# CHASSIS, CONTROL SYSTEMS AND EQUIPMENT

## 1 Introduction

The COVID-19 pandemic that started in 2020 caused an increase in the global demand for semiconductors due to factors such as the shift to remote lifestyles, and the automotive industry is also suffering from chronic supply shortages. As a result, many companies have been forced to reduce or stop production. Under such severe circumstances, the social demand for automatic driving, safety performance, and environmental performance keeps intensifying, and automakers are engaged in research and development.

For automated driving, the development and commercialization of passenger vehicles with level 2 or higher automated driving AD/ADAS functions is accelerating, and accidents and traffic jams are expected to decrease as communication technology evolves. Japan is working to expand the commercialization of level 4 autonomous driving services that only rely on remote monitoring, and to commercialize trucks capable of platoon driving on highways, although those initiatives are limited to only certain areas. In North America, China, and Europe, the commercialization of driverless taxis has begun, and they are being tested on public roads.

With respect to environmental performance, Japan, Europe, the United States, and many other governments have initiated policies aimed at achieving carbon neutrality by 2050 to address global warming. Automobile manufacturers have announced a succession of electrification ratio and sales plan for electric vehicles (EVs). In particular, China has accounted for more than half of the world's EV sales due to its nationwide EV policy, and development-related competition in the market is intensifying as many manufacturers create their own dedicated EV platforms.

In terms of safety performance, collision damage mitigation braking systems (AEBS) have already become standard for new models released after November 2021 in Japan. In Europe as well, the installation of AEBS will be mandatory for new models launched after July 2024, and their applications continue to expand.

This article describes the chassis and vehicle control technology trends with a focus on the new models and technology released in 2021. The main new models launched in and outside Japan in 2021 are shown separately in Table 1. However, technologies such as electronic stability control (ESC) that are mandatory in various countries, and warning functions that are part of active safety technologies, have been omitted.

## 2 Suspension

### 2. 1. Base suspensions

As shown in Table 1, most of the new 2021 vehicle models have MacPherson strut front suspensions, and some vehicles above the medium class continue to adopt the double wishbone system due to the need to install an air suspension or active suspension.

For the rear suspension, the compact class and below use a torsion beam in, while higher classes often adopt a multi-link or double wishbone system. The adoption of multi-link systems (e.g., 5-link) is expected to increase in coming yours, especially in EVs, which are often based on rear-drive systems. The reason is that the suspension arm length can be set shorter than in other types, making it compatible with a large drive motor. It is also considered to be compatible with the high-capacity battery placed under the passenger floor, due to the lack of trailing arm. In addition, since an appropriate anti-squat angle can be set, the behavior of the body pitching can be suppressed when the rear wheels are driven, providing a significant advantage in terms of comfort. In addition, high-capacity batteries are placed under the floor of EVs, increasing the weight of vehicle body and shifting the front-to-rear weight distribution toward the rear. This tends to make ensuring stability in the lateral G range a concern, but it is nevertheless easy to achieve balance

**Table 1** Chassis and Vehicle Control Systems of New Vehicles Launched in 2021

| Market | Manufacturers | Name of vehicle model | Drivetrain type | Drive system | Suspension type Front/Rear ( ): suspension for AWD layout | Vehicle control systems |
|---|---|---|---|---|---|---|
| Japan | Daihatsu | Hijet truck | ICE | RWD/AWD | MacPherson strut/Axle type | Crash-avoidance Support Braking (against vehicle/pedestrian: day/night)/False Start Preventive Control Function with Brake Control (front/rear)/Lane Departure Prevention Control Function/Hill Hold System/4 WD (electronically controlled/mechanical type)/Super Differential Lock |
| | Honda | Civic | ICE | FWD | MacPherson strut/Multi-link | Collision Mitigation Braking System (CMBS)/False Start Preventive Control Function/Rear False Start Preventive Control Function/Short Distance Collision Mitigation Braking System/Pedestrian Collision Mitigation Steering System/Road Departure Mitigation System/Adaptive Cruise Control (ACC) with Congestion Following Function/Lane Keeping Assist System (LKAS)/Traffic Jam Assist (congestion driving support function)/Agile Handling Assist/Hill-Start Assist Function/Electronically Controlled Parking Brake/Auto Brake Hold Function |
| | | Vezel | ICE/HEV | FWD/AWD | MacPherson strut/torsion beam(De Dion type) | Collision Mitigation Braking System (CMBS)/False Start Preventive Control Function/Rear False Start Preventive Function/Short Distance Collision Mitigation Braking System/Pedestrian Collision Mitigation Steering System/Road Departure Mitigation System/Adaptive Cruise Control (ACC) with Congestion Following Function/Lane Keeping Assist System (LKAS)/Reverse leaving garage support/Agile Handling Assist/Hill-Descent Control/Hill-Start Assist Function/Electronically Controlled Parking Brake/Auto Brake Hold Function |
| | Lexus | NX | ICE/HEV/PHEV | FWD/AWD | MacPherson strut/Double wishbone | Advanced Park (with remote function)/Parking Support Brake (surrounding stationary objects, pedestrians behind) (PKSB)/Pre-crash Safety (pedestrians/cyclists: day and night/motorcycles: Daytime Collision Avoidance Support Type with Detection Function/Millimeter Wave Radar and Monocular Camera System)/Emergency Steering Assistance (with active steering function)/Lane Change Assist (LCA)/Downhill Assist Control (DAC)/Electric Parking Brake/Brake Hold/Hill-Start Assist Control /Active Cornering Assist (ACA)/Lane Tracing Assist (LTA)/Radar Cruise Control (with all vehicle speed tracking function)/Driver Abnormal Response System/Proactive Driving Assist (PDA)/Parking Support Brake (front and rear stationary objects + vehicles approaching from behind) (PKSB)/Drive Start Control (DSC) |
| | Mazda | Carol | ICE/HEV | FWD/AWD | MacPherson strut/Torsion beam (isolated trailing link type) | Brake Pedal Retreat Prevention Mechanism/Dual Camera Brake Support/False Start Preventive Control Function (forward)/Back-up Brake Support/False Start Preventive Control Function (rear)/Hill Hold Control |
| | Mitsubishi | Outlander | PHEV | AWD | MacPherson strut/Multi-link | S-AWC (Super All Wheel Control)/Active Yaw Control (AYC)/Collision Mitigation Brake System (FCM) (with pedestrian/cyclist detection)/Emergency Assist for Pedal Misapplication (EAPM)/Lane Departure Prevention Support Function (LDP)/Rear Side Collision Damage Prevention Support System (ABSA)/Rear Vehicle Warning System (with lane change assist function) (BSW/LCA/Hill-Start Assist (HSA)/Hill-Descent Control (HDC)/Radar Cruise Control System (ACC) (with all vehicle speed tracking function)/Lane Keeping Assist (LKA)/Electric Parking Brake/Brake Auto Hold |
| | Subaru | Legacy Outback | ICE | AWD | MacPherson strut/double wishbone | Active Torque Split AWD (electronically controlled AWD)/X-MODE (with hill descent control)/Electric Parking Brake/Hands-off Assist in Traffic Congestion/Start Assist in Traffic Congestion/Active Lane Change Assist/Speed Control before Curve/Speed Control before Tollgate/Driver Abnormal Response System/Pre-crash Brake/Front and Side Pre-crash Brake/Emergency Pre-crash Steering/Reversing Brake Assist/AT False Start Preventive Control/AT Rear False Start Preventive Control/Touring Assist/Cruise Control with All Vehicle Speed Tracking Function/Constant Speed Cruise Control/Lane Departure Control/Emergency Lane Keep Assist/Auto Vehicle Hold/Active Torque Vectoring/Post-collision Brake Control |
| | Suzuki | Wagon R Smile | ICE/HEV | FWD/AWD | MacPherson strut/Torsion beam (isolated trailing link type) | Dual Camera Brake Support/False Start Preventive Control Function/Rear False Start Preventive Control Function/Hill Hold Control/Adaptive Cruise Control (ACC) (with all vehicle speed tracking function) |
| | Toyota | Aqua | HEV | FWD/AWD | MacPherson strut/Torsion beam (double wishbone) | Pre-crash Safety (pedestrians: day/night, cyclists: Daytime Collision Avoidance Support Type with Detection Function/Millimeter Wave Radar + Monocular Camera System/Lane Tracing Assist (LTA)/Radar Cruise Control (with all vehicle speed tracking function)/Parking Support Brake (stationary objects in the front and rear, vehicles approaching from behind)/Plus Support (acceleration suppression during sudden acceleration)/Toyota Teammate Advanced Park (panoramic view monitor: with see-through view function)/Secondary Collision Brake (SCB)/Hill-Start Assist Control/Drive Start Control (DSC) |
| | | Corolla Cross | ICE/HEV | FWD/AWD | MacPherson strut/torsion beam (double wishbone) | Electric Parking Brake/Brake Hold/Pre-crash Safety (pedestrians: day/night, cyclists: Daytime Collision Avoidance Support Type with Detection Function/Millimeter Wave Radar + Monocular Camera System)/Lane Tracing Assist (LTA)/Radar Cruise Control (all vehicle speed tracking function)/Parking Support Brake (stationary objects in front and behind, vehicles approaching from behind)/Plus support (suppression of acceleration during sudden acceleration)/Drive Start Control (DSC)/Hill-Start Assist Control |

**Table 1** Chassis, Control Systems and Equipment of New Vehicles Launched in 2021 (cont.).

| Market | Manufacturers | Name of vehicle model | Drivetrain type | Drive system | Suspension type Front/Rear ( ): suspension for AWD layout | Vehicle control systems |
|---|---|---|---|---|---|---|
| Japan | Toyota | Land Cruiser | ICE | AWD | Double wishbone/ Trailing link axle type | E-KDSS (Electronic Kinetic Dynamic Suspension System)/AVS/Full-time 4 WD, Transfer with Torsen LSD (center differential)/Torsen LSD (rear)/ Electric Differential Lock/Multi-terrain Select/Drive Mode Select/Electric Center Differential Lock/Crawl Control + Active Traction Control/Hill-Start Assist Control/Downhill Assist Control/Electric Parking Brake & Brake Hold/ Sprung Vibration Control/Trailer Sway Control/Pre-crash Safety (Pedestrians: day/night, cyclists: Daytime Collision Avoidance Support Type with Detection Function /Millimeter Wave Radar + Monocular Camera System)/ Lane Tracing Assist (LTA)/Lane Departure Alert (with yaw assist function) (LDA)/Driver Abnormal Response System/Radar Cruise Control (with all vehicle speed following function)/Parking Support Brake (stationary objects in front and behind, vehicles approaching behind, pedestrians behind)/Plus Support (acceleration suppression during sudden acceleration)/VDIM |
| Outside Japan | Audi | A3 | ICE | FWD/ AWD | MacPherson strut/ Torsion beam (multi-link) | Audi Drive Select/Adaptive Cruise Control/Lane Assist/Adaptive Cruise Assist/Audi Pre-sense Front/Side Assist/Rear Cross Traffic Assist/ Audi Parking System (rear)/Park Assist/Electromechanical Parking Brake(EPB)/Audi Hold Assist |
| | | e-tron | BEV | AWD | Double wishbone/ Double wishbone | Active Air Suspension/Progressive Steering/Adaptive Cruise Control/ Adaptive Cruise Assist/Emergency Assist/Audi Pre-sense Front |
| | BMW | iX | BEV | AWD | Double wishbone/ multi-link | Active Cruise Control (ACC) (with Stop & Go function)/Steering & Lane Control Assist/Lane Change Assist/Lane Keeping Assist (with active side collision protection)/Collision Avoidance, Damage Mitigation Brake (with accident avoidance assist)/Emergency Stop Assist/Dynamic Traction Control (DTC)/Cornering Brake Control (CBC)/Dynamic Brake Control (DBC)/Electronic Differential Lock Control (EDLC)/Driving Dynamic Control System/Park Distance Control (PDC) (with front & rear visual display function)/Parking Assist (parallel/tandem)/Reverse Assist/Reversing Steering Assist Function/False Start Preventive Control/Electric x Drive System (electronically controlled front and rear drive force distribution 4-wheel drive)/Driving Performance Control/Integrated Active Steering (front and rear wheel integrated control steering system)/4 -wheel Adaptive Air Suspension/Button Type Parking Brake |
| | Citroën | C4 | ICE | FWD | MacPherson strut/ torsion beam | Electric Parking Brake/Hill-Start Assistance/Active Safety Brake (Damage Mitigation Brake)/Active Cruise Control/Traffic Jam Assist/Lane Positioning Assist/Post Collision Safety Brake |
| | Mercedes-Benz | EQA | BEV | FWD | MacPherson strut/ 4 -link | Active Distance Assist DISTRONIC (with automatic restart function)/ Active Brake Assist (with pedestrian/running out/oncoming vehicle detection function when turning right)/Active Steering Assist/Emergency Avoidance Assist System/Emergency Braking Function during Traffic Congestion/Active Blind Spot Assist (with warning function when exiting the vehicle)/Active Lane Keeping Assist/Traffic Sign Assist/Active Lane Changing Assist/Active Emergency Stop Assist/Drive Away Assist/Rear Cross Traffic Alert/Acceleration Skid Control (ASR)/Brake Assist (BAS)/Cross Wind Assist/Adaptive Brake (Hold function, Hill-start assist)/Active Parking Assist (parallel parking) |
| | | S-Class | ICE/ HEV | AWD | 4 -link/Multi-link | Active Distance Assist DISTRONIC (with automatic restart function)/ Active Steering Assist/Active Lane Changing Assist/Active Emergency Stop Assist/Active Brake Assist (with pedestrian/running out/oncoming vehicle detection function when turning right)/PRE-SAFE® /Emergency Avoidance Assist System/Emergency Braking Function in Congestion/Active Blind Spot Assist (with warning function when exiting the vehicle)/Active Lane Keeping Assist/PRE-SAFE® Plus (Rear Collision Warning System with Damage Mitigation Brake)/Brake Assist (BAS)/ Adaptive Brake (Hold function, Hill-start assist)/Cross Wind Assist/ Active Parking Assist (tandem/parallel parking)/AIRmatic Suspension/ Rear Axle Steering/Cruise Control & Variable Speed Limiter/Button Type Parking Brake/Valet Parking Function/E-ACTIVE BODY CONTROL |
| | Ford | Explorer | ICE/ HEV | RWD | MacPherson strut/ Multi-link | AdvanceTrac® with RSC®/ AVailable Reverse Brake Assist |

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| Market | Manufacturers | Name of vehicle model | Drivetrain type | Drive system | Suspension type Front/Rear ( ): suspension for AWD layout | Vehicle control systems |
|---|---|---|---|---|---|---|
| Outside Japan | Hyundai | Ioniq 5 | BEV | RWD/ AWD | MacPherson strut/ Multi-link | Blind-Spot Collision-Avoidance Assist(BCA)/Rear Cross-traffic Collision-avoidance Assist(RCCA)/Forward Collision-avoidance Assist(FCA)/ Electronic Parking Brake/Rear Cross-traffic Collision-avoidance Assist (RCCA)/Electronic Parking Brake with Automatic Vehicle Hold/Forward Collision-Avoidance Assist with Car/Ped/Cyclist Detection, Junction Turing/Crossing, Lane-Change Oncoming/Side and Evasive Steering Assist/Regenerative Braking System with Anti-lock Braking System (ABS) with 4 -wheel disc brakes/Electronic Stability Control(ESC) with Traction Control(TCS) and Brake Assist (BA) |
| | Mazda | MX-30 | BEV | FWD | MacPherson strut/ Torsion beam | Electronic Parking Brake with auto-hold/Hill Launch Assist(HLA)/Lane Departure Warning System(LDWS) with Lane-keep Assist System(LAS)/Pre-crash safety-Smart Brake Support(SBS) -RWDont with Turn-Across TraFWDic |
| | Nissan | X-Trail | HEV | FWD/ AWD | MacPherson strut/ Multi-link | Pro PILOT Super Intelligent Driving L2/Intelligent Adaptive Cruise Control (ICC)/Constant Speed Cruise Control/Pre-Collision Intelligent Braking (IEB)/Rear Pre-Collision Braking (RAB)/Lane Intelligent Correction (ILI)/ Intelligent Ride Control (IRC)/Electronically Controlled Parking Brake (with auto hold) (EPB)/Electronically Controlled Brake Differential Lock (B-LSD)/ Dynamic Torque Control (YMC)/Intelligent Body Motion Control System (VMC)/Hill-Start Assist (HSA)/Steep Hill-Descent Control (HDC) |
| | Porsche | Panamera | BEV/ PHEV | RWD/ AWD | Double wishbone/ Multi-link | Adaptive air suspension with fully load-bearing air-spring struts(three-chamber technology) and self-levelling function/Porsche Active Suspension Management(PASM)/Porsche Traction Management(PTM) : active all-wheel drive with an electronically variable/map-controlled multi-plate clutch/ automatic brake differential(ABD)/anti-slip regulation(ASR)/Porsche Stability Management(PSM) with ABS and extended brake functions |
| | Tesla | Model Y | BEV | AWD | Double wishbone/ multi-link | Park Assist/Vehicle Hold/Traffic-Aware Cruise Control/Autopark/Smart Summon/Autosteer/Lane Assist/Collision Avoidance Assist/Speed Assist |
| | Toyota | Highlander | ICE/ HEV | AWD | MacPherson strut/ Multi-link | Smart Stop Technology(SST)/Downhill Assist Control(DAC)/Hill Start Assist Control(HAC) |
| | Volkswagen | ID.3 | BEV | RWD | MacPherson strut/ Multi-link | Electronic parking brake/Adaptive Cruise Control(ACC)/Emergency Brake Assist with pedestrian and cyclist detection/Lane Keep Assist |
| | | ID.4 | BEV | RWD/ AWD | MacPherson strut/ Multi-link | Electronic parking brake/Adaptive Cruise Control(ACC)/Autonomous Emergency Braking with Pedestrian Monitoring(Front Assist)/Lane Keeping System(Lane Assist)/Travel Assist |
| | Chery | TIGGO7 PLUS | ICE/ HEV | FWD | MacPherson strut/ Multi-link | Hill Start Assist System (HAC)/Hill-Descent Control System (HDC)/Electronic Automated Parking System (EPB+AUTOHOLD)/Cruise Control System (CCS)/All Speed Range Adaptive Cruise Control (ACC)/Automatic Emergency Braking System (AEB)/Integrated Cruise System (ICA)/Lane Keeping System (LKA) (Lane Centering Control)/Traffic Jam Assist (TJA)/Lane Change Assistance System (LCA)/Fully Automated Parking System (APA) |
| | Great Wall Motor Company Limited Haval (Haval) | Shenshou | ICE | FWD/ AWD | MacPherson strut/ Multi-link | Parking Deceleration Control System (CDP)/Automatic Brake Assist (AEB)/Lane Change Assist (LCA)/Reverse Lateral Brake System (RCTB)/Intelligent Cornering System/Low Speed Emergency Braking (MEB) |

with other areas of performance such as handling in the normal range.

### 2. 2. Suspension Controls

In suspension control systems, electronically controlled damping force adjustment mechanisms, air suspensions, and active suspensions are used in luxury sedans, SUVs, and other high-end vehicles.

As the application of electronically controlled shock absorbers that do not use sensors and shock absorbers that passively change the damping force depending on the amplitude/frequency is expanding to middle and lower class vehicles, the Audi e-tron uses an adaptive air suspension that combines air springs and electronically controlled shock absorbers. The damping force is switched according to the driving and road conditions, and aerodynamic characteristics are improved by adjusting vehicle height when driving on rough roads and lowered vehicle height at high vehicle speeds. Similarly, the Mercedes-Benz S-class is equipped with a hydraulic active suspension that combines an electro-hydraulic unit

with an air suspension. In addition, posture control technology with a mechanism that can steer the rear axle in the same phase has also been adopted.

## 3 Steering

Electric power steering (EPS) has been adopted for the purpose of reducing steering force and improving fuel efficiency. To improve safety performance an increasing number of vehicles are recently being equipped with driving support functions such as a lane departure prevention function that alerts drivers when they stray from the lane and assists steering, pedestrian accident mitigation steering that helps avoid collisions with pedestrians walking on the side of the road, and lane tracing assist (LTA) which recognizes the driving lane of the vehicle and helps the vehicle to stay in the center of the lane to reduce driver fatigue. EPS is indispensable for these functions. Such driving support functions are also installed in large minivans and SUVs, such as Toyota's large Sienna minivan and GM's large Cadillac Escalade SUV. Hydraulic power steering and electro-hydraulic power steering (EHPS) have traditionally been used in these large minivans and SUVs, but with the adoption of various driving support functions, it is conceivable that such steering will be replaced with high-output belt-drive EPS in the future.

In 2021, there were also major changes in steer-by-wire systems, which are expected to evolve technologically on various fronts, such as performance, vehicle package and design. Steer-by-wire, introduced for the first time in the world in the Nissan Skyline in 2014, has a mechanical connection between the steering wheel and tires in the same way as a normal steering system. Under normal conditions, the coupling between the steering force and the steering angle is cut off by disengaging the clutch, and an electrical control law is used to control the steering angle of the tires. As a result, it is possible to provide value such as a highly responsive and accurate steering feel, easy handling with a small amount of steering, and complete blockage of disturbance from the tires. At the same time, the clutch is activated and engaged as a fail-safe when a failure is detected, enabling operation similar to that of a typical steering system. In contrast, the steer-by-wire that will be used in the bZ4X announced by TOYOTA in 2021 does not have a mechanical connection between the steering wheel and tires. In the future, technological competition among automobile manufacturers and EPS manufacturers is expected as individual automakers aim to expand the value they offer by capitalizing on steer-by-wire systems without intermediate shafts or links, to realize steering wheel retraction coordinated with automated driving or the realization of new vehicle packages.

## 4 Brakes

With respect to safety performance, the installation of collision damage mitigation braking systems is becoming mandatory in many countries, starting with Japan. In 2023, the Euro NCAP test mode will add a new evaluation mode for intersections with stricter performance requirements for brakes than those in the regulations. These circumstances is causing the application of high-response ESC and electric service brake actuation to expand.

In the area of environmental performance, the aim of achieving carbon neutrality is leading to an increase in the number of hybrid vehicles (HEVs) and EVs. The fuel efficiency of ICE vehicles is also improving, resulting in a general corresponding decrease in manifold pressure. The need for high responsiveness in terms of safety is also initiating a shift toward applying electric servo brakes instead of negative pressure pumps to counter low negative pressure. For brake emissions, regulations on copper content have already come into effect, but attention has recently been turning toward the effects of brake dust as a source of microscopic dust particles floating in the air that are harmful to the human body. The Particle Measurement Programme (PMP) under WP.29 is considering the standardization of measurement methods for non-exhaust particles such as brake dust and driving reproduction modes, and regulations may be introduced in the future. To reduce such emissions, methods such as coating the disk surface using thermal spraying, and methods to reduce the disk aggressiveness of the friction material are considered. However, there is a trade-off between performance and cost, technical development by automakers is predicted to accelerate in line with future trends in regulations.

In the area of automated driving, the Legend released by Honda in March 2021 was equipped with world's first system compatible with level 3automated driving system that can be used on public roads. That system requires redundant braking performance to ensure a single failure does not result in the loss of automatic pressurization.

Therefore, redundancy was introduced in the pressurization source and control unit by combining the electric servo brakes used in conventional HEVs with ESC, and a power supply system is added to achieve level 3. Similarly, automakers have been proposing a technique to provide redundancy in the increasingly common single unit systems that integrate the pressurization source and ESC by adding a pressurization unit.

## 5 Vehicle Controls

Toyota announced Advanced Drive as an automated driving-related vehicle control technology based on the concept of "advanced driving support that enables drivers and cars to drive together as partners". Advanced Drive incorporates AI technology to detect risks from the surrounding environment and the state of the driver, alert the driver, and achieve two-way communication between the driver and the system, such as giving instructions to the system based on that information. The aim of this system is to achieve smooth, natural driving that is similar to that of a human driving. For example, the Mirai and Lexus LX are equipped with a system that reduces the anxiety felt by the driver by carefully responding to complex environmental changes, such as driving on the right side of the driving lane when overtaking a large vehicle with a wide overall width. The Co-Pilot 1.0 system announced by Mazda monitors the driver's driving operation, head movement, gaze, and other behavior, and performs control such as decelerating and stopping the vehicle without leaving the lane on general roads, or moving off onto the road shoulder on highways if a driver emergency is detected. Furthermore, Co-Pilot 2.0, scheduled to be introduced in 2025, aims to realize more advanced vehicle control, such as searching for a safe place to stop after detecting a driver emergency. Outside Japan, in December 2021 Mercedes-Benz announced the first system in the world to meet the UN-R157 international standard requirements for level 3 automated driving. The system will be installed in the S-class and EQS from the first half of 2022.

With respect to automated driving for commercial vehicles, the government set the goal of "commercializing unmanned autonomous driving transportation services with remote monitoring at 40 locations" by 2025 in the 2021 Public-Private ITS Initiatives & Roadmap. For example, the Tokyo Metropolitan Government announced a project to realize an automated driving transportation service in the Shinjuku area, as well as a project to build a service utilizing automated driving technology in Tokyo Waterfront City. In addition, eight companies—Kawasaki Heavy Industries, ZMP, TIS, Tier IV, Japan Post, Panasonic, Honda, and Rakuten Group—launched the Robot Delivery Association to commercialize delivery services using low-speed, compact automatic delivery robots, and they are promoting the establishment of safety standards and the creation of a certification system. Outside Japan, the Chinese SAIC Motor Co., Ltd. has started field operational tests for a level 4 automated robotaxi in Shanghai, while Volkswagen has also started the operational testing of a level 4 automated commercial vehicle in Munich. In addition, announcements such as the start of automated taxi operations in Dubai by GM Cruise, illustrate the spread of level 4 automated vehicle control technology limited to specific areas.

In terms of other vehicle control technologies, Mitsubishi announced the S-AWC system. This system maximizes the use of all four wheels to achieve driving performance that takes advantage of the characteristics of an electric vehicle by adding brake control for the left and right wheels to the rear wheels instead of only the front wheels. The Honda SH-AWD left/right drive power distribution system is also used in HEVs such as the Legend and NSX. In EVs, the Audi e-tron S is equipped with a motor-based electric torque vectoring mechanism. Vectoring systems using two small motors are expected to become more common in the future due to their high efficiency. Such vehicle control-related initiatives are expected to intensify as research on vehicle dynamics control technology to make human driving more comfortable complements research on control technology for automated driving to realize the prosperous human-centered society advocated for Society 5.0.

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