly skilled workers for leading AV developers, spurring intense competition and allegations of employee poaching. Baidu in 2017, for example, filed a USD 7.6 million (CNY 50 million renminbi) suit against AV startup JingChi (currently known as WeRide), alleging that former executive Wang Jing pilfered proprietary technology and poached staff when he departed Baidu to establish JingChi.

AV companies in China are also dealing with regulatory hurdles. In mid-2016, for instance, the MIIT imposed a moratorium on AV testing and driving on public roads, with officials warning developers not to test self-driving vehicles on highways before authorities established ground rules. Given that the moratorium followed on the heels of a fatal crash in the US involving Tesla and its beta testing Full Self Driving system, the timing suggests Chinese officials were wary of a similar incident within the country. The government in 2018 released national rules for road testing and outlined definitions for key terms, requirements for test vehicles and test drivers, and liability provisions; but the scope of the rules has largely been limited to existing testing zones.

Snapshot: Challenges facing foreign and domestic AV developers

Developers in China face numerous challenges, including technical ones for achieving Level 5 (fully autonomous) vehicles. However, regulatory and industry challenges manifest differently for foreign vs domestic companies operating in this space. The Venn diagram below provides a snapshot.



Source: Eurasia Group

In addition, other geopolitical and technological challenges remain, including:

US-China tech cold war pressures. Amid the ongoing technology and trade confrontation, Chinese technology companies—including those underpinning the AV ecosystem—may face new obstacles in obtaining vital components necessary to support the wide-scale deployment of fully autonomous fleets and the smart infrastructure on which they rely. The US Commerce Department has subjected telecom supplier Huawei to export restrictions under the entity list since May 2019, for example. While the company is most known as China's national champion in 5G network equipment, it has also stepped up efforts to supply smart infrastructure such as cameras, radars, and sensors embedded in traffic signs that communicate with AVs. Indeed, the company reportedly aims to become China's leading platform provider for self-driving vehicles over the next five years. Given its inclusion on the entity list and strong bipartisan support in the US for a hardline stance against Chinese tech companies in general and Huawei in particular, it is possible that export restrictions maintained or increased under President Joe Biden's administration could impede Huawei's ambitions in this space.

In addition, AI could become an issue given concerns about dual-use technologies, with US automakers operating in China, including Tesla, potentially attracting regulatory scrutiny around how they are importing the necessary software and sourcing the data sets used to train the AI. This could elevate the risk that Chinese AV developers, such as Baidu and Pony.ai, could join the ranks of Huawei and dozens of other Chinese tech companies added to the entity list over the last year.

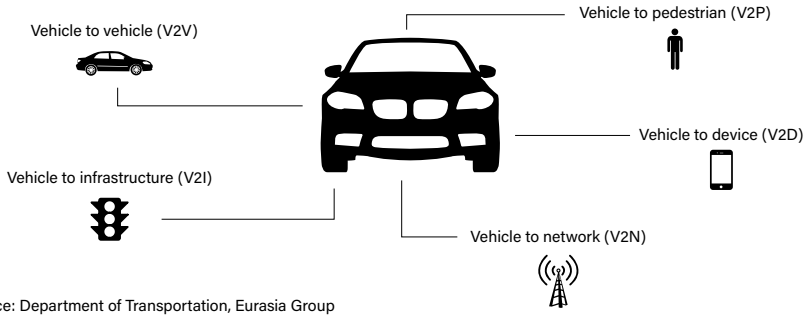
Semiconductors. China's NEV industry will face challenges over the next decade, according to the National New Energy Vehicle Technology Innovation Center, as the auto industry grapples with global semiconductor shortages. As of early 2020, the serious shortages of automotive semiconductors were due to a combination of factors, including production disruptions amid the pandemic, an uptick in demand for consumer electronics such as laptops, and China's growing demand for EVs. This supply shortage is further exacerbated by the previous administration's recent export restrictions designed to curb technology transfers to China. Following the inclusion of China's leading semiconductor manufacturer, Semiconductor Manufacturing International Corporation (SMIC), on the entity list in December, many automakers shifted production to alternative suppliers such as Taiwan Semiconductor Manufacturing Company (TSMC), which have reportedly been struggling to meet the surging demand. At the same time, most car makers slashed production in 2020 because of the pandemic; and then, when the firms began ramping up production again and returned to semiconductor suppliers to resume filling orders, most manufacturers had already reallocated already scarce capacity.

The supply constraints and US government entity list actions highlight China's reliance on imports of core components, which amounted to USD 350 billion worth of integrated circuits in 2020 (a 14.6% increase from 2019) despite US export restrictions. China still depends heavily on foreign suppliers for core semiconductor components in autonomous driving. Semiconductor companies such as Nvidia provide hardware like the graphics processing unit and in-vehicle AI computer, as well as the training platforms and software development kits around it. The technical barrier is especially high in this space; developing reliable hardware and fostering a mature development framework is a long-term investment.

Given mounting political and industry pressures, Beijing will almost certainly intensify its high-level push to reduce supply chain exposure to the US in next-generation technologies, as outlined in the government's 14th Five-Year Plan (2021-2025), as well as efforts to boost production capacity in key areas such as advanced semiconductor manufacturing, software development, and AI.

Vehicle to everything (V2X) connectivity

V2X technology, also known as connected-vehicle-to-everything communication, allows vehicles to communicate with their surroundings in order to improve safety. It has several aspects, including the following:



Source: Department of Transportation, Eurasia Group

Standards. China's push to develop standards for autonomous and connected vehicles, as illustrated in the Strategy for Innovation and Development of Intelligent Vehicles, may pose a challenge for its domestic AV makers as they expand into overseas markets. This is especially true given that international standards have yet to be agreed upon or developed in major markets, such as the US and the EU. Moreover, language in China's emerging standards framework emphasizes the use of "secure and controllable" standards and technologies. The government has not provided a concrete definition of "secure and controllable." However, local and provincial officials have generally interpreted it to refer to local production, which foreign competitors and governments have generally criticized as unofficial guidance and approval to give preferential treatment to domestic suppliers.

This underlines Beijing's distinct preference to favor domestic AV companies, given growing cybersecurity concerns around mobility services, for example, which over time could lead to reduced market access for foreign firms in the sector. That said, Beijing's overarching goal is not necessarily to dominate the standards-setting process, but rather to promote international standards that incorporate or are influenced by Chinese-developed standards. Standards development has become an acute point of global technology competition as Beijing ratchets up efforts to influence the process through support for domestic tech companies, such as Huawei and Baidu, as well as state-affiliated actors.

China's Innovation Driven Development Strategy—an industrial policy blueprint released in 2016 and focused on areas that Beijing feels would gain the most from increased domestic innovation—promotes "supporting Chinese enterprises, alliances, and associations to participate in or lead the development of international standards and promoting China's 'superior' technologies and standards to become international standards." This strategic objective is already aligned with high-level policy priorities as outlined in MIC 2025, including autonomous and interconnected vehicles.

Authorities have significantly downplayed the controversial MIC 2025 industrial policy over the last year and ceased using references in official speeches, policy documents, and government press releases amid heightened tech tensions with the US. While this shift is likely due to the high-level pushback that the document triggered among many of China's trading partners, including the US and Germany, Beijing continues to push out preferential policies and subsidies for MIC 2025 sectors, including NEVs. Meanwhile, a long-awaited industrial policy document, China Standards 2035, aims to establish a blueprint for China's government and leading tech companies to participate in global standards setting. The document has yet to be released.

Navigation. The navigation services of China's BeiDou satellite network are commonly used across the country but have generally lacked the precision necessary to support AV deployment. To address this issue, a budding number of Chinese tech companies have installed base stations, which are used to measure and correct positioning within a certain radius, to help self-driving cars navigate accurately. Hangzhou-based Alibaba, for example, partnered with defense equipment manufacturer China North Industries Group Corporation (NORINCO) in 2015 to establish Qianxun Spatial Intelligence. The company has rolled out more than 3,000 base stations at home and abroad, with its positioning services installed in an EV that was recently unveiled by the state-owned Guangzhou Automobile Group. In addition, Qianxun Spatial Intelligence in November announced plans to supply systems for Guangzhou-based EV manufacturer Xpeng Motors.

NORINCO is among a list of dozens of Chinese firms that the US Defense Department has designated as having ties to the People's Liberation Army, which could lay the groundwork for US actions targeting the company's access to US technologies and broader role in the country's AV development. This illustrates the potential for US government actions against Chinese tech firms, including export restrictions and exclusion from US capital markets, to undermine China's high-tech ambitions in general and AV development in particular.

Antitrust. Large Chinese technology companies, such as Tencent and Alibaba, often dominate the market for software provider services supporting vehicle connectivity. Given China's tightening scrutiny of its tech giants and new antimonopoly rules, they may face mounting regulatory headwinds. The joint venture among US-based General Motors, SAIC Motor, and connected vehicle company PATEO, for instance, submitted a formal complaint against Tencent in early February for allegedly employing illegal and anticompetitive tactics to push back against its rivals. The move is the first in which Chinese automobile manufacturers have reported anticompetitive practices in a complaint about domestic tech titans that are vying for market share in China's auto sector.

Strategic minerals. Geopolitics will continue to define the contours of EV/AV supply chain risks. China's ability to drive domestic industrial growth in the sector depends in part on its ability to secure reliable access to ample strategic minerals such as lithium and cobalt, important to EVs and AVs as both technologies are battery-dependent and technology component-heavy. China has a wealth of some of the minerals key to these technologies, but vast, state-led international acquisitions to source others have sparked fears of market domination and potential trade disruptions. Concerns about China's ability to dominate mineral supply access, and its implications for market price distortions and availability, have initiated international efforts to isolate full supply chain risks, in large part through supply diversification. As countries use restrictive trade measures to manage supply and end use, there will be lasting impacts on AV/EV industry scale-up globally.

2021 will be critical year for the AV sector

China's AV ecosystem is poised to benefit from state investment in digital infrastructure over the next year, including 5G and NEV charging stations, yet challenges remain. The government plans to expand the number of charging stations nationwide to more than 36,000 by 2025, for example, but there has generally been a lack of oversight or accountability for where these stations are installed, and many companies previously placed them in remote areas to benefit from subsidies and without regard to consumer demand. According to industry association China EV100, the usage rate of public charging facilities was less than 10% in 2018 despite an outpouring of state capital. Moreover, although China's demand for EV charging stations is set to soar by 2030, creating a USD 155 million (CNY 1 billion) market, the country's EV charging industry is

struggling. More than half (150) of homegrown EV companies closed or exited the industry in 2019, while an estimated 30% are struggling to break even.

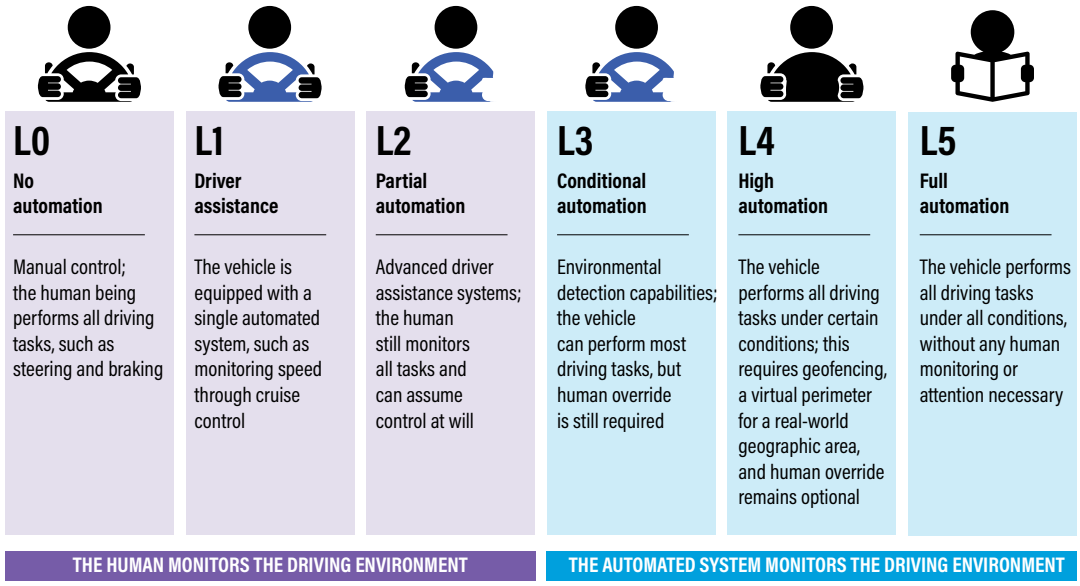
In addition, the Biden administration is conducting a comprehensive review of China policy, including the previous administration's last-minute actions targeting Chinese tech companies—some with AV industry ties. While US trade officials have not focused on this sector, it could become more prominent around issues such as forced technology transfer when and if detailed trade talks resume between the two countries.

Many foreign AV developers, for example, have criticized restricted access to high-definition mapping licenses in China, which require a partnership with one of a handful of Chinese companies to gain access. Tesla, for instance, formed a partnership last year with Baidu—one of the few Chinese companies with access to the high-definition mapping licenses necessary to support autonomous driving—to supply Tesla's map data services. The industry has expressed interest in a mutual recognition agreement that would permit companies to test and verify AV technologies through their vendor of choice rather than a laboratory designated by the Chinese government, citing concerns about the potential for forced technology transfer, as part of the process for obtaining approval to test AVs on public roads.

Chinese industrial planning ministries will likewise face new challenges in 2021 as the complexity of the supply chains for AVs become more apparent and come under new pressure from US-China relations and continuing shortages, particularly for auto-related semiconductors, caused by the pandemic.

Appendix

Levels of driving automation



Source: Synopsys, Eurasia Group

Snapshot: Key AV industry players in China

China's leading AV companies are stepping up efforts to achieve full autonomy, but they still lag their US competitors, such as Waymo and Tesla, in terms of technological capability. Touted as the front-runner of China's AV industry, for instance, Baidu's business model is mainly based on selling smart transportation (surveillance and control) systems to local transportation and public security bureaus, more than targeting fully self-driving cars designed for individual consumers. Indeed, Baidu and its Chinese rivals trail US industry leaders and are unlikely to make substantial breakthroughs to narrow the gap in the near future.

Whereas US industry leaders largely prioritize the consumer market, their Chinese competitors ultimately aim to focus on supplying the public transportation system apparatus. Funds allocated under the NII will keep them afloat commercially as local governments step up investment in smart transportation systems. This is the key distinguishing factor between the Chinese and US AV industries. The table below provides an overview of China's top AV players.

Company	Description	Select known partners
Alibaba.com	E-commerce, payments, and cloud services major Alibaba announced in April 2019 that it has been conducting self-driving vehicle tests, joining rivals Baidu and Tencent in offering technology platforms for the industry. In December, the Alibaba-backed AutoX began fully driverless vehicle tests in China. The company aims to have a fleet of more than two dozen self-driving cars in Shenzhen and five other cities to test the technology. In late January, Alibaba ramped up its involvement in China's EV space, launching a passenger car with wireless charging, which is jointly developed with China's largest automaker, SAIC Motor, under the IM brand.	SAIC Motor, Dongfeng Peugeot Citroen, AutoX
autox	Founded in 2016, AutoX is an Alibaba-backed AV startup that has modified vehicles from a number of original equipment manufacturers (OEMs) and tested them in several Chinese cities, including Shenzhen and Shanghai. In December, the company announced it had begun fully driverless vehicle testing in China with minivans from Fiat Chrysler Automobiles, marking the first time any AV in China has tested on public roads with neither safety drivers nor remote operators. The company has raised more than USD 160 million in funding over five rounds, with the latest funding raised in late 2019.	Alibaba, MediaTek, Shanghai Motors, Dongfeng Motor Corporation, SAIC Motor, Fiat Chrysler

Company	Description	Select known partners
Baidu 百度	Search engine Baidu launched its USD 1.5 billion autonomous driving ecosystem, Apollo, in 2017. The company aims to establish itself as a world-class AI leader, with autonomous driving as one of its key focus areas. In December, Beijing approved permits for Baidu to conduct fully driverless road tests on public streets. The vehicles participating in the tests will rely on Apollo, which has transported over 100,000 passengers across 27 cities around the world. Last May, Baidu announced that it had completed what it claimed to be the world's largest testing area for AVs and V2X infrastructure communication, the 13,500-square-meter Apollo Park in Beijing. While Baidu provides the software, it works with vehicles provided by OEMs such as BAIC, Chrysler, and Lincoln. In addition, in mid-January, Baidu announced plans to partner with Guangzhou Automobile Group (GAC Group) to create intelligent and interconnected vehicles. The strategic partnership will result in a new and as yet unnamed company. The Baidu Apollo fleet comprises an estimated 500 self-driving cars that have accumulated more than 7 million kilometers (4.4 million miles) with more than 210,000 passengers and without accidents reported. Baidu has also tested AVs extensively in the US and, in late January, received approval from California for testing self-driving vehicles without a safety driver. On 25 January, Baidu announced plans to expand its strategic partnership with BlackBerry, which will allow Baidu's mapping tools to be installed in more interconnected and self-driving vehicles in China. The company hailed the move as an opportunity to "provide car manufacturers with a clear and fast path to the production of autonomous vehicles ..."	JAC Motors and BAIC, Cherry Automobile, Volvo and Ford, GAC Group, Blackberry, Valeo, NXP
BYD Build Your Dreams	Founded in 1995, BYD manufactures an array of electronic products, including NEVs and the batteries that power them. The Shenzhen-based company is the world's second-largest EV manufacturer in the world in terms of output but has garnered less attention in part because it lacks US equity exposure. In 2020, it introduced a L2 driver assistance system but reportedly has yet to consider L3 development. Its R&D of higher-level automation (namely, L4 and L5) is likely in the pipeline. BYD in late 2018 announced plans to launch its first self-driving car by 2021. Meanwhile, in November, the company partnered with Didi Chuxing to roll out their customized D1 van model for ride-hailing services.	Daimler, Didi Chuxing, Toyota, Hino
Cambricon 寒武纪科技	Cambricon builds core processor chips for intelligent cloud servers, intelligent terminals, and intelligent robots. Its edge computing chips will be used in some AV applications. Portions of core IP for certain Cambricon chip designs come from the Chinese Academy of Sciences Institute of Computing Technology.	Huawei, Alibaba
DiDi	Founded in 2012, Didi Chuxing is one of the world's largest ride-hailing services. The Beijing-based company announced in August 2019 that its autonomous driving unit would become a standalone company. In May 2020, SoftBank Vision Fund injected USD 500 million into Didi. In June, the company began installing V2X equipment and launched a pilot robotaxi service in China's most populous city. Meanwhile, Didi that month also forged a partnership with Chinese automaker BAIC to develop high-tech, customized AVs through collaboration in automobile technologies and AI. Didi in November partnered with China's largest EV manufacturer, BYD, to design, develop, and manufacture an EV specifically for ride-hailing, the D1. In late January, the company announced it has raised USD 300 million for its autonomous driving unit, marking the second time since last year that Didi has tapped investors to boost its technological capabilities in the field. Last year, Didi announced plans to deploy more than 1 million self-driving vehicles through its platform by 2030.	BAIC, Nvidia, BYD, SoftBank

Company	Description	Select known partners
Horizon Robotics	Horizon Robotics specializes in AI semiconductors for AVs and robots. Horizon in September unveiled a high-level autonomous driving semiconductor and forged a strategic partnership with GAC Group. In late December, the company announced that it had secured USD 150 million in funding in the first tranche of the USD 700 million Series C round.	GAC Group
HUAWEI	In May 2020, the Shenzhen-based company announced it had launched a 5G-enabled automobile ecosystem by collaborating with 18 OEMs and mobility service providers, including domestic heavyweights such as Dongfeng Motor Corporation and Changan Automobile. According to reports in late 2020, Huawei has supplied 200 latest-generation 5G vehicle modules (including Huawei's Balong 5000 5G semiconductors) to GAC Group, with the latter planning to move toward rolling out vehicles using the chips in the near future.	FAW Group, Changan Automobile, Dongfeng Motor Corporation, SAIC Group, BAIC Group, BYD, Great Wall Motor, GAC Group
	Li Auto, established in 2015, is one of China's leading EV startups. The Beijing-based firm raised more than USD 3.16 billion (CNY 20.7 billion) in 2020, according to one estimate. In December, the company unveiled a strategic three-way partnership with the US chipmaker Nvidia and Nvidia's Chinese partner, Huizhou Desay SV Automotive (Desay SV). The partnership will allow Li Auto to become the first OEM to install the Nvidia Orin SoC chipset, which is set to be mass-produced next year, and leverage one development investment across an entire fleet from lower automated system levels (L2) to fully autonomous vehicles (L5).	Meituan, ByteDance, NVIDIA, Desay SV Auto
NIO	Founded in 2014, Nio is one of China's leading EV manufacturers, and it is targeting the medium and high end of the market. Although the Shanghai-based company teetered on the brink of bankruptcy in early 2020, a group of entities backed by the government of Hefei in Anhui province, including Hefei City Construction and Investment Holding (Group) and Anhui Provincial Emerging Industry Investment, injected USD 1.08 billion (CNY 7 billion) in Nio prior to its US IPO. In mid-January, the company unveiled its first autonomous driving sedan. Last summer, the company launched a successful IPO on the New York Stock Exchange (NYSE).	NVIDIA
pony.ai	Founded in 2016, the California-based self-driving car startup also has headquarters in Guangzhou and develops autonomous vehicle platforms. In late 2020, it announced the completion of a USD 267 million Series C funding round, which was led by an innovation fund within the Ontario Teachers' Pension Plan Board. The inflow of fresh capital propelled its valuation to USD 5.3 billion. The company has launched robotaxi pilots in California and Guangzhou; last July, co-founder and Chief Technology Officer Lou Tiancheng said the large-scale commercial deployment of robotaxis would take at least three to five years.	Toyota, FAW, Bosch, Hyundai
Tencent 腾讯	Tencent is a relative latecomer to the auto sector but is eager to capture potential revenue in providing data and cloud processing services in the AV market. Last July, Tencent also released its new generation of autonomous driving simulation software, the TAD Sim 2.0. In the second quarter of 2020, the company committed more than USD 70 billion in high-tech areas, including AV and AI. The software is being used by several AV developers, including BMW and domestic automaker Zhejiang Geely Holding Group (Geely). Indeed, Tencent on 19 January announced plans to partner with Geely on a wide array of automobile technologies, such as intelligent cockpits and automated driving systems as well as low carbon development.	GAC Group, Nio, Didi Chuxing, Tesla, Baidu, BMW, Geely

Company	Description	Select known partners
TESLA	The US EV leader has ramped up production at its Shanghai manufacturing plant and captured a major share of the Chinese luxury EV market. The firm's operations in China have benefited from strong government backing—the USD 1.6 billion Shanghai facility was financed almost completely via state-owned banks, including the China Construction Bank and the Agricultural Bank of China. Tesla has been sourcing batteries from Panasonic since 2011, but it is moving to diversify its battery supply chains. In 2020, Tesla entered a partnership with China's battery leader CATL and is pursuing advanced battery development with CATL for both the China market and other top markets. Meanwhile, the EV company submitted a proposal to the Indonesian government in early February to join in Jakarta's high-level push to develop an integrated EV battery supply chain in the world's largest producer of key battery mineral nickel.	Contemporary Amperex Technology Co Ltd. (CATL), Tencent
WeRide 文远知行	WeRide, previously known as JingChi.ai, was founded in 2017 and is dedicated to R&D of L4 autonomous driving technologies. The company in late 2020 announced that it had raised a USD 200 million strategic round from Chinese bus manufacturer Yutong. The new funding will lay the groundwork for WeRide to partner with Yutong on R&D as well as manufacture self-driving minibuses and city buses.	Guangdong Unicon, Nvidia, Renault-Nissan-Mitsubishi, Baiyun Taxi Group, and Science City Investment Group
XPENG	Founded in 2014, Alibaba-backed Xpeng is one of China's leading EV manufacturers and is targeting the high end of the market, competing directly with Tesla. The Guangzhou-based company announced in mid-January that it had secured a credit line of USD 1.98 billion (CNY 12.8 billion) from major Chinese financial institutions, including Bank of China and China Construction Bank. The announcement comes as the company unveils a new beta autonomous driving solution, the Navigation Guided Pilot, as part of its autonomous driving package. The move is intended to enable Xpeng to better compete with Tesla, which launched an upgrade to its full self-driving software in late 2020. Last summer, along with Nio and Li Auto, Xpeng launched a successful IPO on the NYSE.	Alibaba

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