2022 EMERGING TECHNOLOGY TRENDS
MARKET AND LEGAL INSIGHTS FOR INNOVATORS
What Is Robotics and Autonomous Systems?
“Robotics and autonomous systems,” or RAS, is a complex area with wide-reaching applications. A U.S. congressional report notes that RAS is an accepted term in academia and the science and technology community referring to the physical (robotics) and cognitive (autonomous) aspects of these systems.

In spite of its multiple facets, RAS is considered a single discipline, and this report uses the term in its singular form instead of referring to “robotics” and “autonomous systems” separately. However, RAS can include systems with a robotic element, an autonomous element, or both.

Some overlap exists between RAS and artificial intelligence (AI) due to the focus on autonomous systems. Definitions for AI are more comprehensive (and can vary greatly with various laws and regulations defining AI differently), but generally refer to tasks that would normally require human intelligence. These include visual perception, speech recognition, learning, and decision-making.

Associated Sectors
- Healthcare and Medicine
- Transportation
- Law Enforcement
- Manufacturing
- Agriculture and Food Service
- Aerospace and Defense

RAS is closely associated with transportation, specifically the development of autonomous, or self-driving, vehicles (AVs). Autonomous systems have several other industrial applications as well as end-user applications. In agriculture, for example, unmanned aerial vehicles (UAVs, or drones) are used to monitor crops. In healthcare, applications include surgery assistance, hospital logistics, patient rehabilitation, and long-term care.

Why Is It Important?
The EU’s Rolling Plan for ICT Standardisation 2021 put it succinctly:

The importance of robotics and autonomous systems (RAS) lies in its strong economic contribution as an industrial and commercial activity in its own right and its broad and disruptive socioeconomic impact across diverse market sectors worldwide.
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SECTOR OVERVIEW (CONT’D)

The plan also notes that the potential annual economic impact of advanced robotics (including autonomous and semi-autonomous vehicles) will be on par with mobile internet, advanced materials, or energy markets by 2025.

The economic impact of RAS will be significant for several reasons. Autonomous systems can reduce the likelihood of human error, in both industrial and consumer-facing settings, and by adeptly handling repetitive acts, enable humans to focus on activities requiring uniquely human attributes such as creativity, advanced problem-solving, and empathy. One of the biggest advantages of RAS is the ability to perform tasks in otherwise inaccessible environments, such as internal inspections of nuclear reactors and aero-engines, supporting safety, increasing productivity, and reducing costs.

The AV industry is growing rapidly. In fact, the U.S. Federal Aviation Administration (FAA) expects that by 2023, over 1.6 million consumer (model) drones and 835,000 non-consumer drones will be registered in the United States.

According to Pitchbook, the global market for autonomous trucks could reach $528 million in 2023, then $166.8 billion in 2035. Pitchbook also expects that Level-4 driverless truck sales will increase from 16,500 in 2023 to 1.6 million in 2035.
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ENABLING SCIENCE AND TECHNOLOGY

Advanced Driver-Assistance Systems (ADAS)
ADAS are electronic systems designed to support safe driving. They do so by using an AI function that recognizes objects through various sensors which mimic human senses. These sensors are lidar, radar, cameras, sonar, and GPS.

Applications of ADAS include blind spot detection, traffic sign recognition, automatic emergency braking, forward collision warning, pedestrian detection/avoidance, adaptive cruise control, traction control, and lane departure warning/correction. Deloitte expects 8% of all new vehicles in the United States will have ADAS level 4 or 5 (highly or fully automated; limited, though, to specific urban areas and routes) by 2035.

Vehicle-to-Everything (V2X)
V2X is technology that allows vehicles to communicate with people and objects in the ecosystem, including other vehicles, transportation infrastructure, and government actors like law enforcement or departments of transportation. The U.S. Department of Transportation has been involved in several V2X activities and has stated, “V2X technologies have the potential for significant transportation safety and mobility benefits, both on their own and as complementary technologies when combined with in-vehicle sensors supporting the integration of automated vehicles and other innovative applications.” This is a priority area for the department, which aims to ensure American leadership in automated vehicle technologies.

3D Cuboid Annotation
3D cuboid annotation is a technique that, as the name suggests, identifies objects in three dimensions, providing more precise and accurate recognition of objects than two-dimensional annotation, because it depicts length, width, and depth. This is an important underlying technology in AVs because they must be able to precisely detect objects and navigate around them.

Hyperspectral Imaging (HSI)
HSI refers to combining digital imaging and spectroscopy to capture and process an image at high wavelengths. Color cameras have the ability to capture the intensity of light in one of three primary colors (red, blue, and green), whereas HSI splits the image into tens or hundreds of colors, enabling a vastly expanded range of features and services.

HSI is an emerging area of focus in the UAV industry as it is relatively new remote sensing technology. UAV-hyperspectral systems provide solutions of resolution and signal-to-noise ratio that were not possible with the traditional satellite and airborne platforms. These systems could help tackle various challenges related to ocean, agriculture, forestry, minerals, and environmental protection.

SEVERAL MAJOR TECH COMPANIES AND AUTO MANUFACTURERS ARE DEPLOYING FLEETS OF ROBOTAXIS IN THE UNITED STATES AND GLOBALLY, AND GOVERNMENTS ARE RESPONDING BY CREATING AN INCREASINGLY FAVORABLE ENVIRONMENT.
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SECTOR AND INDUSTRY SIGNALS

Automakers, Tech Companies Collaborate on Self-Driving Technology
In March 2018, Jaguar Land Rover and Waymo revealed their electric Jaguar I-Pace vehicle, and later mentioned an agreement to design and engineer 20,000 self-driving Jaguar I-Pace vehicles. Two years later, in March 2020, Waymo unveiled details about its fifth-generation self-driving sensors.

In January 2021, General Motors and Cruise partnered with Microsoft to advance the commercialization of self-driving vehicles. The companies will utilize Azure, Microsoft’s cloud and edge computing platform, for its AV solutions.

In May 2021, Volkswagen (VM) stated that it will start testing its electric ID Buzz vans in Germany. Hardware and software for the vehicles are being developed by Argo AI, a startup backed by Ford and VW.

Urban Ground Mobility Among First Commercial Applications of AVs, Urban Air Mobility Could Follow
In June 2021, Waymo raised $2.5 billion and increased the company’s total fundraising to more than $5.7 billion. In October 2020, Waymo commercialized its driverless robotaxi in Phoenix to the public, making it the first company to do so.

In June 2021, Cruise received a $5 billion line of credit from General Motors to bring Cruise’s robotaxis to the roads. By 2023, Cruise robotaxis will be entering its first international market, Dubai.

In the U.S. market, both Waymo and Cruise have applied for permits to charge passengers for rides in the San Francisco area, which will put them in direct competition. However, as of June 2021, only Cruise had received authorization to charge for driverless rides.

On a parallel track, Zoox, an Amazon-acquired self-driving vehicle startup, unveiled its robotaxi in December 2020. And, in the same month, Motional, the Aptiv-Hyundai joint venture, announced a plan to launch robotaxis in major U.S. cities by 2023 through partnership with the Lyft network.

Together, these trends suggest that robotaxis are among the first significant commercial applications of autonomous vehicles. Several major tech companies and auto manufacturers are deploying fleets of robotaxis in the United States and globally, and governments are responding by creating an increasingly favorable environment. In May 2021, Germany became the first major economy to legalize the commercial use of robotaxis, and other countries will likely follow.

Urban air mobility (UAM) has existed as a concept for decades, but breakthroughs in autonomous technology have regulators and aircraft manufacturers actively developing vehicles and frameworks to make UAM a reality. In the United States, the FAA released a concept of operations for UAM in June 2020, and it is working with NASA to develop an advanced air mobility system that moves people and cargo between local, regional, intraregional, and urban places previously not served.
or underserved by aviation using revolutionary new aircraft. Other jurisdictions, such as the EU, are also planning for UAM. Major aircraft and aerospace manufacturers, including Boeing, are developing new UAM vehicles.

**AVs Support Shipping and Delivery Businesses, Restaurants, Grocers**

In December 2020, Nuro became the first autonomous delivery startup to receive permission from California regulators to operate a driverless delivery service, and in June 2021, FedEx entered into a multiyear, multiphase agreement with Nuro. FedEx will be testing different uses of Nuro’s AVs such as multistop and appointment-based deliveries.

In addition, FedEx is using delivery bot “Roxo” for on-demand, same-day deliveries in Plano, Texas. The bot was developed in collaboration with DEKA Research and Development Corp. UPS has likewise ordered Generation 2 electric delivery vehicles from British startup Arrival, signaling strong interest among shipping and delivery businesses.

Meanwhile, Nuro has also partnered with Kroger and Domino’s to start delivering groceries and pizza in the Houston area using AVs. Other retailers and restaurants might follow, as they seek to differentiate their services through convenient and affordable deliveries.

**Autonomous Ships, Drones Deployed for Oceanic Observations**

In May 2020, the Mayflower Autonomous Ship, powered by AI and solar energy and capable of monitoring climate change, ocean pollution, and marine-life conservation, was unveiled, with ProMare and IBM acting as lead technology partners and lead scientific partners on the project.

Rolls-Royce is working on autonomous shipping technology for its Advanced Autonomous Waterborne Applications Initiative, and has received 6.6 million euros in funding from the Finnish Funding Agency for Technology and Innovation (TEKES). Its self-driving ship is expected to launch by 2025.

**Saildrone** has developed an autonomous surface vehicle, powered by solar and wind energies, that currently assists in the collection of marine data in various environments and climates. Their technology provides insights on areas that include maritime security, mapping, global fishing, carbon cycling, and weather forecasting. Saildrone claims to be building the world’s largest high-resolution ocean data sets, which would have potential commercial and governmental applications.

In March 2021, the U.S. Department of Defense (DOD) chose AeroVironment to produce Blackwing 10C electro-optic and infrared-equipped UAVs to support the Submarine-Launched Unmanned Aerial System (SLUAS) program. The company’s 120 Blackwing drones will be used by the U.S. Navy with underwater drone carriers.

**Self-Driving Truck Market Expected to Grow**

According to PitchBook, the global market for autonomous trucks could reach $528 million in 2023, then $166.8 billion in 2035. PitchBook also expects that level-4 driverless truck sales will increase from 16,500 in 2023 to 1.6 million in 2035. As such, their forecast is that autonomous trucks will “comprise the majority of global truck sales.”

In January 2021, PACCAR entered a partnership with autonomous vehicle startup Aurora Innovation Inc. to develop self-driving heavy-duty trucks. Under the agreement, PACCAR’s Peterbilt and Kenworth brand trucks will be developed, tested, and prepared as autonomous versions. The focus of the PACCAR-Aurora deal is to build a truck with two separate self-driving systems, each of which can autonomously operate the steering, brakes, and other parts of the truck and can serve as a backup with minimal to no human assistance.
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IMPACT

Economic
Because autonomous vehicles have such diverse applications as taxis, delivery vehicles, public transit, and consumer goods, they represent a significant new market. Industry consultant Steer Group produced a detailed economic analysis that expects investment in AV delivery services alone to reach $1.1 trillion globally by 2035. According to Steer, between 2025 and 2035, the U.S. economy potentially could generate a total value of $4.1 trillion from direct economic impacts that include road safety and time savings.

Social
RAS will disrupt the employment market, particularly in economies that already have sizable delivery/trucking sectors as the nature of the roles in the industries evolves. Demand for drivers is expected to decline over time, while new jobs are created in programming, system maintenance, and fleet management. In the United States, the number of truck drivers reached an all-time high in 2019, at more than 3.5 million people based on census data. Thousands of other workers are represented in the U.S. Bureau of Labor Statistics’ category for “Transportation and Material Moving Occupations,” including taxi drivers and chauffeurs, shuttle drivers, bus drivers, and parking attendants.

Environmental
Several studies have been commissioned on the potential effects of autonomous vehicles upon greenhouse gas emissions, but these effects are uncertain given the many other social and economic variables (the number of vehicles on the road, whether they are used as private or public transportation, the availability of parking spaces and amount of time spent searching for them, and so on). A key question dividing industry leaders and researchers is what percentage of AVs will be fully electric, hybrid gas-electric, or fully gas powered. If most AVs will be electric, this could potentially reduce their carbon footprint—depending on how the electricity is generated.

Policy
The Congressional Research Service reported in April 2021 that comprehensive legislation on autonomous vehicles had not yet been introduced in the 117th Congress. Previous attempts at passing or enacting legislation have been unsuccessful.

One of the biggest advantages of RAS is the ability to perform tasks in otherwise inaccessible environments, such as internal inspections of nuclear reactors and aero-engines, supporting safety, increasing productivity, and reducing costs.

RAS can yield potential social advantages as well—safer roads, decreased traffic congestion, and better urban planning and infrastructure development. However, the U.S. Department of Transportation’s National Highway Traffic Safety Administration (NHTSA) found that 94% of serious crashes are attributable to human error, and automated vehicles have the potential to “remove human error from the crash equation.” This would be a significant benefit, as motor vehicle crashes in the United States cause more than 35,000 deaths each year.

However, the U.S. Department of Transportation developed a comprehensive plan for automated vehicles in January 2021, with goals to promote transparency and collaboration, modernize regulations, and prepare the transportation system through evaluation and improvements.
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LEGAL IMPLICATIONS

OUTLOOK

Transactions and Financing | Companies Respond to Technical Challenges, Tightening Funding Environment Through M&A and Partnerships

Venture capital in mobility reached a high of $8.4 billion in 2020, up 33% from the previous year. Within the sector, autonomous vehicles attracted a significant share of funding. A few notable fundraising rounds took place in 2021, including Cruise’s multibillion-dollar round in January. The General Motors self-driving car unit now has a valuation that matches Alphabet-owned Waymo, at $30 billion.

Special purpose acquisition companies (SPACs) likewise are investing in AV technology, as shown by mergers with light detection and ranging companies Aeva, Luminar, Ouster, and Innoviz. The first initial public offering (IPO) of an AV company, TuSimple, took place in April 2021. The company raised over $1.3 billion on the Nasdaq exchange. This was followed by self-driving vehicle company Aurora, which went public via a merger with a SPAC that gave it a valuation of $13 billion.

This fundraising activity comes at a time when the AV industry is facing ongoing technical challenges, characterized by Waymo’s CEO as an “extraordinary grind.” As noted by the Center for Automotive Research, most announced deployments did not occur by their target dates in 2017-2019, and the ongoing COVID-19 pandemic caused additional delays.

Some companies have responded to production challenges through M&A and corporate partnerships, such as Cruise’s acquisition of its smaller competitor Voyage, that, according to PitchBook, is “another sign that a handful of leading players are starting to dominate the autonomous vehicle race.”

Privacy | Importance of Data Security Grows as Vehicle Data Collection Increases

Vehicles—autonomous or not—are collecting a growing amount of user data, which raises implications for privacy and data security. Manufacturers must ensure that user data is secure and that user privacy is protected. Additionally, there are questions about how long they must continue to issue security updates. A manufacturer might decide, based on commercial reasons, when to decommission a vehicle, but this decision may be subject to limits in jurisdictions that have “repairability” laws.

Currently, the NHTSA is working with the Federal Trade Commission (FTC) to protect user data. The NHTSA considers the privacy implications of its safety regulations and voluntary guidance, whereas the FTC is the primary U.S. federal agency responsible for protecting consumer privacy and data security. As AVs become more common, data collection likely will increase, so this is an area to monitor for any changes in data privacy and security rules.

Some jurisdictions also have limits on where user data may be stored. China recently enacted rules requiring car manufacturers to store driver data in China, whereas the previous practice consisted of sending the data to other countries (including the United States) for analysis. The new rules have implications for the research, development, deployment, and distribution processes in AV manufacturing.
LITIGATION DEVELOPMENTS

GM Alleges Ford Co-opted Brand of Self-Driving Car Unit
The lawsuit alleges Ford’s “BlueCruise” brand of autonomous vehicles misappropriates the trademark of GM’s majority-owned subsidiary Cruise LLC, and constitutes both trademark infringement and unfair competition. GM claims that Ford’s car brand causes confusion in the market because GM had already invested in the “Super Cruise” brand for its semi-autonomous driving technology.

Investors Sue Velodyne Lidar Over Alleged Disclosure Failures
Laser-sensing tech company Velodyne Lidar is facing a proposed investor class action lawsuit alleging it made materially false and misleading statements about the company’s business, operations, and compliance. The lawsuit names the company’s CEO, CFO, and five directors as defendants, accusing them of breach of fiduciary duty, unjust enrichment, and abuse of control, among other claims.

PATENT TRENDS AND OUTLOOK

Autonomous Vehicle Innovation Is Result of Balancing IP, Open-Source Collaboration
Intellectual property protection is important in encouraging innovation in the autonomous vehicle sector, and patents are particularly crucial. Accordingly, the number of patent filings in the AV space globally is on the rise, as shown by the following chart.

The data, curated by PatentSight, shows that Toyota Motors is currently the world’s largest owner of autonomous driving patents.

Another industry source suggests Waymo took an early lead on patent filings in 2013 and has been in the lead ever since. The source further suggests that Waymo’s objective is to develop a platform that works with all vehicles equally, which is why it has not prioritized partnerships with original equipment manufacturers.

At the same time, two industry experts interviewed by the World Intellectual Property Organization propose that "innovation...only happens when this knowledge and know-how is leveraged and made available to Mobility Clubs and other independent operators to build on." Accordingly, they support open-source collaboration, but in a "controlled and regulated way."

There are already several options for open-source automated driving software, including Baidu’s Apollo platform.
Tech Companies Represent Both Threat, Opportunity to Incumbent Auto Makers

From one perspective, automakers are threatened by tech companies, because the latter would create the most value added in autonomous vehicles and thus generate the most profits. This represents a direct threat to auto manufacturers as they face “commoditization” of their core competency: making and supplying cars.

From another perspective, tech companies and auto makers face a partnership opportunity. It is likely that both perspectives have merit, and in response, some auto makers have partnered with tech companies to develop automated driving technologies together.
The transportation sector is one of several areas in which Perkins Coie’s Technology Transactions & Privacy attorneys counsel clients driving innovation. Our team represents some of the key players in the sector, advising companies that design connected information technology along with clean sustainable technology, like electric vehicle infrastructure. Our team has the experience and depth to provide guidance on the full range of legal issues that come into play during the conception, development, and implementation of new autonomous systems products or services. Anticipating and guarding against legal risks facing our clients, we keep in-house legal teams and their business units compliant with U.S. and international laws and regulations by helping them circumvent problems while ensuring they remain up to date on new autonomous vehicle system regulations.
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