2022 EMERGING TECHNOLOGY TRENDS

MARKET AND LEGAL INSIGHTS FOR INNOVATORS

PERKINSCOIE

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TRANSFORMATIONAL TECHNOLOGY: A LOOK AHEAD

Technology—and the innovative deployment of new technologies—has increasingly shaped the way we live and interact with the environment. The following report examines some of the key developments, trends, and implications of 10 emerging and nascent technologies that are not only disrupting today's markets, but are also influencing and shaping those of tomorrow.

- Artificial Intelligence, Machine Learning & Quantum Computing
- Cloud Computing & Distributed Infrastructure
- Digital Media & Entertainment
- Greentech
- Healthtech & Medtech

- Mobile Wireless Technology
- Privacy & Security
- Retail & E-Commerce
- Robotics & Autonomous Systems
- Spacetech

Disruption

Over the past two decades, new business models have emerged as a result of the proliferation and evolution of technologies and transformation, disrupting traditional ways of working and enabling the development of new products and services. While still in their early stages, these disruptions are ongoing.

The Pandemic Has Accelerated the Pace of Change

COVID-19 and the subsequent response measures have fast-tracked the transformation and adoption of innovative technology. Since the pandemic created, exacerbated, or revealed challenges that threatened individuals' health and livelihoods, technology companies set out to invent better solutions that address these problems now and into the future.

The Convergence of Advanced Technologies Will Continue to Drive Growth

As advanced technologies expand and evolve, they are also converging. The combination of technologies once considered separate is expected to foster growth and economic development in the next decade. This includes the disruption of existing business models and the creation of entirely new business categories. New technologies are designed to make businesses safer and more secure, while reducing costs and environmental impact.

Understanding the Implications—for Industry, Society, and the Law

Innovative technologies also create unique challenges—including legal and regulatory requirements—that require foresight and preparation. Breakthrough developments in technology are helping to grow our economy while also reshaping society and the environment. Each section of this report touches on key areas of technological development, industry signals, broader societal impacts, and the related legal implications.

AI, MACHINE LEARNING & QUANTUM COMPUTING

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AI, MACHINE LEARNING & QUANTUM COMPUTING

Economists and commentators are split on the economic impact of AI. On the one hand, the technology could add as much as $13 trillion to the global economy by 2030, representing a significant source of growth for gross domestic product. On the other hand, the purpose of deploying AI is typically to reduce expenses, which include the cost of labor.

SECTOR OVERVIEW

What Are AI, ML, and Quantum Computing?

Artificial intelligence (AI) is the ability of machines to mimic human intelligence to learn, reason, and perceive. AI is divided into two categories: narrow and general. Narrow AI refers to the AI systems that are developed within a narrow domain of knowledge, such as facial recognition and natural language processing. These narrow systems cannot operate or extrapolate outside the narrow domain knowledge in which they are developed.

General AI is an AI system capable of artificial human equivalent intelligence, with the ability to think, learn, plan, and act when faced with novel problems. It is not limited to a narrow domain of knowledge. Machines do not yet have an intelligence equivalent to that of humans, so general AI is currently a theoretical form of technology.

Machine learning (ML) involves the capability of machines to "learn from data rather than through explicit programming," according to IBM. ML techniques are often used in AI systems.

Quantum computing utilizes the phenomena of quantum mechanics to process information in qubits, based on quantum properties of superposition and entanglement.

Because of these properties, quantum computers may prove far more powerful than conventional computers. They operate in multiple states all at once rather than using the binary language of zeros and ones, and this gives them the ability to solve complex problems instead of relying on binary calculations.

Associated Sectors

- Agriculture
- Financial Services
- Digital Media and Entertainment
- Cloud Technology Services
- Transportation
- Advertising
- Energy
- Telecom (including 5G Wireless)

Why Is AI Important?

Artificial intelligence imitates human capabilities effectively, efficiently, and at a low cost, thus representing a labor-saving technology. AI's reliability could also reduce losses and errors in many settings, from industrial applications to consumer technology. For example, if self-driving cars become consistently safer than human-driven cars, the owners of those cars may pay less in auto insurance premiums.

ENABLING SCIENCE AND TECHNOLOGY

Deep Learning

Deep learning is a subset of machine learning that uses deep neural network architectures. Neural networks are interconnected processors which work together to solve problems. They were inspired by the structure and functioning of neurons in the human brain. A neural network can be organized to have hidden layers, and as each layer of the network fires it passes a more tangible view of the data to the next layer. Deep networks may have more than 150 hidden layers to optimize and refine accuracy. Deep learning's various network architectures, such as recurrent neural networks, convolutional neural networks, and brief neural networks, have applications in speech recognition, computer vision, and bioinformatics, among many other fields. Deep learning enhances analytical and physical tasks without human intervention, thereby supporting autonomous systems.

Quantum AI

Quantum AI represents the frontier of AI development. It is based on the concept of building quantum algorithms for computational tasks in AI and ML. Although currently in its early stages, quantum AI is expected to be the next generation of AI. In 2021, Google established its Quantum AI lab in Santa Barbara, California, where it is aiming to build a "useful, error-corrected quantum computer" within 10 years.

As mentioned, the ability of quantum technology to operate in superposed and entangled states is what makes it much more powerful than binary code. Applying quantum technology to AI opens the door to several applications that are beyond the capabilities of existing computers.

Cognitive Computing

Cognitive computing is a combination of computer science and cognitive science designed to simulate the human thought process. It overlaps with AI and involves many of the same underlying technologies. For example, to solve complex problems cognitive applications may use data mining, visual recognition, and natural language processing.

Early adopters are deploying the technology for customer acquisition, customer engagement, and customer service, among other uses.

TO MITIGATE HARMFUL BIAS, THE NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY (NIST) PROPOSED AN APPROACH THAT MANAGES BIAS THROUGH THREE STAGES (PRE-DESIGN, DESIGN AND DEVELOPMENT, AND DEPLOYMENT) MODELED ON THE AI DEVELOPMENT LIFE CYCLE.

SECTOR AND INDUSTRY SIGNALS

NASA 'Tipping Point' Program to Use AI-Driven Analytics

Among other objectives, NASA's "Tipping Point" program aims to develop robots that can navigate the moon's surface without human intervention. Bosch will support the program through "AIoT"—a combination of AI and Internet of Things (IoT) that refers to intelligent processing capabilities. Bosch's focus is on connecting devices to acquire data, process it, and use it through AI, with the ultimate goal of creating a robot that can safely and reliably navigate on the moon.

Apple Acquires AI Startups to Improve Speech, Image Recognition

In May 2020, Apple took a step toward advancing its speech recognition software through the purchase of ML startup Inductiv. A few months earlier, Apple also acquired Xnor.ai to use its image recognition technology for security applications. Other notable AI and data company acquisitions by Apple in recent years include Tuplejump, Laserlike, Turi, and Perception.
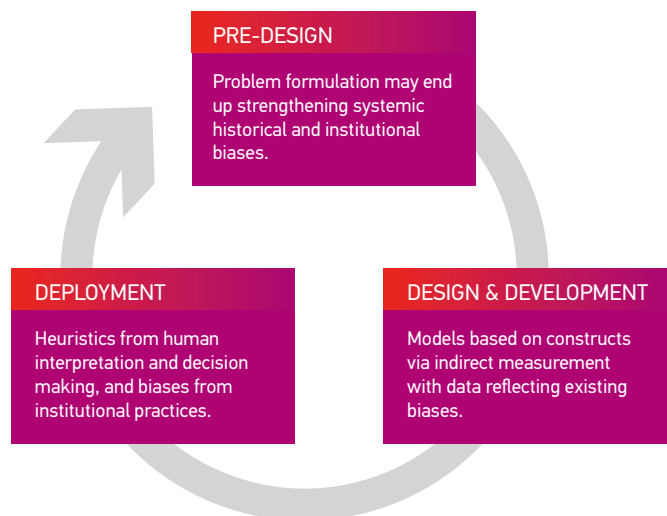
Growth Prospects of Industrial AI Strengthen

Industrial AI helps automate industrial processes with new technologies for purposes that include supply chain optimization, crop maximization, and predictive analysis. PitchBook expected that in 2021, companies would spend around $9.9 billion on industrial AI, and that the market for industrial AI will increase at a 24.1% compound annual growth rate to reach $18.9 billion in 2024. A few recent innovations in the industrial AI sector include McFly's intelligent agricultural monitoring drone and GAGO's large-scale application of AI technology in crop production.

NIST Proposes New Methods to Identify and Manage Harmful AI Biases

In June 2021, the National Institute of Standards and Technology (NIST) issued a proposal to advance methods for understanding and reducing harmful forms of AI bias. Citing the International Organization for Standardization, NIST notes the definition of bias in statistical terms is "the degree to which a reference value deviates from the truth" and cautions that not

all forms of bias are negative. Bias can either contribute to, or mitigate, harmful or discriminatory outcomes.

To mitigate harmful bias, NIST proposed an approach that manages bias through three stages (pre-design, design and development, and deployment) modeled on the AI development life cycle. NIST cautions that bias can occur in each of these stages, as shown by the following chart.

PRE-DESIGN
Problem formulation may end up strengthening systemic historical and institutional biases.

DEPLOYMENT
Heuristics from human interpretation and decision making, and biases from institutional practices.

DESIGN & DEVELOPMENT
Models based on constructs via indirect measurement with data reflecting existing biases.

In March 2021, five U.S. financial regulators issued a request for information on how banks use AI. In addition, the U.S. Federal Trade Commission (FTC) released guidelines on truth, fairness, and equity in AI. In May, Sen. Edward Markey and Rep. Doris Matsui introduced the Algorithmic Justice and Online Platform Transparency Act of 2021. Meanwhile, Sen. Ron Wyden planned to reintroduce the Algorithmic Accountability Act in 2021. Internationally, the European Commission proposed new rules on AI in April.

All current and proposed AI laws have three elements in common: (1) an obligation to conduct risk assessments and to document how risks are mitigated or resolved; (2) accountability and independence, meaning the personnel who test and validate the AI should be different from those who originally developed it, and the testers should have different

SECTOR AND INDUSTRY SIGNALS (CONT'D)

incentives than the developers; and (3) a duty to continuously review AI systems.

There are industry-led solutions to combating AI bias as well. One of these is the use of synthetic data, which replicates real-world statistical components without variables that could produce harmful outcomes. This form of desirable (nonharmful) data generation bias is created by adding either synthetic or redundant data samples to a data set.

Retail Industry Among Top Supporters of AI

In 2020, International Data Corporation (IDC) identified retail and banking as the two industries that spend the most on AI solutions globally. At the time, IDC said retailers focused their investments on improving the customer experience via chatbots and recommendation engines, while banks prioritized fraud analysis and investigation as well as program advisors and recommendation systems.

More recently, IDC updated its findings to note that retailers will overtake banks as the top spenders on AI. This is because retailers are deploying AI in a wider range of applications, including inventory management. Two early adopters are Home Depot and Wayfair. Home Depot is in the early stages of using ML to spot products that need to be restocked on store shelves. Wayfair relies heavily on computer vision to match shoppers' searches with the items they're looking to buy. Other notable developments include Walmart's partnership with Adobe to offer AI-powered substitutions, pickup, and delivery. Target invested in AI to improve recommendations and offer a virtual product-trying application. Costco and other grocers

have leveraged ML to keep track of fresh food inventory and reduce waste.

Government Acquisitions of AI Technologies

The U.S. Department of Defense (DOD) intends to speed up its AI acquisition through a rapid procurement process. The project, called Tradewind, is intended to help the Joint Artificial Intelligence Center (JAIC) find use cases for AI throughout the military and acquire the right algorithms. As we have discussed elsewhere, the DOD policy seeks to promote "Responsible AI" in defense procurements, which reaffirms the department's ethical principles. Reportedly, at least nine projects worth approximately $74 million are in the program's pipeline.

Efforts are underway to deploy AI elsewhere in the federal government as well. The leaders of the U.S. Senate Homeland Security and Government Affairs Committee proposed the Artificial Intelligence Training for the Acquisition Workforce Act, which, if adopted, would set up a training program for federal workers to learn more about AI technology.

Healthcare-AI Subsector Sees Growing Number of Applications

One of the main applications of AI in the healthcare industry is drug and compound development, because it considerably reduces the time and money needed to market new drugs and represents a significant competitive advantage. Other applications include clinical decision support, genetic analytics, healthcare administration, and personal health.

THERE ARE ONGOING INDUSTRY-LED SOLUTIONS TO COMBATING AI BIAS. ONE OF THESE IS THE USE OF SYNTHETIC DATA, WHICH REPLICATES REAL-WORLD STATISTICAL COMPONENTS WITHOUT VARIABLES THAT COULD PRODUCE HARMFUL OUTCOMES.

IMPACT

Economic

Economists and commentators are split on the economic impact of AI. On the one hand, the technology could add as much as $13 trillion to the global economy by 2030, representing a significant source of growth for gross domestic product. On the other hand, the purpose of deploying AI is typically to reduce expenses, which include the cost of labor. As pointed out by the McKinsey Global Institute, AI reduces employer demand for jobs that involve repetitive tasks and puts downward pressure on wages. This trend widens the gap between countries, companies, and workers.

Social

Microsoft-funded research suggests that on a global level, low- and middle-income countries will be more exposed to the negative impacts of AI, such as automation. This could increase social inequalities and political instability in those countries.

Another issue is the perpetuation of social inequities through algorithmic discrimination. As discussed above, AIs can produce both harmful and beneficial forms of bias. Knowing how to identify and mitigate harmful bias, and how to use synthetic data, will produce fairer results.

Environmental

AI is helping countries meet their sustainable development goals (SDGs). For example, climate modeling that incorporates AI is supporting climate action, which is SDG 13. NASA, IBM, and Microsoft continue to use AI and ML to improve the efficiency of climate models. PwC proposed a timeline outlining the different ways in which AI could support the environment.

Policy

The U.S. government adopted a new defense bill (the National Defense Authorization Act for Fiscal Year 2021) and earmarked $6.4 billion of government funding to AI initiatives. The legislation provides for the creation of a National Artificial Intelligence Initiative Office, which will be led by the White House. The office's mission is to serve as a point of contact for federal departments and agencies that use AI.

AI FOR THE EARTH GAME CHANGERS: INDICATIVE TIMELINE
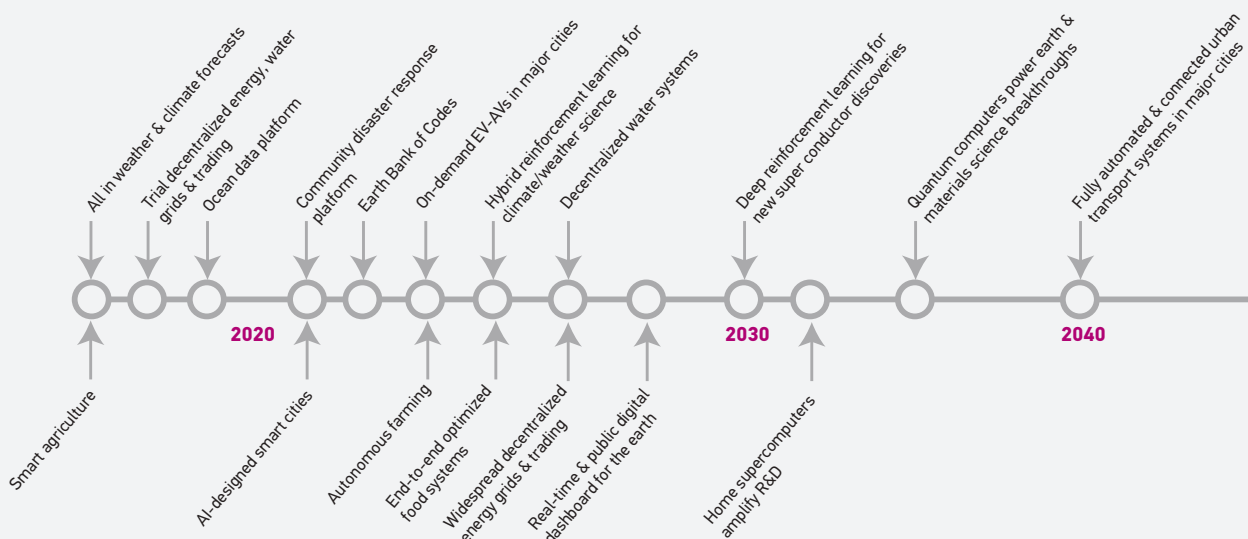

Source: PWC Research

LEGAL IMPLICATIONS

OUTLOOK

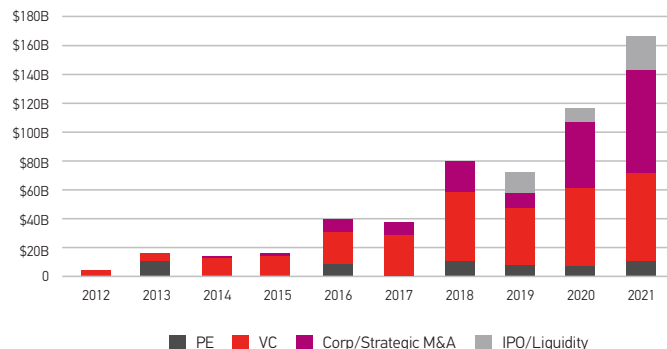### Transactions | AI and ML Investment Values Increasing

Venture capital and private equity investment in artificial intelligence and machine learning technology companies continues to rise in value, even as deal volumes have remained relatively flat over the past three years. As the space becomes more mature, the levels of strategic M&A and public listings have risen.

The pace of consolidation moderated in 2020, following five years of growing M&A deal volume, although the numbers through the end of July 2021 suggest that the pace may be picking up again. The largest tech companies have been active in acquiring AI and ML companies, particularly those that focus on AI core software, natural language processing, and consumer AI.

INVESTMENTS OVER TIME
Deal Count

Legend: PE | VC | Corp/Strategic M&A | IPO/Liquidity
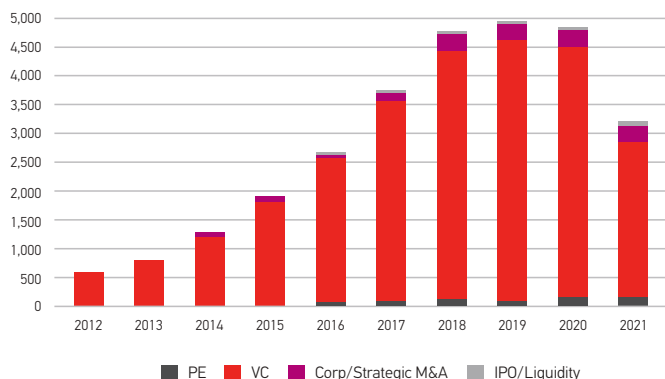
Data retrieved 29 July 2021

Source: PitchBook Data

INVESTMENTS OVER TIME
Capital Raised

Legend: PE | VC | Corp/Strategic M&A | IPO/Liquidity

AI MERGERS & ACQUISITION TRENDS
Deal Count

Legend: IPO | Buyout | Merger/Acquisition | Secondary Buyout
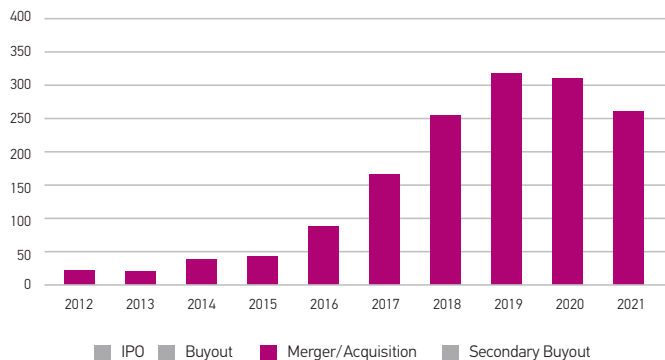
Source: PitchBook Data

LEGAL IMPLICATIONS (CONT'D)

Transactions | Interest in Quantum Computing Rising Sharply

The ranks of new quantum technology–focused companies began to rise steadily in 2014. Since then, investment and M&A activity in the quantum computing space have been accelerating, particularly over the last two years. Deal volumes and values are smaller than those for AI and ML, reflecting that it is a nascent subsector.

NUMBER OF QUANTUM-COMPUTING (QC) FOUNDINGS AND INVESTMENT VOLUME BY YEAR (not exhaustive)

< 10%
of total investment allocated outside of hardware players

■ Volume of PE/VC Investment, $ million   ■ Number[1] of QC Start-ups Founded

[1] Number quoted only until 2018, since start-ups with a later found date may still be in "stealth" mode (i.e., have not disclosed their activity publicly).
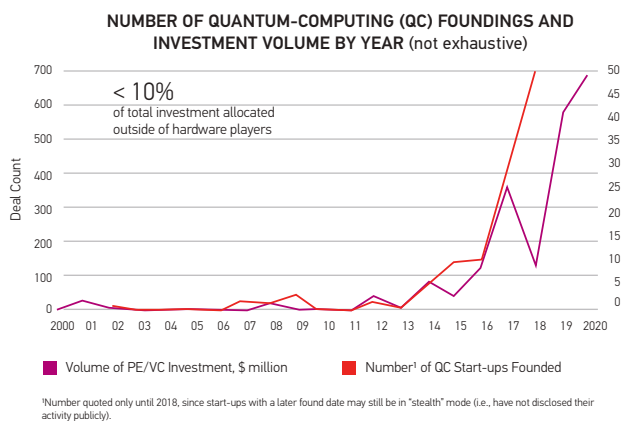
Source: Crunchbase, PitchBook, McKinsey analysis

Litigation | Alleged Biases in Decision Support and Collection of Confidential Information Subjects of Recent AI Litigation

As AI technology becomes more deeply embedded in a wide variety of tools to support decision-making, reports have emerged alleging that the algorithms, data, and models used in these systems may demonstrate biases. There has been an increase in lawsuits against companies and organizations that use "black box" AI tools to provide guidance for decisions related to areas such as employment, consumer credit, or criminal justice.

Social media and other digital media platforms have relied heavily on AI technology to help moderate user-generated content. Conflicts regarding social media companies' actions in deleting posts and suspending or banning users are on the rise generally, and the use of AI to enforce these policies is

also coming under fire. Critics suggest that AI is being used to suppress legitimate speech, and also to suppress speech from specific racial, ethnic, gender, or political sources.

Automated voice assistants incorporate AI in their systems, including extensive use of recorded data to further train the AIs. However, the collection and use of that data—as well as the conditions and extent of what is actually collected—have prompted lawsuits. Further, when the information collected includes data that is confidential or otherwise protected by law, such as conversations between patients and medical professionals, the risk of litigation increases.

Privacy | Datasets Needed for AI, ML Raise Privacy Implications

Advanced machine learning is only possible with significant amounts of data—often user data that includes personally identifiable information. Both the collection and the use of this data raise compliance and ethical risks that companies may need to address.

One of the main risks is the use of data for purposes that were not anticipated at the time the data was collected. This may occur when companies purchase or leverage third-party datasets to train their algorithms. From a commercial perspective, the key is to provide appropriate notice, and secure appropriate consent, when collecting the personal information—or ensure that a supplier has done the same, even though the AI supply chain is increasingly complex.

Regulatory | US Financial Services Regulators Looking Closely at AI and ML, While FTC Issues New AI Guidelines

A recent notice in the Federal Register suggests that regulators are seeking to update rules concerning the use of AI and ML in financial services. In March 2021, a collection of U.S. federal bank and financial services regulators, including the U.S. Department of the Treasury (DOT), the Board of Governors of the Federal Reserve, the Federal Deposit Insurance Corporation (FDIC), the FTC's Bureau of Consumer Protection,

LEGAL IMPLICATIONS (CONT'D)

and the National Credit Union Administration (NCUA) issued a joint request for information on how banks use AI and ML. The regulators note that they are seeking to determine whether any clarifications in their rules would be helpful to ensure AI is used in a "safe and sound manner."

Meanwhile, the FTC released new guidelines on "truth, fairness, and equity" in AI in April 2021. These guidelines define unfairness as any act that "causes more harm than good," suggesting the agency will take a more active approach to addressing instances in which AI systems could potentially introduce racial or other illegal biases into consumer and employment decisions.

LITIGATION DEVELOPMENTS

US Immigration and Customs Enforcement (ICE) Faces Class Action Over Use of Automated Risk Assessment Tool

The New York Civil Liberties Union filed a class action against ICE over the government agency's use of the Risk Classification Assessment Tool, an automated system that makes recommendations regarding whether people awaiting an immigration hearing should be held or released. The plaintiffs in the suit, filed in the U.S. District Court for the Southern District of New York, charge that the system has been manipulated to recommend detention in nearly every case, improperly denying due process. *Jose L. Velesaca v. Chad Wolf et al., case number 1:20-cv-0180, in the U.S. District Court for the Southern District of New York.*

PATENT TRENDS AND OUTLOOK

International Developments Push the Debate Over Whether an AI Can Be an Inventor

A July 2021 patent granted in South Africa is the first in the world to recognize an AI system, known as DABUS in this case, as the inventor—while granting patent ownership to DABUS' owner, Stephen Thaler. The same patent is the subject of legal proceedings in the United States, the U.K., and elsewhere in

Europe, where patent authorities had previously refused to grant patents if an AI was listed as the inventor.

Other developments indicate views might be shifting in those jurisdictions, however. For example, in 2021, the U.K. Intellectual Property Office (UKIPO) released a report on consultations it had conducted regarding the impact of AI on intellectual property. Included in the report was the suggestion that UKIPO could eventually seek legislation allowing AI tools to be recognized as inventors. According to a UKIPO official, "We recognise that AI systems have an increasing impact on the innovation process. We want to ensure the intellectual property systems support and incentivise AI-generated innovation."

COPYRIGHT ISSUES

Use of Datasets for Training ML Models Raises Copyright Issues

Machine learning requires access to large amounts of quality data to train ML models. Such training involves making a temporary copy of the training data, which raises copyright issues if the data includes copyrighted materials or datasets. Some countries have addressed this by adopting text and data mining (TDM) exceptions that allow for certain uses of copyrighted material for training machine learning models. The United States, however, has not adopted text and data mining exceptions, and companies here must rely on the fair use doctrine to determine whether such use is permissible without a license. Although there are no relevant decisions yet in AI, there are cases in other areas (such as search engines and the reverse engineering of video games) that are arguably analogous and support an argument for fair use, at least where intermediate copies are made merely for training models. However, fair use is a very fact-specific defense, which makes it hard to rely on and requires a detailed fact analysis of a particular use.

Some experts have speculated that the applicability of the fair use defense could turn on factors such as whether the model is utilizing expressive elements of the data, rather than factual ones, the nature of the output of the model, and to what

LEGAL IMPLICATIONS (CONT'D)

extent the purpose of the model is similar to the expression contained in the training data. But there is little guidance. There is concern that the uncertainty around the legality of using copyrighted materials to train machine learning models may make it difficult for AI to thrive and may affect the quality of the models created. This uncertainty, and the fear of infringement claims, may drive companies without clear access to good data to use low-quality data, or insufficient amounts of data, to train models for AI, which may affect the quality of the models and the ability of companies to compete equally if they cannot obtain licenses. It may also exacerbate algorithmic bias due to using insufficient and outdated data.

Copyright Protection for AI-Created Works

Another interesting question at the intersection of AI and copyright is whether works created through AI are copyrightable. In the United States, copyright protection requires human authorship (which is why Naruto the monkey was held not to be the "author" in the famous monkey selfie case). However, the Compendium of U.S. Copyright Office Practices says that the Copyright Office "will not register

works produced by a machine or mere mechanical process that operates randomly or automatically *without any creative input or intervention from a human author.*" (emphasis added). Therefore, it may be possible to argue that a work is copyrightable if there was some human guidance in the training process (or elsewhere). Some countries, including the U.K., Ireland, Hong Kong, India, New Zealand, and South Africa, recognize statutory protection for "computer generated works," even without human authorship contribution (with the author generally being considered the person "by whom the arrangements necessary for the creation of the work are undertaken"). Other countries are more like the United States and require human authorship.

USPTO Reports on IP and AI

In August of 2019, the U.S. Patent and Trademark Office (USPTO) issued a request for comments on questions relating to AI and patents, and in November 2019, the USPTO requested comments on certain questions regarding AI and copyright (and other forms of IP). The USPTO published a report with these comments in October 2020.

AI, MACHINE LEARNING & QUANTUM COMPUTING

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ABOUT US

Technology Transactions & Privacy | AI, Machine Learning & Quantum Computing

Enabled by our broad experience working with many of the world's most innovative technology companies, our AI team is advising companies—from startups to *Fortune* 50 corporate giants and government agencies—as they explore the ways in which AI can help meet their organizational goals. From concept to launch, we have provided guidance to clients developing technologies related to machine perception, machine learning and reasoning, deep learning, anomaly detection, scalable data structures, clustering, image and data analytics, pattern mining, regression, classification models, natural language processing, and context awareness technologies. Our team also assists research organizations as they develop hardware architecture and deep-learning software application framework standards. Our team's multidisciplinary capabilities and experience also span the wide range of machine learning and sensing technologies, including engineering, biometrics, optics, microelectronics, systems engineering, signal processing, and neural networks.

CLOUD COMPUTING & DISTRIBUTED INFRASTRUCTURE

2022 EMERGING TECHNOLOGY TRENDS

MARKET AND LEGAL INSIGHTS FOR INNOVATORS

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CLOUD COMPUTING & DISTRIBUTED INFRASTRUCTURE

It is estimated that in 2022, 60% of organizations will rely on cloud services—double the number from 2018, a trend that shows no signs of slowing.

SECTOR OVERVIEW

What Is Cloud Computing?

At its core, cloud computing is the delivery of scalable computing services and information technology (IT) resources over the internet (the "cloud"), including "on-demand" computing power and data storage and analytics. Cloud services are typically subscription-based, "pay as you go" services that can be requested, provisioned, and scaled up or down quickly without the need for manual configuration. A core feature of cloud services is its "one-to-many" multitenancy model, in which a single instance of a common application is shared by multiple users across multiple different enterprises, enabling economies of scale and rapid innovation that offers users the benefits of digital transformation while also lowering their IT operating costs. Services for these public or broadly shared clouds are designed to function with a wide range of devices and platforms, including through virtual desktops and machines.

The physical infrastructure of the cloud is distributed across servers housed in data centers around the world connected by high-speed fiber optic lines. Users can also adopt in-house solutions hosted on their own proprietary servers. In addition to publicly available, broadly shared clouds, other cloud variants have arisen to address perceived data and privacy risks (e.g., private cloud, hybrid cloud, and sovereign cloud). Each of these variants attempts to trade aspects or elements of public cloud flexibility, scalability, and redundancy with enhanced control and resource localization to address

specific data and privacy concerns of particular user domains. Public cloud infrastructure, as supplemented by these variants in applicable uses cases, provides an aggregate solution to address the particular computing needs of most individual and enterprise users.

How Is It Evolving?

While the cost of cloud services fell along with its widespread adoption over the last decade, in recent years costs have remained flat. Important changes in the way cloud computing services will be provided, however, could alter pricing in the coming years. First, many large, institutional cloud service providers are able to position their platforms as one-stop shops that address all customer needs from entry level, off-the-shelf scaling up to the higher end, customized solutions. At the same time, there is increasing demand for cross-platform solutions and interface capabilities, especially as businesses collaborate in supply chains using different providers. This trend could break down barriers between services that are currently based on walled-garden business models, affecting prices.

Users are also demanding flexibility, and many providers are responding by introducing hybrid services that allow clients to use a combination of on-premises and remote cloud services. This is occurring alongside the rise of "cloud bursting," wherein private cloud services can "burst" into public services during peak hours. Second, advancements in artificial intelligence (AI)

SECTOR OVERVIEW (CONT'D)

could reduce prices for clients, especially as they are applied to logistics processes within cloud service providers to reduce costs by, for example, making better use of power and cooling systems. Finally, virtual cloud desktops allow outsourcing of IT services, including maintenance (and the related costs) of hardware, software, and security. Client costs could be reduced by adopting by-the-hour subscriptions for employees working on virtual desktops.

Associated Sectors

- Healthcare
- Finance
- Education
- Automotive
- Manufacturing
- Retail
- Professional Services
- Government/Public Sector

Cloud computing has a broad range of applications across industry sectors. Healthcare professionals use the technology to offer telehealth solutions, manage client data and to employ diagnostic systems. Financial institutions have adopted it for a variety of banking and financial services offerings, including the traditional administrative tasks such as storing and accessing client account data. Secondary education institutions use the cloud to enable teachers to instruct students in a virtual classroom and develop collaborative learning environments. Similarly, operating in a common cloud allows automotive suppliers and manufacturers to streamline data sharing and

better coordinate supply chain, production and distribution. As connected cars become more common, data analytics in the cloud can help auto companies interpret large quantities of data coming from the road. Finally, manufacturing companies can integrate cloud-based solutions directly into the manufacturing process, including enterprise resource planning solutions.

Why Is It Important?

Cloud computing is one of the most significant and influential information technologies of our time. It is changing how businesses store and access data and, critically, how they operate. It can offer significant cost reductions for businesses, data integrity and recovery, minimal maintenance, on demand access, the flexibility to tailor services to the needs of individual clients, and a higher level of security than many on-premises or other IT solutions internal to businesses. Importantly, cloud computing is available to a wide range of large, medium, and small firms, many of which forgo in-house data centers. Still other firms deploy cloud computing technology in their own data centers. Cloud technology has enabled startups to flourish as they take advantage of low barriers to entry. It is also being adopted (using public, sovereign, and other variants) by governments for purposes such as national defense. As more aspects of our world's activities go online, and as new telecommunications infrastructures, such as 5G, are rolled out, the cloud investment space will continue to grow.

CLOUD COMPUTING IS ONE OF THE MOST SIGNIFICANT AND INFLUENTIAL INFORMATION TECHNOLOGIES OF OUR TIME. IT IS CHANGING HOW BUSINESSES STORE AND ACCESS DATA AND, CRITICALLY, HOW THEY OPERATE.

ENABLING SCIENCE AND TECHNOLOGY

Edge Computing

Edge computing involves small, modular, and portable data ingestion and servers designed to reduce the distance between services and users. Positioning servers close to users minimizes latency and facilitates data streaming. Server-side applications also run faster when processors are positioned closer to where data is gathered. Edge computing is especially useful in large-scale manufacturing logistics as well as the Internet of Things (IoT), where sensors and data-collecting devices are numerous. In addition to minimal latency, the technology is simpler to maintain and cheaper to cool when compared to large, centralized data centers.

Virtualization and Multitenancy

Virtualization separates a single computing unit into one or more virtual devices. Each of these devices can then be used to perform discrete computing tasks. Idle computing resources can be used more efficiently by creating a scalable system of independent virtual devices. This accelerates operations while simultaneously reducing costs by increasing infrastructure utilization and reducing labor input by automating the process whereby users provision resources on demand. Multitenancy is a computing system design that enables server or cloud-based applications to serve different users or customers (each, a "tenant") at the same time. This enables providers to serve several cloud tenants simultaneously by pooling IT resources. Frequently, this is implemented using virtualization technologies.

Broadband Networks and Internet Architecture

Cloud computing depends on networking, whether through the internet or locally through a local area network (LAN). Wide area networking allows for the remote provisioning of IT resources and supports ubiquitous access to the cloud. As internet connectivity and service quality advances, so too does the potential for diverse and advanced cloud solutions. The rollout of 5G technology will greatly improve speed, connectivity and service quality, while reducing latency (see the Mobile Wireless Technology section for more details), as will new technologies such as Microsoft's TV White Spaces technology, Google Fiber, Amazon's Project Kuiper, or Elon Musk's Starlink initiative.

> Positioning servers close to users minimizes latency and facilitates data streaming. Server-side applications also run faster when processors are positioned closer to where data is gathered.

SECTOR AND INDUSTRY SIGNALS

Sector and Industry Signals

Cloud computing is changing business practices in several industries. It decreases costs in healthcare while enabling easier, more secure sharing of medical records, automating backend operations, and facilitating the use of telehealth apps. It is transforming finance too, with processes like credit risk management, transactions, consumer due diligence, and trading algorithms being moved to the cloud. Cloud computing is also revolutionizing education, where it has become mission-critical technology, enabling online courses by giving instructors, students, and administrators a platform on which learning materials, such as videos, can be uploaded and assignments managed at lower cost than traditional in-person delivery methods. The automobile industry is integrating 5G and cloud technology into its products, which will enable self-driving vehicles and onboard entertainment, such as video streaming. Finally, manufacturing is adopting the technology to optimize inventory levels and manage supply chain.

In addition to industry-specific applications, cloud computing is increasingly being used to deliver tools and technologies, such as data analytics, AI-enabled solutions, storage, networks, sustainability, and the autonomous delivery of goods, all "as a service" and across various industry sectors worldwide. The acceleration of the adoption of cloud technologies is fueled by the increase of the Anything as a Service (XaaS) model and the transformative approach many companies are embracing in this digital age.

Market for Cloud Computing Spurred by COVID-19 Pandemic

It is estimated that in 2022, 60% of organizations will rely on cloud services—double the number from 2018, a trend that shows no signs of slowing. The rush to remote working due to COVID-19 has made companies more reliant on cloud technology to continue operations as employees work from home. It has also improved business efficiency, reduced costs, and allowed for flexible communication and collaboration around the world. Cloud service providers, especially Microsoft, Amazon, Google, Alibaba, and IBM, have helped to transform the business landscape in this period. Cloud-based software accounted for 35% of the total software market in 2020, but this is projected to increase to 83% by 2030.

United States Begins 5G Network Rollout

After years of expectation, major U.S. telecom carriers have begun the introduction of 5G service, which will facilitate further cloud computing growth. While the 5G rollout has been

IN ADDITION TO INDUSTRY-SPECIFIC APPLICATIONS, CLOUD COMPUTING IS INCREASINGLY BEING USED TO DELIVER TOOLS AND TECHNOLOGIES, SUCH AS DATA ANALYTICS, AI-ENABLED SOLUTIONS, STORAGE, NETWORKS, SUSTAINABILITY, AND THE AUTONOMOUS DELIVERY OF GOODS, ALL "AS A SERVICE" AND ACROSS VARIOUS INDUSTRY SECTORS WORLDWIDE.

SECTOR AND INDUSTRY SIGNALS (CONT'D)

slower than anticipated, analysts expect two-thirds of U.S. customers will have enhanced coverage by 2022 or 2023. The revolution in mobile communications technology will enable ubiquitous access to the internet and cloud-based services, especially in larger population centers where ultra-dense, small-cell wireless networks operating on high-frequency bands alongside edge computing centers will provide high data transfer rates, low latency, and robust computing power. These advancements will facilitate the deployment and use of cloud-based applications and storage, while enhancing the functionality of cloud-integrated IoT devices and related services.

Public Sector Looks to Cloud for Better Data Management and Collaboration While Also Focused on Compliance

Government entities facing increased demand for collaboration and data management tools are also embracing cloud computing to improve functionality and accountability, reduce costs, and increase productivity. At the same time, regulators in the United States and globally are developing policies adapted to these evolving technologies. Two recent examples include (1) the new Joint Warfighter Cloud Capability (JWCC) from the U.S. Department of Defense (DOD) and (2) the statement from the Bank of England (BOE) regarding the need for further policies to mitigate cloud risks.

The DOD announced its plans for its JWCC, a multi-cloud initiative providing equal service across three classification levels: unclassified, secret, and top secret. The cloud service will integrate cross-domain solutions, ensure global availability, and involve sophisticated cybersecurity controls. It is a multibillion-dollar project that will seek proposals from both Microsoft and Amazon Web Services. While immediate needs will be met by these providers, the longer-term vision for the initiative is to involve multiple cloud providers via an open industry competition, which could occur as soon as 2025.

The BOE issued a statement in July 2021 warning that—despite efficiencies and cost reductions—there are risks associated with cloud technologies hosted by third parties. Big providers could dictate terms, conditions, and prices to key financial institutions. The BOE is concerned that concentrated

power of this sort could result in secrecy, with customers not being provided the information they need to monitor risk in the service. The BOE's Financial Policy Committee has indicated that policy measures are required to mitigate such risks, and regulators in other countries may take similar positions.

Education Sector Moves to the Cloud for Increased Security

In the race to cloud-based learning during the COVID-19 pandemic, many educational institutions overlooked cybersecurity measures, putting online courses and virtual classrooms provided via self-hosted platforms at risk of malicious attacks. In the first few months of the pandemic, the education sector witnessed a large spike in cyberattacks—an increase of 30% compared to 6.5% across all U.S. industries. As a result, institutions of higher education are increasingly opting for cloud-based services to improve security, scale up capacity when there are regular surges in activity, and allow for on-demand access to the cloud. Furthermore, the technology enables places of learning to upgrade communication and learning management systems without having to invest in new infrastructure on their own, yielding significant cost savings.

Professional Services Use Cloud-Based Customization to Increase Conversion Rates

Cloud computing enables professional services firms to tap global labor markets for talented workers, as it allows them to work remotely. The technology also helps businesses extend their reach to international clients. Further, cloud computing enables firms to offer a client-centric approach to service provisioning. Services can be customized to meet customer needs, resulting in increased conversion rates. Hewlett Packard Enterprise, for example, is implementing a pay-per-use hybrid cloud service called GreenLake, allowing customers to take advantage of the benefits of both on-premise and public cloud deployments to meet business needs. Finally, by outsourcing IT services through the cloud, businesses reduce costs, such as fixed capital, operational expenses, and IT specialists. While the cloud professional services market stood at $14.2 billion in 2020, it is estimated that it could grow to $37 billion by 2026, at a compound annual growth rate of 17.2%.

CLOUD COMPUTING & DISTRIBUTED INFRASTRUCTURE

IMPACT

Economic

Increased adoption of cloud services is expected to free up financial and human resources, with the savings reinvested in the business or returned to shareholders. The main incentives for the adoption of cloud computing technology include cost reduction, scalability, flexibility, more effective use of labor, data analytics and accessibility and disaster recovery. Businesses reduce costs by adopting pay-per-use services online, because resources are acquired (and payments are made) only as needed. It can also reduce labor and maintenance costs because—at least for most cloud implementations—the system is owned, housed, and operated in another location. Cloud scalability removes the need for individual businesses to hold reserve capacity. Moreover, cloud computing frees up resources that companies would otherwise devote to disaster recovery plans, because service providers take these issues in hand directly and help customers recover more quickly.

A number of studies suggest that efficiencies and productivity gains resulting from cloud computing can be expected to ripple through the economy and improve gross domestic product (GDP) growth over the long term. In the United States, the cloud economy tripled in size between 2002 and 2017. In 2017 alone it added $214 billion to GDP and improved employment prospects for 2.15 million people. Measuring the impact of cloud computing on GDP is difficult, however, and any estimates of the technology's impact on future GDP should be used with caution.

Social

Cloud computing is transforming the world in which we live by using cloud-based technologies to drive the social good. While the cloud presents both opportunities and risks, robust solutions to issues such as the loss of data control, risks to privacy, and freedom of speech are enabling companies to take full advantage of the centralization of computing resources and the efficiencies that accompany it. Adoption has skyrocketed. The cloud enables important endeavors that serve the social good such as access to education through

virtual learning, innovation using digital education, and remote work. It also powers a host of other systems which benefit from the data aggregation that is inherent in certain cloud implementations, such as precision and smart agriculture and autonomous vehicles through intelligent cloud computing networks. For example, in agriculture, the cloud can help increase crop production, preserve water to manage scarcity, and reduce food waste down the supply chain by linking consumers with producers more directly.

Environmental

Cloud computing is also driving significant changes in the way information is stored and processed. According to an International Data Corporation (IDC) study, global data traffic will have grown 60% by 2025, to 175 zettabytes (175 trillion gigabytes). Powering information systems in this context requires vast amounts of electricity. Already in 2012, the IT sector consumed more power than all of Russia, according to an analysis of public data by Greenpeace. Of additional environmental concern are the coolant chemicals used in the server rooms and batteries used for backup power in those same rooms.

However, there are factors that may offset some of the negative environmental impacts. Energy consumption can be reduced by moving commonly used software applications to the cloud. According to a 2013 study funded by Google, this could reduce energy usage by as much as 87%. Cloud computing also substantially enables remote work and education, potentially reducing energy and carbon footprints. Similarly, data centers could recover and reuse heat generated by servers as a source of energy.

Policy

Cloud computing is subject to the decisions of telecommunications regulators and policymakers whose attention has been drawn to the technology as it has grown in importance globally. Of particular concern to regulators are its implications for financial stability and data storage transparency and localization. The BOE expressed concern

IMPACT (CONT'D)

that the finance industry's switch to cloud computing is concentrating sensitive information in the hands of a few large technology companies.

Global distribution of data is likely to fuel further privacy and data security legislation and regulation. Cloud computing is borderless in the free and open internet, and cloud companies spread data across data centers around the world. Often, however, users of these services are unaware of the physical location of their personal data. Similarly, concerns about "data sovereignty" may drive national security laws such as the USA Patriot Act, which requires that those firms operating data centers abroad disclose information to the U.S. government if requested. New cloud variants, such as sovereign cloud implementations, are arising to address these perceived deficiencies.
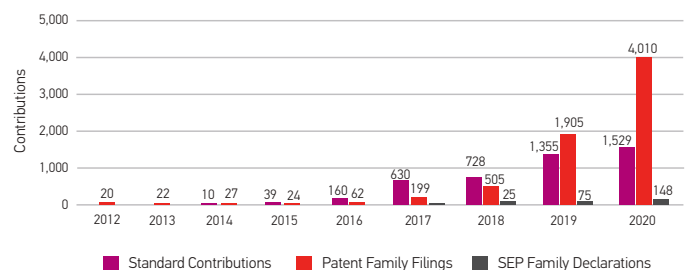
New patterns in investment and cross-border transactions pose challenges for national accounting, and the distributed nature of the cloud computing resources that complete these transactions is fostering efforts by federal, state, and local governments to assess and levy taxes.

PATENT TRENDS AND OUTLOOK

Patent Race Focused on Edge Computing

As the number of connected devices continues to rise exponentially, the attractiveness of the enhanced cloud capability known as "edge computing" increases. As noted above, edge computing brings cloud computing functionality closer to the end user by making greater use of local devices. Patent activity related to edge computing has flourished in the past five years and is expected to continue for the foreseeable future as the rollout of 5G communications technology enables greater wireless broadband communications.

**NUMBER OF STANDARDS CONTRIBUTIONS,
NUMBER OF PATENT FAMILIES BY PUBLICATION YEAR AND
NUMBER OF STANDARD ESSENTIAL PATENT FAMILIES BY YEAR OF
DECLARATION THAT DESCRIBE EDGE COMPUTING TECHNOLOGIES**

Year	Standard Contributions	Patent Family Filings	SEP Family Declarations
2012	20	22	
2013	10	27	
2014	39	24	
2015	160	62	
2016	630	199	
2017	728	505	25
2018	1,355	1,905	75
2019	1,529	4,010	148

Sources: Managing IP, IPlytics

CLOUD COMPUTING & DISTRIBUTED INFRASTRUCTURE

LEGAL IMPLICATIONS

Cloud computing is propelling novel legal questions, both overall and in many industry-specific matters (for more information on the privacy and data security implications of cloud computing, please also see the Privacy & Security section of this report). According to a report released by the Financial Industry Regulatory Authority (FINRA), for example, a firm's adoption of the cloud may lead to changes in how it collects and stores sensitive consumer data. Critically, FINRA has emphasized that if cloud services are outsourced to a third party, the hiring firm is still responsible for ensuring the integrity of the outsourced systems. It is required to oversee outsourced tasks in the same way it would oversee in-house tasks.

Similarly, the Health Insurance Portability and Accountability Act (HIPAA) of 1996 sets national standards for electronic
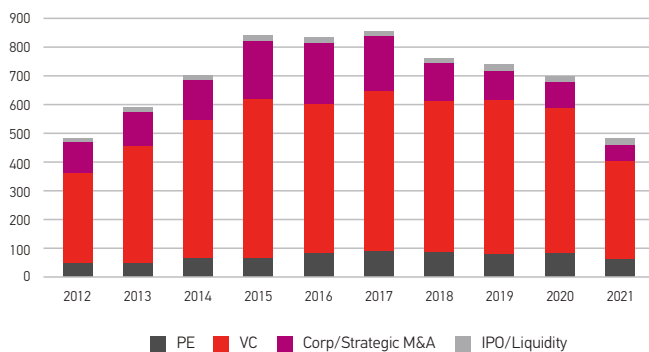
servers. However, as in the financial sector, the adoption of cloud technology by the healthcare industry comes with a responsibility for mitigating against data fraud and identity theft. For healthcare, that means protecting the security of the data stored on- or off-site to ensure HIPAA compliance.

OUTLOOK

Mergers and Acquisitions | Active Market Shows Signs of Maturation

An analysis of transactions in the cloud computing technology space shows that deal volume is steadily decreasing from its 2017 high point. Meanwhile, transaction values continue to grow year over year, suggesting this technology segment is reaching a mature phase that will feature fewer but more valuable deals.

INVESTMENTS OVER TIME
Deal Count

Legend: PE | VC | Corp/Strategic M&A | IPO/Liquidity

Source: PitchBook

INVESTMENTS OVER TIME
Capital Raised

Legend: PE | VC | Corp/Strategic M&A | IPO/Liquidity

healthcare transactions and requires providers to securely store sensitive data, such as Social Security numbers and medical history. The Health Information Technology for Economic and Clinical Health (HITECH) Act widens the scope of privacy and security protections under HIPAA and increases legal liability for noncompliance. Cloud computing provides a solution for securing data that would otherwise be stored on relatively unsecure mobile devices, laptops, or departmental
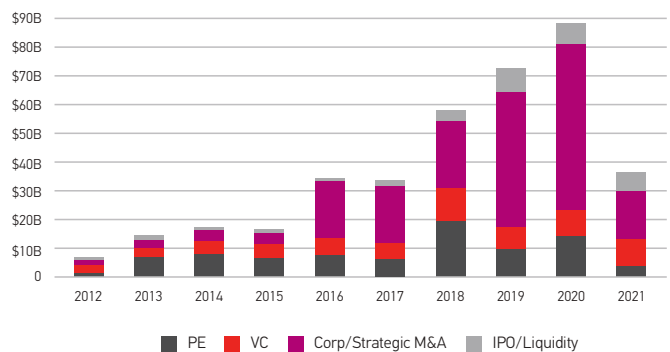
Commercial Transactions | The Nature of Cloud Systems Creates Contracting Challenges

As noted above, the architecture of cloud systems—particularly multitenant implementations—is fundamentally different from that of legacy on-premises systems. The move to the cloud creates end-customer educational challenges in which concepts that had been generally accepted or "market" in an on-premises world may not always translate to a hosted environment.

LEGAL IMPLICATIONS (CONT'D)

Privacy | US Companies Must Comply With Growing Numbers of Data Localization and Data Sovereignty Laws

Russia, China, and Indonesia are among the increasing number of countries enacting laws requiring personal or commercial data to be stored domestically. The proliferation of data localization laws can complicate the delivery of cloud-based services that rely on a globally distributed network for operations and emergency backup.

Other countries, including the United States, have taken various steps to compel cloud providers to produce data held by those cloud providers in locations overseas in response to requests from law enforcement and national security authorities. New models, such as sovereign clouds, have arisen in response to these laws.

Securities | EU Securities Regulators Warn of Over-Reliance on Cloud

In December 2020, the European Securities and Markets Authority (ESMA) produced new guidelines stipulating how financial services institutions, including investment firms and trading venues, must vet cloud service providers. The guidelines address corporate governance, as well as pre-outsourcing and due diligence requirements, among other provisions. ESMA had previously issued a consultation paper warning financial market participants of the risks of overreliance on cloud technology.

LITIGATION DEVELOPMENTS

Litigation | Government Contracts, Data Breaches Among Top Litigation Issues

Legal challenges to a series of DOD contracts for cloud services involve many of the industry leaders in the cloud space. As more U.S. government departments and agencies move their infrastructure to cloud systems, it is likely to prompt additional challenges that will need to be resolved in the courts.

The DOD announced in July 2021 that it was canceling its Joint Enterprise Defense Infrastructure (JEDI) program, which was intended to create a cloud-based operating environment across the armed forces. The contract process faced multiple court challenges, the most recent of which was launched by Amazon after the DOD awarded the work to Microsoft.

In place of JEDI, the DOD plans a new cloud project, the Joint Warfighter Cloud Cawpability, that is intended to utilize multiple vendors.

In addition, high-profile data breaches continue to spur consumer class actions against cloud service providers and their clients. Cybersecurity failures have hit businesses in the healthcare, retail, education, professional services, and other industries, often leading to lawsuits over the data breaches themselves and the actions of the parties in the aftermath of the events.

> Government entities facing increased demand for collaboration and data management tools are also embracing cloud computing to improve functionality and accountability, reduce costs, and increase productivity.

LEGAL IMPLICATIONS (CONT'D)

Cloud computing company Blackbaud continues to face a class action related to a 2020 ransomware attack and data breach, after a U.S. District Court judge denied the company's motion to dismiss the case. The case of *Clayton et al. v Blackbaud* is a consolidation of 15 federal lawsuits involving 34 plaintiffs in 20 states.

Tax | All Levels of US Government Seek to Tighten Digital Services Tax, Amid Push for International Collaboration

The nature of cloud-based services, in which transactions often occur outside of the jurisdictions where the contracting parties are located, has prompted the Internal Revenue Service to propose new rules for cloud computing. Released in 2019 but not yet finalized, those rules would provide some clarity on taxation by treating most cloud computing functions as a service, rather than as a lease of property. The U.S. Department of the Treasury is reportedly wrestling with additional questions, however, regarding how to source income in cloud transactions that involve multiple sources.

Meanwhile, state and local governments are taking a closer look at cloud computing services, seeking to collect sales and corporate income taxes for revenue derived from their residents. One recent example is the city of Chicago, which set a $100,000 nexus threshold before imposing a tax on cloud and digital streaming services earning revenue from city-based customers.

Looking internationally, the Organisation for Economic Co-operation and Development (OECD) is leading an initiative to harmonize the treatment of digital revenue, including revenue from cloud computing services, across international borders. While it holds the promise of reducing the risks of duplicate taxation and tax avoidance that stem from unilateral approaches, the effort has been slowed by numerous technical and diplomatic complications.

CLOUD COMPUTING & DISTRIBUTED INFRASTRUCTURE

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ABOUT US

Technology Transactions & Privacy | Cloud Computing & Distributed Infrastructure

Perkins Coie's Technology Transactions & Privacy attorneys represent both buyers and providers of web and cloud computing services in online agreements and negotiated transactions. Our attorneys stay abreast of the different cloud computing service models and the challenges they pose to traditional concepts of data ownership and control, contractual rights, privacy and security, law enforcement, intellectual property, and conflicts of law. We also help our clients assess their data security needs and draft internal company policies for classifying data and identifying appropriate internal controls and external contract clauses based on the mission criticality and sensitivity of the data.

DIGITAL MEDIA & ENTERTAINMENT

2022 EMERGING TECHNOLOGY TRENDS

MARKET AND LEGAL INSIGHTS FOR INNOVATORS

PERKINSCOIE

DIGITAL MEDIA & ENTERTAINMENT

> Advances in technology represent the new face of media and entertainment, for example in video gaming and live streaming.

SECTOR OVERVIEW

What Is Digital Media and Entertainment?

"Digital media" and "digital entertainment" are umbrella terms that refer to technology-supported media and entertainment in any form. Advances in technology represent the new face of media and entertainment, for example in video gaming and live streaming.

Associated Sectors

- Content Creation
- Production and Editing
- App Development
- Streaming Services and Devices
- Music Production
- Video Game Production
- Social Media Platforms
- Immersive Reality

Emerging Sector Twist: International Markets With State Support, Intervention

Innovation in digital entertainment has facilitated the flow of media across national borders, creating opportunities—and potential obstacles—for digital media technology and production companies. In this globalized environment, some governments respond with protectionist barriers, while others want to support their own cultural industries, and still others focus on protecting the consumer. To accomplish these goals,

governments have generally taken a combination of two approaches: restrict the flow of foreign products and increase domestic producers' competitiveness.

The French cultural exception (_l'exception culturelle_) is one of the best-known examples of the first approach, where cultural products are treated differently from other commodities in international trade agreements. Another example of this approach is the Chinese quota on foreign movie imports. The second approach consists of providing production incentives. These are sometimes controversial in the United States, where 13 states have eliminated their film production subsidies in the past 10 years. The directives and regulations promulgated by the European Union as part of its "Digital Single Market" approach are an example of the third approach, which was in some instances at odds with the views of copyright owners.

One of the biggest challenges facing governments today is how to support their domestic industries in a digital environment. The French government is requiring major streaming services to invest at least 25% of their revenue generated in the country to fund local productions. Meanwhile, China is easing restrictions on foreign investment in entertainment venues (such as theme parks and cinemas), which represents an opportunity for U.S. business.

ENABLING SCIENCE AND TECHNOLOGY

Convergence Observed in Digital Media and Entertainment

The barriers between different forms of digital entertainment are collapsing. Increasingly, concerts take place as multidisciplinary events, art galleries offer immersive experiences, social media platforms change their interfaces to look like each other, and streaming services, which have already introduced interactive movies and shows, will soon expand into immersive reality and gaming platforms too.

These new forms of digital entertainment are supported by a growing list of industries and occupations in the arts and entertainment sector. The U.S. Bureau of Labor Statistics estimates that 1.8 million people are employed in arts, design, entertainment, sports, and media occupations in the United States.

Recommendation Engines Face Growing Scrutiny

Leveraging powerful algorithms and artificial intelligence (AI) has allowed streaming services and other platforms to pool

AI Voice Actors and Digital Humans Improve in Quality, Raise Concerns of 'Deepfakes'

Startups have leveraged deep learning, a subset of machine learning that uses architectures of neural networks often referred to as deep neural networks, to create synthetic voice actors and digital humans that are more convincing than ever. These systems are so powerful, they are increasingly used for corporate e-learning videos, digital assistants, call center operators, video game characters, and even music. The technology has implications for the livelihood of voice actors and singers as well as the right of publicity. Deepfakes are becoming more common, and more convincing, while the legitimate use of an actor's voice and likeness is an area where the law is evolving.

XR Set for More Growth in 2021, While Adoption Rates Improve

Extended reality, or XR, faced setbacks early in the COVID-19 pandemic. However, a survey of industry stakeholders conducted in April 2021 by Perkins Coie and the XR Association

LEVERAGING POWERFUL ALGORITHMS AND ARTIFICIAL INTELLIGENCE (AI) HAS ALLOWED STREAMING SERVICES AND OTHER PLATFORMS TO POOL DATA FROM MILLIONS OF USERS TO IMPROVE THE ACCURACY OF THEIR RECOMMENDATION ENGINES.

data from millions of users to improve the accuracy of their recommendation engines. Questions are now being raised about the ease with which these engines can be manipulated, namely to further misinformation and hateful content. There are also questions about whether recommendation engines can be used for programming, as research shows that engines can actually change users' preferences.

found 83% of respondents expressed optimism about increased investment in immersive technology. Alongside this optimistic outlook, the number of applications for XR is growing. Opportunities are found in education, retail, healthcare, and medical devices, as well as the automotive industry. Lack of content is one of the most salient barriers to mass adoption, so software development offers great potential as well.

SECTOR AND INDUSTRY SIGNALS

NFTs Present New Opportunity for Content Monetization

NFTs, short for "non-fungible tokens," are unique units of data stored on a blockchain and associated with photos, videos, audio, and other digital content. Whereas each Bitcoin is the same (and thus "fungible"), this is not true for NFTs; indeed, each NFT is, at least potentially, one of a kind and not interchangeable.

Although NFTs have been in existence for a while, they suddenly became headline news in March of 2021 when the artist Beeple sold an NFT tied to digital artwork at Christie's for over $69 million, one of the highest prices ever paid for a work by a living artist. As we explained in a recent webinar, NFTs represent an opportunity for sports leagues, music companies, video game developers, and other media and entertainment companies to monetize their content in a digital form; however, due to legal and regulatory concerns, companies do need to exercise care in launching their NFT initiatives.

Intermediary Channels and Advertisers Challenged by DTC Trend

The direct-to-consumer (DTC) media trend reduces the importance of, and demand for, advertising. Ad-free streaming is seen as a benefit for which consumers are ready to pay, while at the same time, streaming companies' own ad spend becomes less important as they gain market share. Although these trends began before the pandemic, they accelerated as more consumers turned to online-only content and streaming services boomed. The DTC media trend continues to represent a challenge for traditional intermediaries (such as movie distributors) as well as for advertisers.

E-Sports Influencer Marketing Emerges, Along With Specialized Talent Agencies

E-sports—competitions involving multiplayer video gaming— have transformed from a niche form of entertainment into an entertainment industry of their own, one that is expected to surpass $1.5 billion in revenue by 2023. This is leading to the development of related industries and services, such as talent industries. Specialist firms have emerged, and one of the biggest talent agencies in the United States now has an e-sports talent roster. Likewise, e-sports stars have acquired influencer status and entered into brand partnerships.

Social Media Platforms Turn to Direct Payment

As social media platform TikTok grows in popularity, prominent social media incumbents such as Snapchat, Meta, and Instagram are paying creators to use their platforms or enabling fans to pay their favorite influencers. This strengthens content creation's outlook as one of the fastest-growing segments of small business. Meta CEO Mark Zuckerberg said in a Facebook post that by paying $1 billion to content creators, the company "want[s] to build the best platforms for millions of creators to make a living."

IMPACT

ONE OF THE BIGGEST CHALLENGES FACING GOVERNMENTS TODAY IS HOW TO SUPPORT THEIR DOMESTIC INDUSTRIES IN A DIGITAL ENVIRONMENT.

Economic

Questions are being raised as to the effectiveness of movie subsidies, but this issue is connected to a broader debate on the role of government in creating and shaping markets. The state of Georgia is one of the most popular destinations for filming movies and series, in part due to its tax credit. Industry lobbyists point out that the success of the industry should support the continuation of the tax credit.

Social

Advancements in artificial intelligence—such as synthetic voices, voice clones, digital "resurrections," and deepfakes—all have implications for artists whose livelihoods depend on the right of publicity. The right is not applied evenly across the United States, and without legislative protections, some artists will receive a smaller share of profits from the use of their image, likeness, and voice.

Environmental

The quality of animation is constantly improving, which produces more convincing video games, movies, and series. To produce this animation, however, requires powerful computers and data centers. On the users' side, strong internet connections, powerful computers, and consoles are needed to fully use and enjoy large data files. These factors mean the animation industry has a significant carbon footprint. Efforts are underway within the industry to reduce this footprint, while consumers also have decisions to make about their individual data usage.

LEGAL IMPLICATIONS

OUTLOOK

Transactions and Financing | Private Capital Makes Inroads in Entertainment, Sports

Institutional investors and private equity (PE) firms are increasingly buying minority stakes in professional sports franchises. Specialized venture capital firms have also emerged specifically to invest in games, while Epic Games had several successful financing rounds that valued it to around $29 billion. In addition, private equity has always been an important component of movie financing, but it appears to be playing a bigger role. PwC's 2021 research found "continued deal activity" in the media and telecom sector and attributed a growing portion of this activity to private equity deals, as shown by the following chart.

PE vs. CORPORATE DEAL MIX
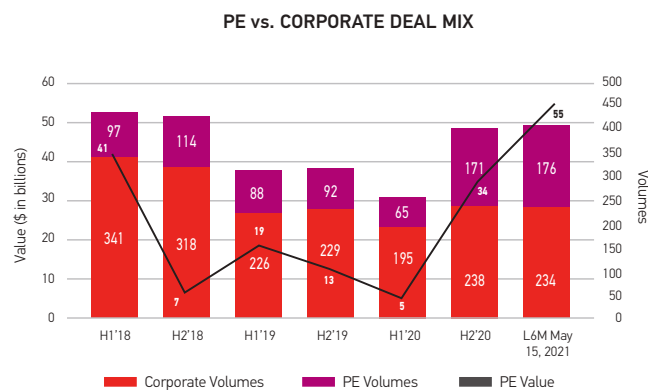
Source: PwC Analysis

M&A | Dealmaking Increasingly Reflects Convergence in Media, Entertainment Industries

As mentioned above, a convergence is taking place in the digital media and entertainment space as different forms of art and entertainment combine. This creates novel opportunities for dealmaking, with companies offering different services under one roof.

M&A | Consolidation Occurring in Video Game, Media Industries

Holding companies are facilitating the consolidation of the video game industry, as shown by the acquisitions of the Daybreak Game Company by Enad Global and the acquisition of Snapshot Games by the Embracer Group. This is a relatively popular business model, as dozens of video game holding companies exist globally, and the video game industry is undergoing a period of consolidation.

> Intellectual property protections are more important than ever for content creators and copyright holders.

The media sector also offers opportunities for acquisition, whether of an entire company or of a portion of its assets. For example, Fox Corporation acquired television stations from Nexstar Media in 2020. This is the continuation of a years-long trend as a wave of consolidation has reshaped the local television landscape in the United States.

Litigation | Copyright Infringement Suits Increasingly Common in Music Industry

Reports indicate a substantial increase in copyright infringement lawsuits in the music industry, following a landmark decision involving Marvin Gaye's 1977 hit "Got to Give It Up." A federal court ruled that parts of the 2013 pop hit "Blurred Lines" by Robin Thicke and Pharrell Williams used parts of the song and awarded substantial damages and profits to the plaintiff. On appeal, the judgment was cut to $3.2 million in damages and

LEGAL IMPLICATIONS (CONT'D)

$357,000 in profits. The trend may have had a potential chilling effect on artists and songwriters, who are increasingly buying insurance policies to protect against such lawsuits. More recently, a U.S. federal court ruled compositional rights to a remix are limited, in a decision that could reduce the flow of music copyright litigation.

## Data Privacy | Media and Entertainment Companies Face Growing Regulation

Although the United States does not have an omnibus federal privacy law, states are increasingly regulating this space.

Questions have recently been raised about the collection of user data through a messaging service, but data privacy considerations are inherent in any media and entertainment subsector—from gaming and e-sports to streaming and social media.

Property Law | Physical and Digital Worlds Are Merging Through XR

In 2017, a Milwaukee ordinance was struck down in federal court on the basis that it was likely to infringe on freedom of assembly under the First Amendment. The ordinance required producers of virtual games to obtain a permit before releasing their games for use in public parks. The court ruled the ordinance "does not employ sufficient procedural safeguards to ensure the protection of First Amendment rights."
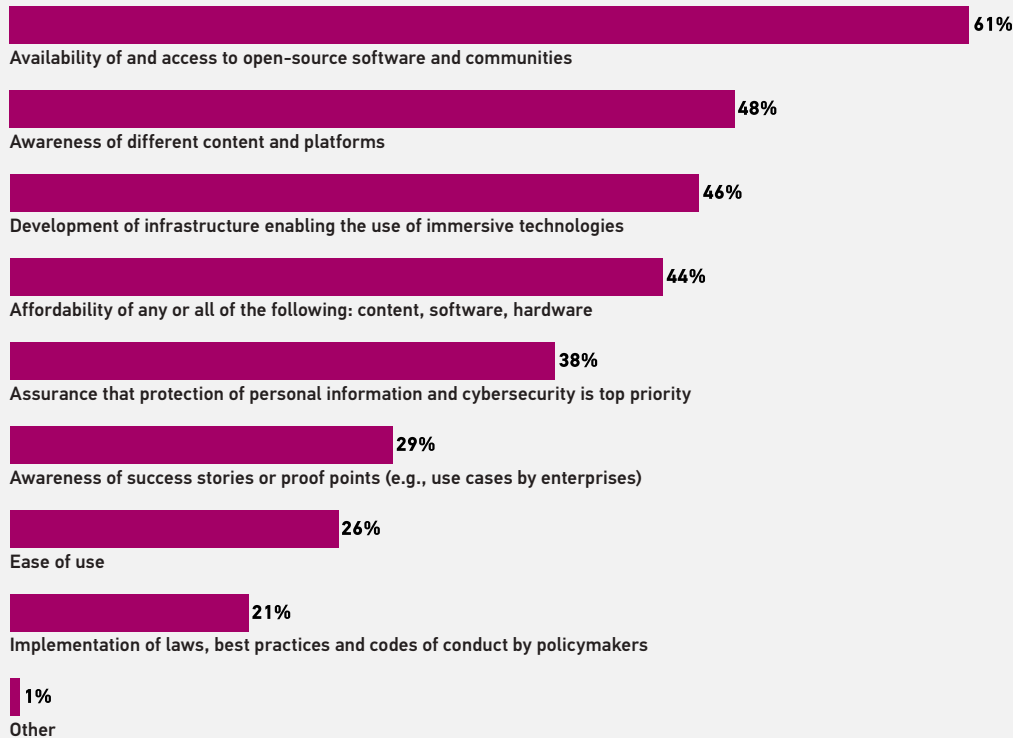
Since that decision, there have been outstanding questions on the ownership of digital spaces and on the extension of public law into digital places. Governments have an opportunity here to clarify the law and to support the implementation of best practices and codes of conduct. As shown in a recent survey, around 20% of XR industry stakeholders think the implementation of laws, best practices, and codes of conduct would influence greater consumer adoption.

US State Privacy Legislation Tracker
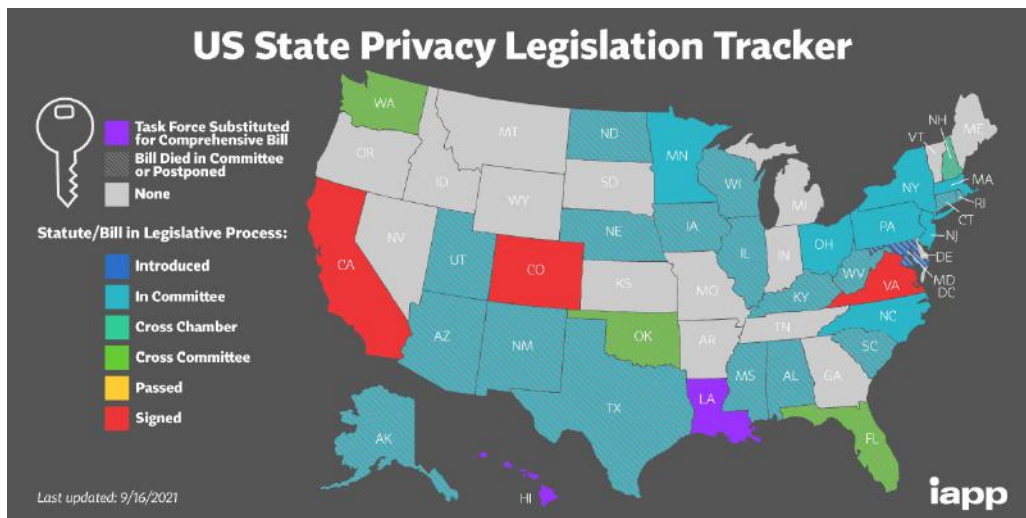
LEGAL IMPLICATIONS (CONT'D)

Which factors are key in increasing the adoption of immersive technology by consumers? (Select all that apply)

- **61%** Availability of and access to open-source software and communities
- **48%** Awareness of different content and platforms
- **46%** Development of infrastructure enabling the use of immersive technologies
- **44%** Affordability of any or all of the following: content, software, hardware
- **38%** Assurance that protection of personal information and cybersecurity is top priority
- **29%** Awareness of success stories or proof points (e.g., use cases by enterprises)
- **26%** Ease of use
- **21%** Implementation of laws, best practices and codes of conduct by policymakers
- **1%** Other

Source: Perkins Coie XR Industry Survey Report

LITIGATION DEVELOPMENTS

Music Publishers Allege Roblox Allows Game Creators to Use Unlicensed Music

A group of music publishers is suing Roblox for copyright infringement, alleging the video game company failed to license the music used by creators on its platform. Roblox sells a "boombox" feature that allows users to upload copyrighted music. Roblox replied that it does not tolerate copyright infringement and that it responds to valid requests to remove content. The lawsuit follows a series of disputes between platforms and music rights holders focused on how platform users can play copyrighted music. Some platforms have entered into broad licensing agreements to cover the music played by platform users.

LEGAL IMPLICATIONS (CONT'D)

Regulators Crack Down on 'Scalper' Bots

The United States made ticket bots illegal in 2016 through the Better Online Ticket Sales (BOTS) Act, and in 2021 the Federal Trade Commission carried out the first enforcement case against three ticket bots. The problem isn't limited to tickets, however. Bots have notoriously snatched up the PlayStation 5 and increased prices dramatically, making it harder for individuals to secure the gaming consoles. Retailers such as Walmart have taken measures to stop the bots, but these have not been completely successful and bots continue to be a global problem.

App Revenue Commission Challenged Under Antitrust Rules

Some early legal challenges to app marketplace policies are forcing changes that give developers more flexibility to monetize their apps. In the *Epic Games v. Apple* litigation in the United States, the trial court held that Apple violated antitrust laws by restricting developers from including links or statements in an app that directs users to make payments outside of the app, and thereby avoid Apple's commissions. The decision came on the heels of a $100 million settlement of a class action lawsuit by U.S. app developers against Apple, which resulted in other changes to its App Store practices. Outside the United States, legislation and regulatory investigations in numerous other countries may require operators of app marketplaces to make more significant changes to their policies in the future.

IP TRENDS AND OUTLOOK

NFTs Blend Art, Fashion, and Currency in Digital Media—With Implications for Brands and Their IP

Brands have opportunities to sell their own NFT items within video games and other digital platforms—for example, Hermès must decide whether it wants to sell digital items on Roblox and, if so, how tightly it will control its trademarks. NFTs are receiving more attention as they increase in value. One notable example is the "Baby Birkin" NFT, an image that represents an embryo growing inside a transparent Hermès Birkin bag. The NFT was created by artists not affiliated with the Hermès brand and sold for $23,500—far more than the $9,500 price tag of the "baby" Birkin handbags themselves.

New York Extends Right of Publicity to Digital Replicas

Following years of advocacy by the Screen Actors Guild - American Federation of Television and Radio Artists (SAG-AFTRA), the state of New York enacted legislation that extends actors' right of publicity to AI-enabled replicas of their image, voice, and likeness. The act likewise prohibits the use of a deceased individual's voice and image in advertising and for the purposes of trade without obtaining prior written consent. This new legislation joins the hundreds of state and federal decisions recognizing the right of publicity.

DIGITAL MEDIA & ENTERTAINMENT

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ABOUT US

Technology Transactions & Privacy | Digital Media & Entertainment

Perkins Coie's Digital Media & Entertainment, Gaming & Sports attorneys partner with our established and emerging media, entertainment, and technology clients to capitalize on the digital media, next-generation entertainment, and interactive entertainment innovations that are dominating the industry. Our attorneys focus on meeting the business and legal needs of our clients by leveraging our collective experience in the transformative convergence of the media and entertainment, gaming, and sports industries.

We are at the forefront of representing some of today's most innovative content creators, content marketplaces, music streaming services, video streaming services and devices, immersive technology platforms and devices, digital media companies, app developers and publishers, mobile and broadband providers, gaming studios and platforms, regulated gaming platforms, e-sports providers, social media influencers, brands, and professional teams and leagues.

GREENTECH

2022 EMERGING TECHNOLOGY TRENDS

MARKET AND LEGAL INSIGHTS FOR INNOVATORS

PERKINSCOIE

Expectations for greentech are rising as governments and consumers put increased emphasis on environmental sustainability, in turn exerting increasing pressure on businesses across the economy.

SECTOR OVERVIEW

What Is Greentech?

Greentech is an umbrella term that covers a broad array of technologies associated with improving environmental sustainability and energy and other resource efficiency across the economy. Companies that develop green technologies are often said to be part of a greentech subsector.

It is related to—and sometimes used interchangeably with—the term cleantech. The term climate tech is also used to describe the subset of those technologies that are intended to reduce greenhouse gas (GHG) emissions or mitigate the impacts of climate change.

Associated Sectors

- Energy
- Transportation/Mobility
- Agriculture and Food
- Manufacturing
- Construction

Greentech is closely associated with the energy sector, specifically the development and application of new solutions to generate, store, distribute, and expend energy that have a smaller environmental footprint than hydrocarbons. Within the energy sector, greentech is also sometimes referred to as clean energy, renewable energy, smart energy, or energy tech.

Various emerging greentech businesses target industries outside of the energy sector with a significant GHG footprint or other substantial environmental impacts. The transportation,

manufacturing, agriculture, and construction sectors are growing areas of interest, for example.

Why Is It Important?

Expectations for greentech are rising as governments, investors, businesses, and consumers put increasing emphasis on environmental sustainability. Companies in various industries are looking for ways to decrease their carbon footprint, water use, and environmental impacts, and existing and emerging green technologies are helping organizations meet more aggressive environmental and sustainability goals. In addition, leading private and institutional investors seeking to mitigate climate risks and bolster long-term value are pushing for companies to improve their environmental records and sustainability efforts.

Bumpy History, but Positive Outlook

The recent history of investments in sustainable technologies includes the so-called cleantech boom of the late 2000s and early 2010s that was followed by a downturn that marked much of the last decade.

Recently, the outlook for companies focused on greentech has been turning positive, as a result of improvements in sustainable technologies, coupled with decreases in pricing for greentech infrastructure, a renewed focus on human-caused climate change, and increasing government, investor, and consumer attention on sustainability in recent years.

SECTOR OVERVIEW (CONT'D)

Analysts are reporting more early-stage investment in greentech companies and technologies, and, over the past four years, investors representing over $60 trillion in assets under management have committed to driving action on climate change across their portfolios. Further, the movement among large commercial and industrial consumers of power, including technology companies such as Google, Meta and Microsoft, to achieve carbon-free energy consumption targets continues to gain momentum and drive increasing demand for renewable energy.

Innovation in Greentech Requires New Legal Strategies

Breakthrough developments in green technologies are helping to propel the economy, driving growth in key sectors such as transportation, manufacturing, agriculture, and construction, and have the potential to reduce emissions and other environmental impacts. Many of these innovative technologies are also generating unique legal and regulatory issues that require foresight and preparation. For greentech, such issues can involve a wide range of issues, including those related to privacy and data protection, cybersecurity, use of artificial intelligence and machine learning, intellectual property, blockchain, and trade, among others.

THE U.S. GOVERNMENT AIMS TO REDUCE GHG EMISSIONS TO PRE-2005 LEVELS BY 2030 AND TO ACHIEVE NET-ZERO EMISSIONS BY 2050.

ENABLING SCIENCE AND TECHNOLOGY

Industries Poised to Benefit From Technology Advances

There are many exciting areas of science and technology research that fall within the greentech category; we have highlighted several below that are considered by industry analysts to be essential to the next generation of breakthroughs. Many of these developments will directly benefit the energy and power distribution sectors, as they will facilitate the generation, storage, and distribution of clean energy. However, other sectors are also poised for potentially significant boosts from such breakthroughs.

> The recent increase in sustainable technology funding, coupled with a stronger alignment of government policy priorities, points to more robust years ahead for new greentech patent applications.

Energy

Several promising technological developments pertain to the increased deployment and use of clean energy. A primary focus is battery technology, including advances in lithium-ion battery technology—however, green hydrogen, smart energy grids, and other technologies also will play a role. Advanced storage solutions and smart energy technologies could help electricity producers and distribution utilities manage the intermittent nature of the most promising renewable production technologies, such as solar and wind, while cheaper, more powerful, and longer-lived batteries would support further growth within the electric vehicle market.

In addition, technological developments that permit construction of small modular reactors (SMRs), including microreactors, could offer opportunities for reliable carbon-free energy in areas that have limited infrastructure or lack sufficient access to other renewable energy sources, with a reduced environmental footprint and without the same safety risks associated with traditional nuclear power reactors.

Green Hydrogen

Green hydrogen is another promising area. Green hydrogen is created from water using electrolysis produced from renewable power and leaves no by-products other than oxygen. Although hydrogen is a promising fuel source and energy storage medium, the two most cost-effective ways to produce it currently rely on natural gas, creating a CO_2 footprint (gray hydrogen) or an extra carbon capture step (blue hydrogen). If scalable production of green hydrogen can be achieved, it is likely to become a pillar of decarbonization, according to reporting by Wood Mackenzie, with a wide range of potential applications.

Carbon Capture and Storage

Carbon capture and storage technologies remove CO_2 from both industry and the atmosphere and put it in long-term storage. Carbon capture can take place in three stages where hydrocarbons are burned during industrial processes: pre-combustion, post-combustion, and during combustion. Once captured, the CO_2 is dissolved into a solvent that must be stored in a sealed location. Advances in technologies related to carbon capture and storage could create an easier path to long-term decarbonization by enabling the continued use of hydrocarbons in the short term, while still meeting reduced emissions goals and allowing time for the transition to alternative energy sources to take place.

In addition, research is being conducted into direct air carbon capture and storage (DACCS). DACCS technologies capture previously released CO_2 from the atmosphere and either lock it up in the ground or use it, for example, in industrial products such as concrete or by combining it with hydrogen to

ENABLING SCIENCE AND TECHNOLOGY (CONT'D)

produce synthetic fuels. While these technologies are still in early stages of development, analysis from the International Energy Agency (IEA) and other research indicates that they could play an important role in mitigating the impact of climate change. Interest in carbon capture and storage is driven by the imperative to lower GHG emissions more rapidly than relying on the more gradual transition to renewable energy sources.

Photovoltaic and Wind Generation

While solar and wind technologies have existed for decades, research and technological developments are continuing to lower the cost of such technologies, increase output, and improve efficiency and durability. These technologies will continue to accelerate the deployment of solar and wind generation facilities, while new technologies, such

as perovskite solar cells, could further lower costs of renewable generation.

Convergence With Other Emerging Technologies

Other areas of emerging science and technological developments are converging to accelerate new green technologies that will help make major industries more sustainable. For example, artificial intelligence, machine learning, and blockchain can enable rapid and ongoing optimization, decentralization, and enhanced security. Cloud computing and wireless technologies mean that greentech solutions can be deployed and distributed further, faster, and in more places.

BREAKTHROUGH DEVELOPMENTS IN GREEN TECHNOLOGIES ARE HELPING TO PROPEL THE ECONOMY AND DRIVE GROWTH IN KEY SECTORS SUCH AS TRANSPORTATION, AGRICULTURE, AND CONSTRUCTION AND HAVE THE POTENTIAL TO REDUCE EMISSIONS AND OTHER ENVIRONMENTAL IMPACTS.

SECTOR AND INDUSTRY SIGNALS

Corporate Leaders Pledge Zero Emissions and Launch Major Funds

In 2019, Amazon pledged to achieve net-zero carbon emissions by 2040 and launched a $2 billion Climate Pledge Fund to support the development of green technologies. Microsoft and Unilever also have made aggressive emission pledges and launched their own climate-focused funds ($1 billion and €1 billion, respectively), while over 1,800 companies have committed to net-zero emissions by 2050 via the Science Based Targets initiative. These are strong signals of demand—and financial support—for emerging greentech companies.

Leading Investment Managers Focus on Climate Opportunities and Risks

Leaders in the asset management sector—notably BlackRock and State Street Global Advisors—have recently put corporate boards on notice that environmental sustainability and other nonfinancial matters are increasingly important investor considerations. Funds, in turn, offer a growing number of options for investors to screen for environmental, social, and governance considerations.

Increasing Adoption of Electric Vehicles and Charging Networks

An increasing number of automakers are announcing plans to increase their electric vehicle offerings and some, such as General Motors, Volvo, and Jaguar, are planning to shift to selling only electric vehicles within the next 10 to 15 years.

In January 2021, Royal Dutch Shell Plc, which has been investing heavily in renewable energy assets and the mobility sector since setting out a net-zero emissions by 2050 goal in April 2020, announced the acquisition of Ubitricity, a European electric vehicle charging network. The combination of Ubitricity's on-street charging sites and technologies and Shell's retail locations could accelerate electric vehicle adoption in Europe.

Aircraft Manufacturers Planning Zero-Emission Commercial Planes for 2030s

According to its 2021 Sustainability Report, Boeing has committed that its commercial airplanes will be capable of and certified to fly on sustainable aviation fuels by 2030. Boeing also is researching and investing in electrification technologies as well as supporting research to develop technology for green hydrogen fueled aircraft.

Wright Electric, a World Economic Forum Technology Pioneer, is developing a zero-emissions passenger plane capable of operating at the same cost as a fuel-based model, and aims to reach market by 2030. Meanwhile, European conglomerate Airbus is considering three different concepts for its own zero-emissions commercial aircraft, and it hopes to have one entering service by 2035.

Penn State Researchers Generating Hydrogen Fuel From Seawater

A Penn State research team integrated water-purification technologies with an electrolyzer, converting seawater to hydrogen, with a proof-of-concept design. Funded by the U.S. National Science Foundation (NSF), this development has the potential to eliminate a major barrier to using the most abundant source of water (i.e., seawater) for green hydrogen production.

> Other areas of emerging science and technological developments are converging to accelerate new green technologies that will help make major industries more sustainable.

GREENTECH

IMPACT

Economic

Advances in renewable energy generation and storage will accelerate the decarbonization of the energy economy, and also lead to major shifts up and down the current energy supply chain, according to industry analyst Wood Mackenzie and others. This is because some electric generation will be more distributed and closer to end markets, a shift that will create new opportunities for alternative energy producers and distributors. In addition, large-scale industrial energy users, such as manufacturers, will be able to take advantage of greater diversity and competition in the energy market, while also reducing their own carbon footprints.

Social

Social pressure is increasing on energy producers and manufacturers for more sustainable goods and services, according to analysis by PwC. While various greentech developments have the potential to improve sustainability and reduce environmental impacts within the key sectors identified above, the gains from such developments will need to be balanced with associated social, economic, and environmental impacts.

Increasing access to affordable and reliable renewable technologies that have the potential to make electricity available at a lower cost to more people, even in remote locations where access to traditional utilities is difficult, is a focus. However, certain adverse consequences associated with deploying such technologies will need to be considered and, ideally, shared more equally among communities.

The widespread adoption of lower-impact, less-polluting technologies also presents opportunities to reduce certain social, economic, and environmental issues that have disproportionately burdened certain communities, allowing such communities a chance to recover. Over the longer term, greentech technologies could help reduce the risk of disruptions caused by large-scale population displacement due to rising sea levels, extended drought, or severe weather if the implementation of such technologies can sufficiently mitigate the negative consequences of climate change.

Environmental

An essential premise of greentech is that science and engineering can reduce—and possibly reverse—the negative impacts that businesses and people have on the natural environment. One focus of green technology is to reduce the release of greenhouse gases, which are identified as the main contributor to climate change. Other significant environmental changes that green technologies could enable include reduced industrial consumption of fresh water, reduced plastic waste, and reduced air pollution, among others.

Although certain greentech development paths could have significant benefits, other environmental challenges may emerge as a consequence. For example, certain advanced battery designs have created an increased demand for select metals and chemicals, potentially increasing environmental damage caused by extraction and production processes. Further, the disposal of advanced technology products could create new sources of pollution. Consequences such as these could be ripe areas for further innovation in the future.

Policy

Globally, more than 100 countries have committed to net-zero emissions by 2050, and analysts expect the policies stemming from these pledges to include subsidies for green technologies and infrastructure spending, carbon pricing, and new bans and phase-out periods for high-impact products and processes.

In the United States, the Biden administration has announced a goal of reducing GHG emissions to pre-2005 levels by 2030 and achieving net-zero emissions by 2050. In addition, 24 states and Washington D.C., have established greenhouse gas reduction targets, including many carbon neutrality and net zero goals. These goals are informing new policy directives and rulemaking across the federal government, and driving new spending and investment-attraction initiatives on sustainable technologies and the infrastructure to deploy them.

2022 EMERGING TECHNOLOGY TRENDS | MARKET AND LEGAL INSIGHTS FOR INNOVATORS   PERKINS COIE LLP | 43
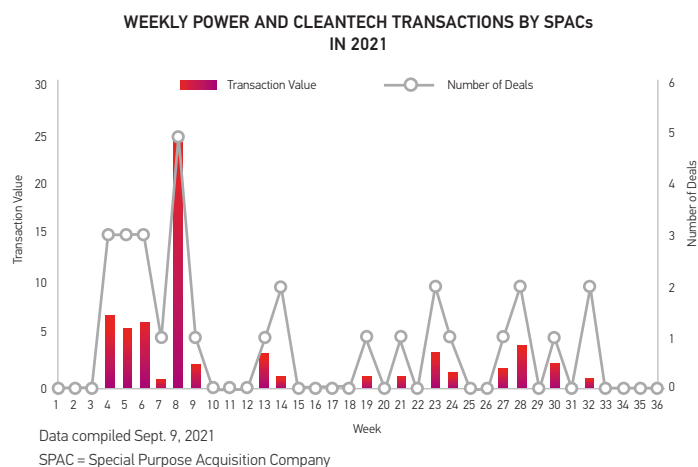
LEGAL IMPLICATIONS

OUTLOOK

Transactions and Financing | Early-Stage Funding Rising Fast, Use of SPACs to Go Public

Funding for greentech businesses has been increasing recently after years of muted interest. In the climate tech category, for example, total funding, average funding levels, and startup creation rates are all on the rise, according to analysis by PwC. Larger deals (i.e., over $100 million) are a significant part of the funding growth, which may signify a new degree of maturation in the greentech ecosystem.

Such a level of activity is likely to continue as long as the overall greentech environment remains positive, though as investors witnessed previously, this sector can be more sensitive to changing government policies (e.g., investment, trade, and regulatory) than others.

As greentech companies mature and consider going public, many are following the trend of listing through a merger with a special purpose acquisition company (SPAC). In fact, U.S. public listings by SPACs with a broad sustainability focus were already increasing early in 2021, with 49 such listings in the first four months of 2021 alone. A report by S&P Global indicates that there had been nearly three dozen cleantech SPAC deals through the end of August 2021, largely in the energy sector.

WEEKLY POWER AND CLEANTECH TRANSACTIONS BY SPACs IN 2021

Data compiled Sept. 9, 2021
SPAC = Special Purpose Acquisition Company

Source: S&P Global Market Intellence; Raymond James

In addition, an ever-widening variety of power contracting structures are growing out of consumers' interest in achieving 100% renewable energy for their power needs. Over the last decade, virtual and physical power purchase agreement structures have been developed to enable consumers to match annual electricity demand with annual carbon-free energy production. Increasingly, consumers are using sophisticated models to understand the carbon intensity of grid-sourced energy at all hours of the day and are exploring ways to match their hourly electricity demand with carbon-free energy.

M&A Muted in 2020, Activity Renewed in 2021

Until recently, the pace of mergers and acquisitions activity has been relatively flat, with deal volume remaining well below the levels achieved in the mid-2010s. However, there are signs that the market may be picking up, with the number of deals in 2021 eclipsing those completed in 2020. Total deal value was well above the previous year's level, according to data from Pitchbook.

CLEANTECH M&A DEAL VALUE

CLEANTECH M&A DEAL VOLUME
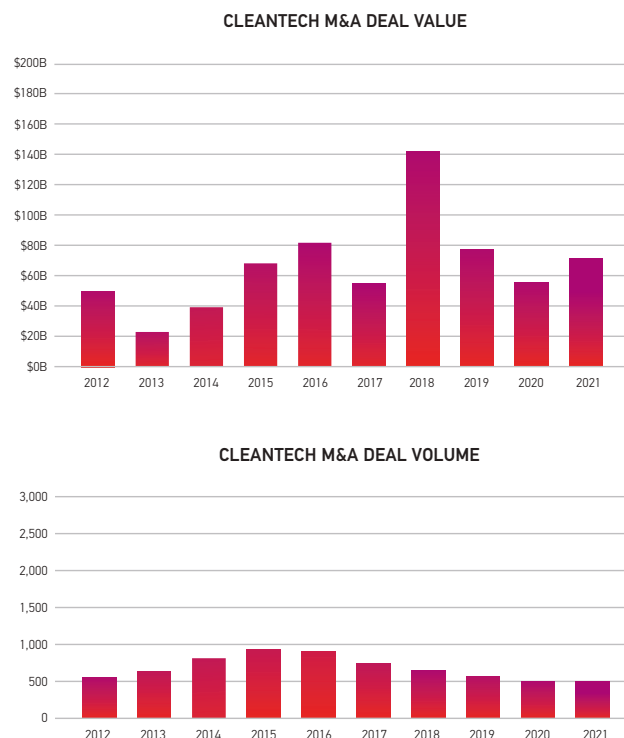
Source: PitchBook, September 28, 2021

LEGAL IMPLICATIONS (CONT'D)

Litigation | New Product Performance and Government Incentives

The litigation outlook for greentech companies reflects the widely varying technologies and their uses, but there are a few areas to watch.

As more products that incorporate green technology elements become available in the market, product liability claims are likely to rise as typically happens with any new class of products put to test in the "real world."

In addition, as the number of government incentives intended to encourage the development of sustainable technologies grows—such as tax breaks, grants, and loan programs—disputes may arise related to which organizations qualify for them, or to which parties the benefits should flow within greentech partnerships.

Cybersecurity | Threats on the Rise

Greentech includes the use of many digital tools, platforms, and processes—in energy production and distribution, electric vehicles, other mobility solutions, and more. Increased digitization translates to a higher level of cybersecurity risk, requiring increased defenses and risk mitigation strategies. The number of targeted attacks against the energy sector alone rose from 87 in early 2015 to 155 by the end of 2019, according to a 2021 World Economic Forum (WEF) report. Grid infrastructure, nuclear plants, gas pipelines, and safety systems for oil production operations have all been targets of cyberattacks in the past five years.

Regulatory and Compliance | New Priorities in the United States

The Biden administration has signaled that it intends to take a more active approach in its efforts to combat climate change and address other environmental priorities through public commitments and executive orders. This shift is expected to mean the establishment of more stringent regulations and increased enforcement activity.

Globally, other governments continue to take actions intended to combat climate change, which include carbon pricing, new regulatory mandates, and other measures.

Trade | Lingering Barriers

Global trade barriers increased—though not consistently—in the last decade. While there are some signals that outright trade wars may be on the wane, a certain degree of protectionism and trade uncertainty is expected to persist, and flare-ups may create headwinds for greentech companies that sell (or source) internationally. Some green technology companies, such as those that develop or manufacture alternative energy generating equipment (e.g., solar panels, wind turbines), may be more sensitive to these changes, particularly given the emergence of China as a leading manufacturer of necessary components.

Most recently, targeted trade bans and disrupted international supply chains may be putting large solar projects at risk.

LITIGATION AND REGULATORY DEVELOPMENTS

States Seek Curbs on Federal Government's GHG Regulation Authority

In April 2021, nineteen states filed an appeal with the U.S. Supreme Court seeking to overturn a decision of the U.S. Court of Appeals for the District of Columbia Circuit that would increase the Environmental Protection Agency's authority to regulate GHG emissions. The circuit court decision in question vacated a Trump administration decision to roll back Obama-era standards known as the Clean Power Plan and replace them with the less-stringent Affordable Clean Energy Rule. The case is scheduled for argument on February 22, 2022. Significantly, a group of innovative technology companies, including Amazon, Apple, Google, Meta, and Microsoft filed an amici brief in support of the Environmental Protection Agency's (EPA) regulation of GHG emissions. See *State of West Virginia et al. v. U.S. Environmental Protection Agency et al.*

U.S. Appeals Court Upholds a Federal Order to Open Wholesale Markets

In July 2020, the D.C. Circuit upheld the Federal Energy Regulatory Commission's (FERC) Order 841, which could clear the way for transmission grid operators across the country to open their markets to energy storage. The decision is seen

LEGAL IMPLICATIONS (CONT'D)

as a victory for the energy storage industry. See _National Association of Regulatory Utility Commissioners v. Federal Energy Regulatory Commission_.

FERC Issues Order to Open Organized Wholesale Markets to Aggregations of Distributed Energy Resources

In September 2020, the FERC issued Order No. 2222 in an effort to promote competition in electric markets by allowing distributed energy resources (DERs) to compete on more equal footing with regional grid operators. FERC's Order No. 2222 enables DERs to participate in the capacity, energy, and ancillary service markets operated by regional transmission organizations (RTOs) and independent system operators (ISOs) alongside traditional resources by allowing entities to combine or aggregate DERs in order to satisfy minimum size and performance requirements. While FERC's Order No. 2222 is currently in the implementation stage, its impact on regional organized wholesale markets is expected to be significant.

PATENT TRENDS AND OUTLOOK

Global Greentech Patent Filings Rising

The overall volume of international patent applications in key greentech indicator areas appears to be recovering after several years of declines starting in 2013, according to data and analysis from the World Intellectual Property Organization (WIP). This timing suggests a link to the cleantech funding bust around the same time frame.

Further, the recent increase in sustainable technology funding, coupled with a stronger alignment of government policy

TOTAL RENEWABLE PATENTS FILED
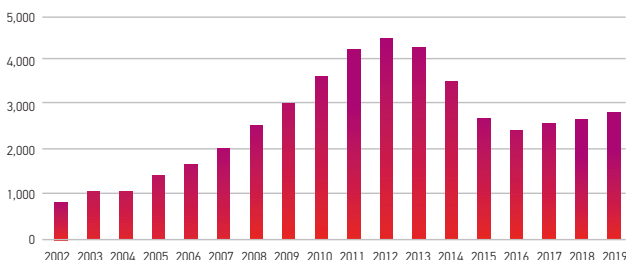
Source: WIPO Magazine

priorities, points to more robust years ahead for new greentech patent applications.

U.S. International Greentech Patent Activity Ranks Third Globally, Behind EU and Japan

Europe, Japan, and the United States dominate the global low-carbon energy (LCE) innovation landscape, together accounting for more than three-fourths of all international patent families (IPFs) generated from 2000 to 2019, according to a 2021 report by the IEA and European Patent Office (EPO).

GROWTH IN GREENTECH (LOW CARBON ENERGY INNOVATION) INTERNATIONAL PATENTS
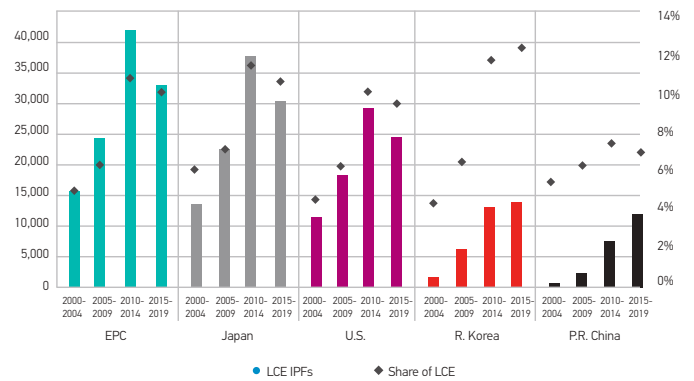
Source: European Patent Office

Within the larger sphere of clean technology, patent analysis in the IEA and EPO report shows that leading areas of innovation by U.S. filers include:

- Bioenergy
- Efficient Energy Combustion
- Nuclear Energy
- Aviation
- Carbon Capture and Storage

In addition, a high share of international collaborations related to the development of clean technologies involve the United States and Europe and have the potential to accelerate technological progress. The IEA and EPO report indicates that international co-inventions have increased in the United States and most European countries and that there is a high share of co-invention in U.S. IPFs.

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ABOUT US

Technology Transactions & Privacy | Greentech

We advise our greentech clients on numerous key issues including startup formation, founders issues, and raising capital. Our Intellectual Property attorneys help our greentech clients patent and protect their intellectual property. In addition to providing startup, corporate, and intellectual property counsel, we advise greentech clients on labor and human relations matters. Our Environment and Energy attorneys counsel public and private clients who are advancing scientific and technological responses to climate change. Our Energy Regulation and Policy attorneys help clients site and operate manufacturing plants as well as market and execute strategic partnerships and acquisitions.

Working across multiple practice groups, we counsel greentech clients on a variety of issues involving key sectors of greentech, including energy efficiency, renewables, alternative energy, transportation, and water.

HEALTHTECH & MEDTECH

2022 EMERGING TECHNOLOGY TRENDS

MARKET AND LEGAL INSIGHTS FOR INNOVATORS

PERKINSCOIE

Because they have different purposes, healthtech and medtech involve different forms of enabling technology.

SECTOR OVERVIEW

What Is the Difference Between Healthtech and Medtech?

The term "healthtech" refers to technology-enabled healthcare, or healthcare administration. The product or service is typically delivered outside of a hospital or a doctor's office, but hospital and practice management software is considered an exception.

Whereas healthtech focuses on operational improvements, the term "medtech" refers to medical technology improvements. By enabling the development of the latest medical devices and techniques, medtech improves the diagnosis and treatment of medical conditions.

Associated Sectors

- Healthcare
- Telehealth
- Medical Device Manufacturing
- Medical Research
- Pharmaceuticals
- Software Development

Technological improvements have implications for each vertical in the healthcare sector. Healthtech supports healthcare providers in running more efficient organizations and providing services in different ways. This has been especially important during the pandemic, as telehealth has become the preferred delivery option or, in some cases, the only option.

Medtech represents the cutting edge in medical research. As researchers and doctors find better ways to diagnose and treat medical conditions, their techniques are supported by specialized equipment.

Healthtech, Medtech Supported by Different Technologies

Because they have different purposes, healthtech and medtech involve different forms of enabling technology. As shown by the following charts, the Internet of Things (IoT) is the technology of choice for well-being and care delivery, whereas artificial intelligence (AI) and machine learning (ML) receive more investment from data and platform innovators. Investment in both subsectors rose substantially in 2020, reflecting the need for technology-enabled healthcare.
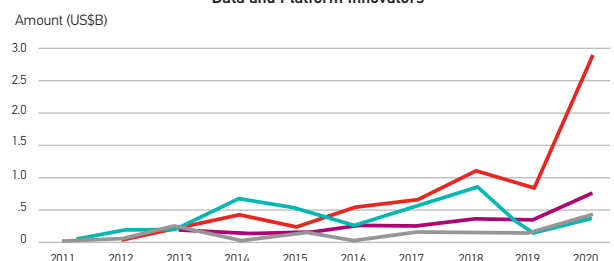
DIFFERENT TYPES OF INNOVATORS ARE LEVERAGING DIFFERENT TECHNOLOGIES
Healthtech venture funding ($B) by technology

— AI, ML, and deep learning — Digital medical device — Genomics and sequencing
— IoT (includes remote monitoring, telehealth, sensing) — Nonmedical device hardware — Other

Well-Being and Care Delivery Innovators
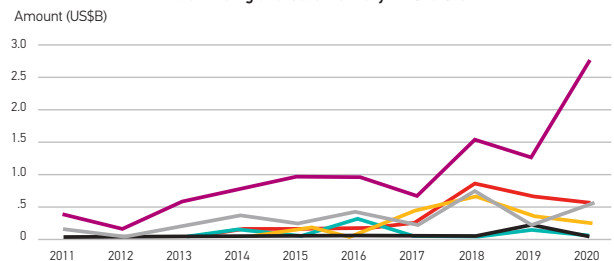
Data and Platform Innovators

ENABLING SCIENCE AND TECHNOLOGY

Mobile and Digital Options Meet Increased Demand for Remote Care

Delivering healthcare through mobile and digital services offers several advantages—convenience, reduced costs, and, during the COVID-19 pandemic, personal safety. To meet increased demand, startups and incumbent providers and payers invested in their virtual health offerings. The Centers for Disease Control and Prevention (CDC) identified three different telehealth modalities: synchronous (or real-time) interaction, asynchronous interaction, and remote patient monitoring. Healthcare providers choose among a range of telehealth solutions, from specialized software to cloud

comfortable using at-home diagnostic tools, citing results from the Deloitte Center for Health Solutions' latest consumer survey. There are signs that deal activity is following this trend, as digital pathology and point-of-care testing companies received investor attention in the in-vitro diagnostics space in Q1 2021.

Another area to follow is Amazon's investment in at-home testing, as the company reportedly plans to launch a general diagnostics service. The move is part of a trend that began before the pandemic, namely when Apple Health and other companies partnered with direct-to-consumer health startups.

Paige announces Series C funding round of $100M to accelerate transformation of digital pathology

JANUARY 14, 2001 | PAIGE

Ibex Medical Analytics Raises $38M to accelerate adoption of AI-powered cancer diagnostics in pathology

MARCH 9, 2021 | IBEX

Truvian raises $105M, plans to submit benchtop blood-testing tech to FDA

FEBRUARY 26, 2021 | TRUVIAN

Inflammatix nets $102M to advance its immune system tests for infectious diseases

MARCH 16, 2021 | INFLAMMATIX

Source: State of Healthcare Q1'21 Report: Investment & Sector Trends to Watch (CB Insights)

solutions. Specialized solutions sometimes integrate several functionalities, such as video conferencing, store-and-forward data capabilities, and remote collecting/monitoring of patient medical data. Some clinics may also have a patient portal.

Diagnostics Improvements Achieved Through Digital Pathology and Point-of-Care Testing

Deloitte recently predicted that more diagnostic tools will be developed for home use, and that consumers will increasingly become accustomed to monitoring their health at home. They noted that between 30% and 50% of consumers are

The need for at-home testing and diagnostics plus consumers' willingness to use these services both increased during the pandemic. This led to growth in demand and investment, as observed above.

Care Coordination Software Helps Reduce Waste in US Healthcare System

As medical services are increasingly provided outside of the hospital setting, the number of physicians and care providers is on the rise, therefore increasing the need for coordination in the U.S. healthcare system. One study found that poor

ENABLING SCIENCE AND TECHNOLOGY (CONT'D)

communication among providers leads to $78 billion in wasted healthcare spending annually. To solve this problem, the Centers for Medicare and Medicaid Services (CMS) enacted a Conditions of Participation rule that requires hospitals to inform primary care physicians and post-acute care providers when patients are admitted, discharged, or transferred from inpatient services or emergency rooms. To meet this need, a market has now emerged for care coordination software.

AI and ML Shorten the Research and Development Cycle for New Molecular Compounds

AI and ML are leveraged for medical research and development because of their powerful predictive and data analytics capabilities. The technology helps reduce the cost of launching new drugs by shortening the amount of time needed to develop new molecular compounds. It also helps determine a drug's side effects before the drug is released, reducing the

time needed for clinical trials. Carnegie Mellon University is improving R&D by integrating big data with an ML algorithm that can test and analyze various drugs. Partnerships are increasingly common between pharmaceutical companies and AI companies, as shown by recent deal activity.

3D Printing Technology Leveraged for Devices, Tissues

A growing number of medical devices and equipment components can be manufactured through additive technology. Examples include orthopedic and cranial implants, surgical instruments, dental restorations such as crowns, and external prosthetics. The technology can also be used to re-create tissues and organs, a process called "bioprinting." This is an area to follow for further research and investment, as well as government regulation.

Iktos announces collaboration with Pfizer in AI for drug design

MARCH 2, 2021 | IKTOS | PFIZER

Cambridge Quantum to develop quantum algorithms with Roche for drug discovery and development

JANUARY 28, 2021 | CAMBRIDGE QUANTUM COMPUTING LIMITED | ROCHE

Mila collaborates with Astrazeneca to maximize the potential of AI for drug discovery and development

FEBRUARY 26, 2021 | MILA | ASTRAZENECA

Valence Discovery announces multi-target AI-enabled drug design collaboration with Servier

MARCH 16, 2021 | VALENCE | DISCOVERY

Source: State of Healthcare Q1'21 Report: Investment & Sector Trends to Watch (CB Insights)

SECTOR AND INDUSTRY SIGNALS

Medtech Growth Prospects Are Closely Connected to Hospital Demand; Healthtech's Prospects Are More Diverse

The prospects of the medtech industry are directly tied to medical procedures—including elective surgeries. Accordingly, hospital demand is an important indicator within the industry.

Healthtech has a broader reach because it includes both technology-enabled healthcare and healthcare administration. Accordingly, this subsector encompasses more businesses' models. In fact, there are at least nine "value pools" within the healthcare industry that directly relate to healthtech or present further opportunities for innovation.

NINE HEALTHCARE VALUE POOLS ARE RIPE FOR TECHNOLOGICAL INNOVATION

Examples of innovations in nine value pools across five categories

RESEARCH AND DEVELOPMENT **Enhance drug R&D process** Artificial-intelligence and machine-learning drug discovery, siteless trials, protocol optimization, trial site operations, and patient engagement **1**	**SCREENING AND DIAGNOSIS** **Intercept diseases through screening** Genomics and omics **3**	**FINANCE AND OPERATIONS** **Optimize the financial model** Value-based care arrangements, population health management, benefits administration **5**
PREVENTION **Improve wellness and prevent disease** Sleep-tracking, meditation and fitness, and disease-prevention tools **2**	**SCREENING AND DIAGNOSIS** **Identify the right patient** Digital at-home diagnostics Imaging diagnostics based on artificial intelligence and machine learning **4**	**FINANCE AND OPERATIONS** **Increase operational efficiency** Back-office simplifiers (ePrescribe) Nonclinical workflow support for providers **6**
CARE DELIVERY **Provide more effective therapies** CDS, [1] adherence solutions, disease management, digital therapies,[2] EMR[3] and claims data analysis, ePR0s[4] **7**	**CARE DELIVERY** **Provide remote patient support** Telehealth, remote monitoring, digital information, digital communities, logistics and care navigation support **8**	**CARE DELIVERY** **Supply therapies to patients** Rx onboarding, digital pharmacies, supply-chain solutions for medical supplies **9**

[1] Clinical-decision support.   [2] For example, cognitive games and cognitive behavioral therapy.   [3] Electronic medical records.   [4] Electronic patient-reported outcomes.

Source: Rock Health; McKinsey analysis

SECTOR AND INDUSTRY SIGNALS (CONT'D)

This chart shows that digital technology can improve almost any aspect of the healthcare industry, from care delivery to finance and operations. Hence, demand indicators are much more varied than for medtech and medical equipment.

Direct Contracting Rules Could Accelerate the Adoption of Value-Based Care in US Market

CMS enacted direct contracting rules in 2021, incentivizing value-based care by linking earnings and losses to the quality of care and patient outcomes. Value-based care has implications for healthtech, because providers can leverage technology to rein in costs. With better data and predictive modeling, physicians can intervene proactively and improve patients' health, thereby keeping costs low and improving their practices' profitability under the new direct contracting rules. Some startups now specialize in developing infrastructure for value-based care and risk-based models, creating a growing area in venture capital (VC) as investors respond to a market opportunity created by the new regulatory environment. Patient engagement portals and dashboards, combined with remote patient monitoring, can also help physicians engage with patients at a lower cost.

Government Makes Telehealth Billing Rules Permanent, as Utilization Stabilizes

In the first months of the pandemic, CMS enacted temporary rules on telehealth coverage. Some of the coverage provided by those rules was made permanent in January 2021, thus strengthening a new market opportunity even though the rules received pushback from medical groups due to lower reimbursement rates. Consumers view telehealth favorably, as utilization stabilized at 38 times the pre-pandemic levels.

Reflecting telehealth's popularity and a favorable regulatory environment, VC investment in the subsector increased threefold from 2017 levels and nearly doubled from 2019 to 2020.

**GROWTH IN TELEHEALTH USAGE PEAKED DURING APRIL 2020 BUT HAS SINCE STABILIZED**

Telehealth Claims Volumes, Compared to Pre-COVID-19 (February 2020 = 1)[1]
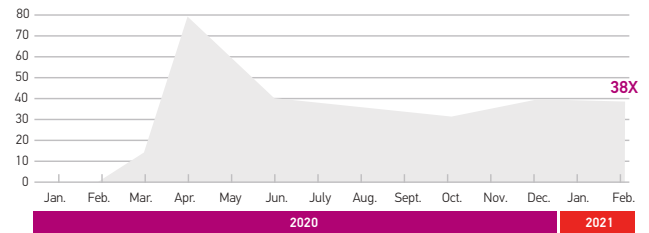
1 Includes cardiology, dental/oral, dermatology, endocrinology, ENT medicine, gastroenterology, general medicine, general surgery, gynecology, hematology, infectious diseases, neonatal, nephrology, neurological medicine, neurosurgery, oncology, orthopedic surgery, poisoning/drug tox./comp. of TX, psychiatry, pulmonary medicine, rheumatology, substance use disorder treatment, urology. Also includes only evaluation and management visits; excludes emergency department, hospital inpatient, and physiatry inpatient claims; excludes certain low-volume specialties.

Source: Compile database; McKinsey analysis

INVESTMENT IN DIGITAL HEALTH AND THE REVENUES OF TELEHEALTH PLAYERS ALMOST DOUBLED COMPARED TO 2019

Total venture funding for digital health companies, by year
$ billion

Total annual revenues
$ billion
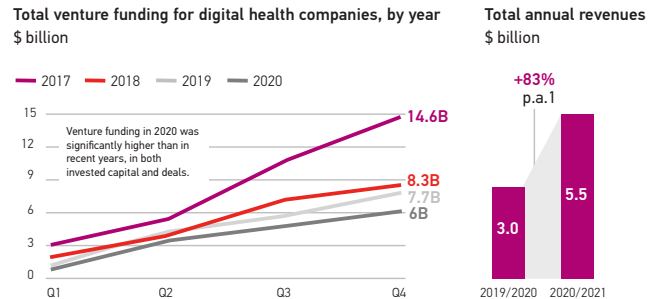
[1] p.a., per annum

Source: Adriana Krasniansky et al. "H1 2021 Digital Health Funding: Another Blockbuster Year…In Six Months," Rock Health, July 2021, rockhealth.com; McKinsey virtual health vendor database

SECTOR AND INDUSTRY SIGNALS (CONT'D)

Industry Executives Point to Recovery in Equipment Spending

Medical equipment manufacturer Medtronic's CEO explained, during a February 2021 earnings call, that the company's earnings are directly tied to procedures. Thus, when elective procedures were down during the pandemic, demand for medical equipment also dropped. With pandemic recovery underway, elective procedures are up again and Medtronic's CEO expressed optimism about demand in the coming months. The CEOs of Johnson & Johnson and Stryker have expressed similar confidence about upcoming demand for medical equipment.

INDUSTRY EXECS POINTED TO EARLY SIGNS OF RECOVERY

MEDTRONIC

" The use of our capital equipment is tied directly to procedures. So, it's telling that hospitals are prioritizing spending on this type of equipment...It is, in our mind, a signal to a step back [up] in patient volumes that we expect over the coming months. And that's consistent with conversations we've had with hospital CEOs [recently]."

GEOFF MARTHA, CEO
Earnings Call (2/23/2021)

JOHNSON & JOHNSON

" We remain very confident in the longterm prospects around the medical device market. We would expect to see continued impact certainly in Q1'21, although [based on] the early signs, we're encouraged by what we're seeing...We would expect to see expansion over the course of 2021, and beyond that, see a return to a market... growing in the midsingle-digits."

ALEX GORSKY, CEO
Earnings Call (1/26/2021)

STRYKER

" On the large capital front, we're actually very excited. From an order book standpoint, it's continuing to be very strong... We have enough confidence now with the hospitals being ready to do these procedures as soon as the pandemic starts to subside...They will turn on [capital investment] pretty quickly, and they'll be pretty agile, and that's why we feel pretty confident of being able to give a healthy guide."

KEVIN LOBO, CEO
Earnings Call (1/28/2021)

Source: State of Healthcare Q1'21 Report: Investment & Sector Trends to Watch (CB Insights)

IMPACT

Economic

Some healthtechs specialize in helping healthcare providers and payers run leaner, more efficient organizations. Care coordination software, for example, ensures that physicians receive patient information when they need it. Likewise, data analytics help physicians identify and solve problems before they turn into chronic conditions. Finding efficiencies in healthcare systems represents a significant commercial opportunity and frees up public resources to improve the quality of care. Globally, there appears to be a gap between healthcare spending, at $8 trillion, and the healthcare industry's market capitalization. This gap is expected to narrow, as investors increasingly want to participate in the health market and there are dozens of unicorns from which to choose.

Social

Technology can simplify healthcare administration and free up resources for frontline care. This is particularly important in the United States, which suffers from an ongoing shortage of nurses. Nurses' wages increased only modestly in 2020, and many nurses are thinking of leaving the occupation altogether.

Environmental

Medical waste continues to be a global problem, for many reasons. Some medical equipment is used only once and then discarded, even if it could potentially be sterilized and reused. In other situations, the equipment may not be recyclable or biodegradable. Even medications do not necessarily break down, representing a challenge for wastewater treatment facilities. Industry and nonprofit stakeholders are working toward more sustainable solutions, which include recyclable and biodegradable equipment. Around eight years ago, the International Joint Commission found that only half of drugs were removed by sewage treatment, and more efforts are still needed today to clean up public waterways.

Policy

Care coordination software and other health technologies support value-based care by improving the efficiency of the healthcare system and promoting the exchange of patient information. A more efficient system furthers the dual goals of improved patient care and reduced healthcare spending. Governments might therefore continue to enact rules that
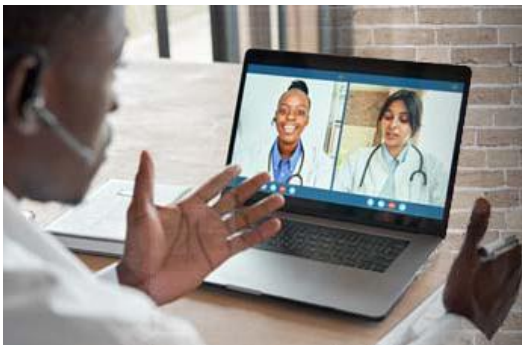
AS MEDICAL SERVICES ARE INCREASINGLY PROVIDED OUTSIDE OF THE HOSPITAL SETTING, THE NUMBER OF PHYSICIANS AND CARE PROVIDERS IS ON THE RISE, THEREFORE INCREASING THE NEED FOR COORDINATION IN THE U.S. HEALTHCARE SYSTEM.

This is a global problem, as 90% of nursing associations recently told the International Council of Nurses they're concerned about heavy workloads, insufficient resources, and pandemic-related burnout. An improvement in employment conditions for nurses in the United States may help solve the retention issue and improve the quality of care.

favor value-based care; this is an area to follow in the U.S. market in particular.
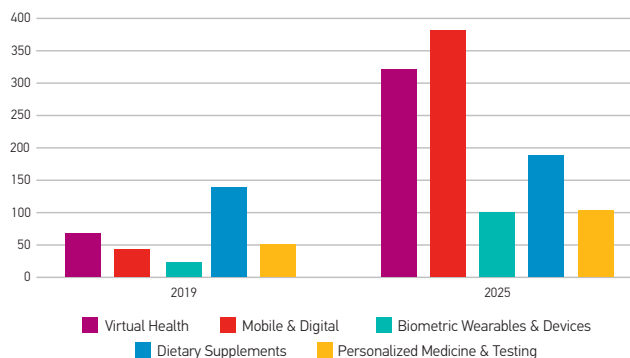
LEGAL IMPLICATIONS

Healthtechs are receiving a growing share of VC investment, particularly if they specialize in virtual, mobile, or digital health. As technology becomes more powerful, questions are being raised related to AI's ability to provide medical "advice," and regulators are following the area closely. On a parallel track, companies are said to have an increasingly "collaborative" mindset, which spurs M&A and other forms of partnership but also raises potential antitrust implications.

OUTLOOK

Transactions and Financing | VC Investors Drawn to Healthtech

The investment outlook for the health and wellness technology market is strong, particularly in mobile and digital services, and virtual health.

RETAIL HEALTH & WELLNESS TECH MARKET SIZE ESTIMATE ($B) BY SEGMENT

Legend: ■ Virtual Health ■ Mobile & Digital ■ Biometric Wearables & Devices ■ Dietary Supplements ■ Personalized Medicine & Testing

* As of March 31, 2021

Source: PitchBook, Geography Global

Overall, VC funding in healthtech almost doubled in 2020 compared to 2019. Companies focused on well-being and care delivery received around $6.4 billion in funding, closely followed by data and platform innovation at $6.1 billion. As the healthtech sector grows and receives more investment, IPOs and M&A become more likely.

M&A | Dealmaking Expected to Resume as Restrictions Lift

Globally, healthcare deal values declined 37% in 2020, to $338.6 billion. Deal volume also dropped by 9% to 2,845 deals. There are some bright spots in the data, however. Biopharma was the most active sector, accounting for 67% of total deal value.

As for medtech companies, dealmaking slowed during the pandemic, partly due to restrictions on elective surgeries. Currently, restrictions are being lifted in many jurisdictions, which brightens the prospects—and M&A potential—of medtech companies. As mentioned above, industry executives have observed signs of recovery.

As for healthtech companies, they are said to be shifting from a competitive to a collaborative mindset. Companies can access complementary capabilities and realize efficiencies through joint ventures and other forms of partnership. This is a trend to watch for, potentially leading to more consolidation among healthtechs.

Litigation | Data Breaches Increasingly Target Healthcare Providers

Healthcare data breaches experienced a 25% year-over-year increase in the United States, based on government data. The data further shows that 2019 was itself a record-breaking year. This makes it more likely that class actions will be filed against healthcare providers, plans, and other stakeholders handling patient data. Healthcare providers are at greatest risk of being affected by data breaches.

2020 HEALTHCARE DATA BREACHES BY ENTITY TYPE

Legend: ■ Healthcare Provider ■ Health Plan ■ Business Associate ■ Healthcare Clearinghouse
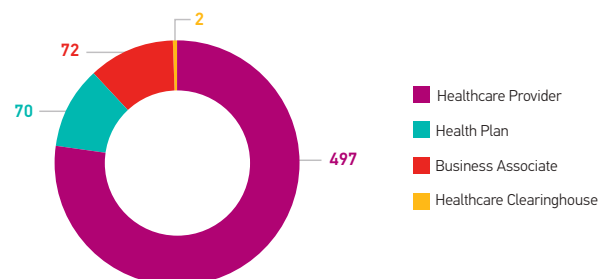
Source: HIPAA Journal, 2021

LEGAL IMPLICATIONS (CONT'D)

Due to the national public health emergency, however, the government has provided some relief from enforcement of the Health Insurance Portability and Accountability Act (HIPAA). In a March 2020 notice, the Office for Civil Rights (OCR) at the U.S. Department of Health and Human Services (HHS) said it would "exercise its enforcement discretion and will not impose penalties for noncompliance with the regulatory requirements under the HIPAA Rules against covered healthcare providers in connection with the good faith provision of telehealth during the COVID-19 nationwide public health emergency." Several other notifications of enforcement discretion were issued in later months.

Data Privacy | HHS Enacts Healthcare Interoperability Rules

Two HHS rules recently took effect, clarifying which activities constitute information blocking and granting patients more access to their health data. Information blocking is any activity that interferes with the access to and exchange of electronic health information, whether by providers, health information technology developers, or health information networks. The information blocking rule aims to discourage the practice, while the patient access rule provides patients with unprecedented access to their medical information.

LITIGATION DEVELOPMENTS

Questions Raised About Algorithms' Ability to Provide Medical 'Advice'

Global reinsurer Swiss Re issued a warning on the litigation risk posed by health apps and wearables. The company notes that "faulty data or algorithm-bias can lead to inadequate health advice, resulting in bodily injury and single large-losses in casualty." If this happens, the fault or bias could affect multiple users, thus increasing morbidity or mortality and triggering liability coverage. Such an event would also pose reputational and investment risks for the companies involved, as well as their insurers.

Health AIs Face Growing Regulatory Scrutiny

Two high-profile enforcement cases show that healthcare AIs in the United States are coming under increased regulatory scrutiny. The first case involves "Project Nightingale," a partnership between Google and Ascension that provided Google with access to the medical records of 50 million patients. After the story broke through a whistleblower, HHS launched an investigation and prompted scrutiny from lawmakers. Some advocates also called for legislative reform.

> ## AI and ML are increasingly leveraged for medical research and development because of their powerful predictive and data analytics capabilities.

The rule changes represent an opportunity for electronic health record (EHR) vendors, namely to provide mobile applications that facilitate the exchange of health information. The rules are also part of a broader international trend toward healthcare interoperability, a market that is expected to be worth around $7.96 billion by 2024. Despite this opportunity, most providers and health plan executives are said to view the interoperability rules from a compliance angle, instead of a business opportunity angle.

In a separate proceeding, New York's Department of Financial Services and Department of Health are investigating whether Optum's ImpactPro algorithm discriminates against Black patients in violation of New York law. The investigation followed a study published in the journal *Science*, which suggested the algorithm prioritized care of white patients over Black patients through a "risk score" that was based on historical healthcare spending. Because Black patients often

LEGAL IMPLICATIONS (CONT'D)

spend less on healthcare, the algorithm concluded they were healthier than white patients with identical health conditions. Optum committed to correcting the software, but these events highlight the risks of incorporating bias into health AIs.

Drug Payment Assistance Programs Before Federal Court

The U.S. Department of Justice (DOJ) alleges that Regeneron Pharmaceuticals used a patient assistance foundation to fund co-payments on its expensive macular degeneration drug Eylea. Drug companies are prohibited from subsidizing co-pays for Medicare patients. The proceeding is ongoing. Once resolved, it might have implications for the healthtech and medtech sectors, by clarifying or confirming the rules applicable to co-payments.

PATENT TRENDS AND OUTLOOK

'Patent Monopolies' at Heart of US Drug-Pricing Debate

As noted by the World Intellectual Property Organization (WIPO), IP law incorporates a complex balance between global health, access to medical technologies, and a supportive environment for research and development.

In the U.S. context, patent monopolies are at the center of an ongoing controversy, particularly in the pharmaceuticals industry where such monopolies typically result in higher drug prices. The U.S. government recently supported waiving IP rights on COVID-19 vaccines, in a move welcomed by developing countries that have struggled with vaccine access. President Biden also issued remarks at the signing of an executive order promoting competition in the U.S. economy through tougher enforcement of antitrust laws. This new stance could have implications for the enforcement of IP protections in the health sector.

A GROWING NUMBER OF MEDICAL DEVICES AND EQUIPMENT COMPONENTS CAN BE MANUFACTURED THROUGH ADDITIVE TECHNOLOGY.

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ABOUT US

Technology Transactions & Privacy | Healthtech & Medtech

Healthtech and medtech innovations are accelerating at a blistering pace. Our attorneys have significant experience structuring strategic alliances, collaborations, joint ventures, licenses, and research, development, manufacturing, and distribution relationships, often using novel approaches and pioneering methods that further the business objectives of healthcare and life sciences companies. We guide clients engaged in traditional and innovative healthcare businesses through complicated regulatory frameworks, including clinical research regulated by the Food and Drug Administration, Office for Human Research Protections, National Institutes of Health, and Office of Research Integrity, as well as clinical development, post-approval marketing compliance, telehealth/telemedicine and multistate provider licensing compliance, Stark Law and Anti-Kickback Statute compliance, Federal Trade Commission and Centers for Medicare & Medicaid Services regulations regarding clinical integration, and federal research grant management compliance.

MOBILE WIRELESS TECHNOLOGY

2022 EMERGING TECHNOLOGY TRENDS

MARKET AND LEGAL INSIGHTS FOR INNOVATORS

PERKINSCOIE

MOBILE WIRELESS TECHNOLOGY
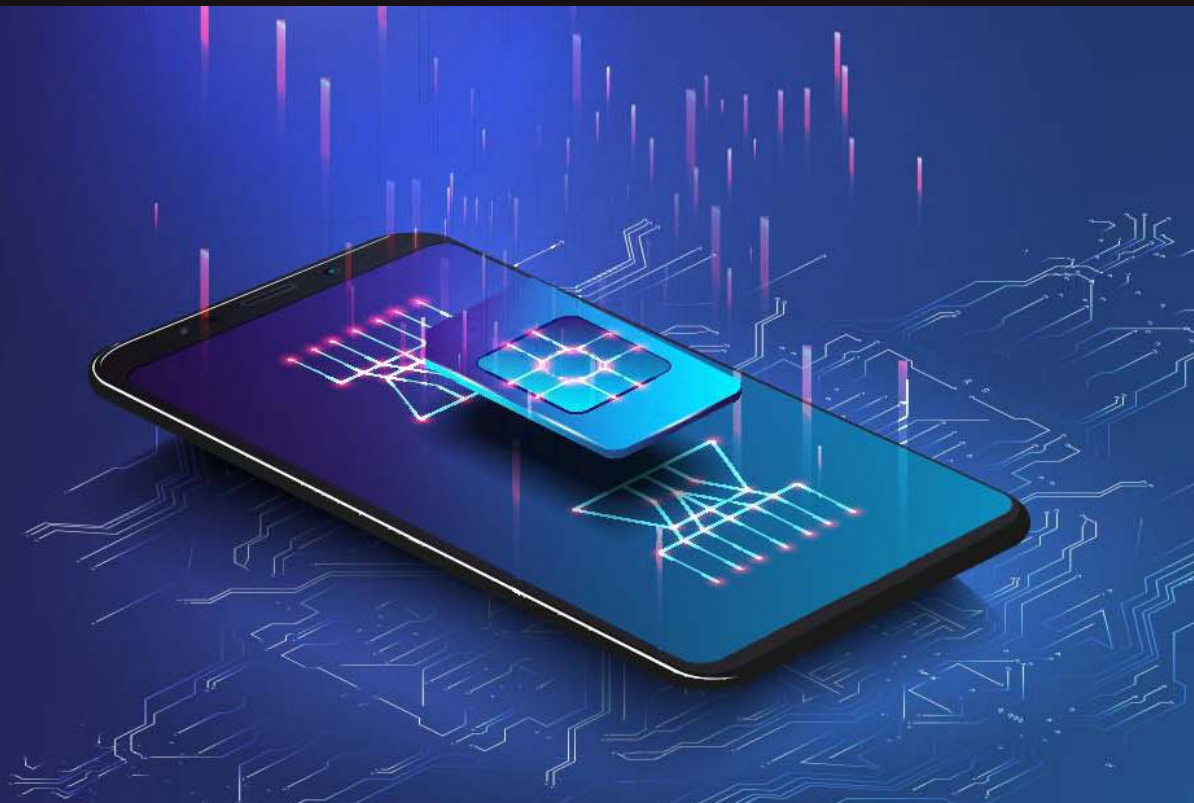
Smartphones are rapidly evolving to incorporate AI, GPS, biometrics, and other technologies to enable the development of new products and services, while also shaping the future direction of wireless innovation.

SECTOR OVERVIEW

What Is Mobile Wireless Technology?

Mobile wireless technology permits communication between persons, devices, or information systems in different locations by relying on radio spectrum rather than end to end landline connections between end users. It includes telecommunications, computing, Internet of Things (IoT), and networking technologies. Today, it is used to make consumer and commercial devices "smart" and is being deployed by business, government, and consumers to support a variety of use cases. The global rollout of fifth generation (5G) network technology is providing greater bandwidth and speed with lower latency, features that will enhance mobile performance and enable innovative applications and services. And the wireless industry is already at the beginning stages of preparing for 6G network technology, which will usher in unforeseen wireless innovations.

Associated Sectors

- Cloud Computing
- Infrastructure/Construction
- Information Services
- Healthcare
- Retail
- Finance
- Transportation
- Artificial Intelligence

Why Is It Important?

Mobile wireless technology, especially 5G mobile networks, is an essential part of the Fourth Industrial Revolution, which fuses the digital, biological, and physical dimensions of human life with developments in artificial intelligence (AI), cloud computing, robotics, and IoT. The term 5G refers to wireless technology that achieves certain high levels of speed and bandwidth and low latency (the response time for data to move from one point to another), enabling a broad range of innovative applications and services. AI and cloud technology can go farther on a 5G network. Innovation is moving rapidly, and some contours of the 6G future are already visible on the horizon.

Recent Technological Developments

The most significant developments regarding advanced wireless technologies include the millimeter wave spectrum (mmWave) and visible light communication, multiple-antenna technology (called "massive MIMO"), dense small-cell networks, network slicing, cloud-based wireless network management services, and AI for spectrum sharing.

Over the next decade, technical changes could include quantum computing, decentralized networks via handheld devices, over-the-air charging, and reflective surfaces facilitating one-terabyte-per-second transfer rates. However, development and deployment of 5G are ongoing, and it is too early to tell for certain what the next generation of mobile wireless technologies will look like.

ENABLING SCIENCE AND TECHNOLOGY

Unlocking the Spectrum: mmWave and Terahertz Spectral Bands

Millimeter wave spectrum (mmWave) sits between microwave and infrared waves and can be used for certain high-speed wireless services under certain conditions. This band is relatively uncongested, and the wavelength is shorter, meaning it can transfer greater quantities of data in less time, although it is more vulnerable to obstructions. While the technology currently operates in gigahertz frequencies, it will be extended into terahertz frequencies in the future. Terahertz usage has been proposed by the Federal Communications Commission (FCC) and is expected to be operational by 2030.

Unlocking the Spectrum: Visible Light Communication, or Light Fidelity

The visible light range of the electromagnetic spectrum is being considered to increase bandwidth, raise transfer rates, lower latency, and heighten security. Visible light communication (VLC) systems are also called light fidelity (LiFi) systems. The technology allows providers to use existing lighting infrastructure (high-speed light-emitting diodes and photodetectors) for communication. Visible light is on the terahertz spectrum and allows for greater bandwidth and faster data transmission speeds. It provides an extra layer of security because visible light cannot travel through opaque objects. This is especially useful in aircraft, medical equipment, and military zones, where security is paramount. Moreover, VLC operates on non-licensed frequencies, which is advantageous with respect to its implementation. Finally, terahertz frequencies are non-ionizing and generally considered safer than those purportedly cancer-causing ionizing frequencies higher on the spectrum, beginning with ultraviolet light. In summer 2021, the FCC determined that wireless communication technologies do not cause cancer. However, advocacy groups maintain that the FCC failed to adequately explain why its guidelines protect against the harmful effects of radiation unrelated to cancer and negative effects on sleep, memory, learning, perception, and motor abilities, and prenatal and child health.

Massive MIMO

MIMO stands for multiple-input and multiple-output. It is a method for multiplying transmission and receiving capacity through multiple radio antennas. Massive MIMO uses hundreds or thousands of antennas to support channel capacity, which increases with the number of antennas. The technology could deliver improvements in multiplexing, reduced interference, lower latency times, and higher efficiencies. It can also better mitigate intentional signal jamming, which enhances security.

> Massive MIMO could deliver improvements in multiplexing, reduced interference, lower latency times, and higher efficiencies. It can also better mitigate intentional signal jamming, which enhances security.

Ultra-Dense Small-Cell Networks

High-frequency bands like mmWave and terahertz spectrum have a large path loss due to atmospheric absorption and vulnerability to physical obstructions such as walls, tunnels, and trees. Operation at these frequencies therefore requires the careful placement of ultra-dense small-cell networks. In the initial years of 5G, these small cells will coexist with 4G technology. The former will cater to high-capacity users, while the latter will ensure better reliability and in-building penetration.

Wireless Time-Sensitive Networking

The Institute of Electrical and Electronic Engineers created protocols for time-sensitive networking, that is, connectivity enabled through "guaranteed packet transport with bounded

ENABLING SCIENCE AND TECHNOLOGY (CONT'D)

latency, low packet delay variation, and low packet loss." According to Intel, achieving time-sensitive networking over wireless "has been met with skepticism" by the industry, but this is an area of ongoing research and development.

Network Slicing

Network slicing allows several virtualized networks to exist on a single physical network infrastructure. This decreases energy costs and increases efficiency because each process receives only the physical resources it needs. Resources are allocated to each service dynamically based on usage, allowing the services to operate on the same physical infrastructure.

Artificial Intelligence

AI is an essential technological component of next generation wireless systems. Simultaneous support for many devices is and will continue to be a priority in the design of 5G and 6G networks. Massive MIMO technology requires AI to model channels, manage mobility, and optimize resource allocation. Predictive analytics and scenario adaptation are central to these networks, which makes continued developments in AI processes like machine learning and deep learning an indispensable enabling technology for growth.

SECTOR AND INDUSTRY SIGNALS

Broadband | Bipartisan Infrastructure Investment and Jobs Act

The $1 trillion proposed Bipartisan Infrastructure Investment and Jobs Act includes $65 billion to expand broadband internet access for millions of Americans who remain unconnected. It is expected to boost competition in areas where providers have not offered sufficient coverage. The funds will be distributed to states, and local businesses may bid on contracts. The time to complete projects will vary, but longer horizons and knowledge that the funds are available will help businesses plan. The improvements themselves will enable businesses in underserved areas to compete online across the country and increase digital equity by facilitating remote work, education, and healthcare.

Telecoms Roll Out 5G Millimeter Wave Spectrum

Some U.S. consumers currently have access to 5G technology either on the low-band spectrum, or on mmWave spectrum. AT&T offers mmWave through its 5G+ service, and Verizon is rolling out mmWave technology as well. Qualcomm claims to have achieved a "world's first" 5G mmWave data connection for 200MHz carrier bandwidth.

New Prospects in 5G Technology After FCC's C-Band Spectrum Auction

The FCC's auction of C-band frequencies in January 2021 raised $80.9 billion. This mid-band spectrum has less vulnerability to obstructions than high-band mmWave. The C-band will complement 5G deployments, especially by applying it to the next generation of wireless time-sensitive networks.

United States Partners with South Korea to Develop 6G

In the spring of 2021, the presidents of the United States and South Korea released a joint statement declaring that the two countries would collaborate to develop 6G technologies, especially in the fields of open radio access network and

AI IS AN ESSENTIAL TECHNOLOGICAL COMPONENT OF NEXT GENERATION WIRELESS SYSTEMS. SIMULTANEOUS SUPPORT FOR MANY DEVICES IS AND WILL CONTINUE TO BE A PRIORITY IN THE DESIGN OF 5G AND 6G NETWORKS.

SECTOR AND INDUSTRY SIGNALS (CONT'D)

quantum technology. Collaboration in the private sector began in 2020, when Samsung joined the Next G Alliance, whose members include prominent U.S. firms like Microsoft, Google, Apple, and Cisco. China's Huawei was not invited, but it did set up a research and development center for 6G in Canada the year before. Critically, the United States aims to become the leader in quantum cryptography communication, a technology capable of neutralizing existing internet security systems. Business competition and national security concerns—including the impact of quantum computing on current cryptographic methods—appear to be driving this cooperation with South Korea.

Meanwhile, China launched an experimental 6G satellite alongside 12 other orbital communications devices in late 2020. The satellite uses terahertz frequencies that could transmit data at speeds several times that of prevailing technology. It will also monitor crop disasters and help to prevent forest fires. Because the telecommunications industry is still years away from agreeing on 6G specifications, the trial satellite might not reflect the final standards.

LG Transfers Data Over 100 Meters on Terahertz Frequency, 6G Milestone

In the summer of 2021, LG successfully transmitted data over 100 meters outdoors using the terahertz frequency for the first time. Before August, the chief obstacle to successful communication was the band's short range and power loss during transmission. The achievement was made possible by a new power amplifier developed by LG, Fraunhofer HHI, and the Fraunhofer Institute for Applied Solid State Physics. The company also successfully demonstrated adaptive beamforming technology, which modifies the direction of the signal based on changes to the channel and receiver position.

Advances in Smartphone Technology Driving New Wireless Services and Innovation

Smartphones are rapidly evolving to incorporate AI, GPS, biometrics, and other technologies to enable the development

of new products and services, while also shaping the future direction of wireless innovation. AI-based services, such as Google Assistant, are ubiquitous and continue to evolve, while uses of GPS technology go beyond ride sharing and navigation services to mobile apps that can deliver customized and targeted support services. AI and GPS are being deployed for augmented reality services and games like Pokémon GO, which has surpassed one billion downloads. Smartphones are increasingly being synched with wearable and home devices as well. Uses range from healthcare to air conditioning and dynamic LED lighting. They are also being linked to smart cars (see below). Electric bike and scooter services, such as Lime, use the technology to make finding and renting vehicles easier. Biometrics are being used for device access and online banking, while real-time payment technologies have revolutionized business-customer relations.

Smart Cars, Autonomous Vehicles, and the Future of Mobility

Smart cars and autonomous vehicles can gather and process data in real time. Advances in wireless technology are enabling new services and will eventually provide the foundation for the mobility sector. Information collected from the road helps prevent accidents and smooth the flow of traffic, while on the horizon 3D technology will allow users to control parts of their car like windows, air conditioning, and entertainment systems using gestures. Smartwatches are already being synched to cars, allowing users to lock or unlock doors, turn headlights on or off, and beep horns. Synching to smart devices also allows users to locate their vehicle or call roadside assistance. Beyond improvements for user-friendliness, the capabilities of smart cars and autonomous vehicles are growing at a rate that is transforming the transportation sector. More information is available in the Robotics & Autonomous Systems section of this report.

IMPACT

Economic

New wireless technologies will deliver substantial economic benefits—the deployment of 5G technology alone is expected to contribute between $400 and $500 billion to the U.S. gross domestic product (GDP) directly and create up to a million jobs by 2030, representing merely 30% of the total value potential of the technology's implementation, according to Boston Consulting Group (BCG).

Building out broadband internet access is a pillar of the Biden administration's infrastructure investment initiative. Federal funding can facilitate a faster and more widely distributed build-out nationally, creating new economic opportunities for underserved areas and advancing access to greater health and educational resources.

The indirect economic impact of further developments in wireless technology is expected to be wide-ranging and affect almost every sector of the economy as the technology is adopted and used to solve productivity problems. BCG estimates that the indirect benefits attributable to the introduction of 5G technology could create 3.6 million jobs by 2030 and add up to $1.2 trillion to U.S. GDP, representing 70% of the total value potential of the technology.

Social

Ongoing developments in mobile wireless technology have far-reaching social implications. Terahertz frequencies, edge computing, satellites, and the cloud are likely to affect online education, remote work, precision agriculture, transportation, and smart implants. For example, online education and remote work are being powered by mobile hotspots, improved bandwidth, and cloud computing. These same technologies are transforming the agricultural sector, where wireless, edge computing, and satellite technology make possible real-time data streaming and precision agriculture. These developments help to increase crop production, manage water scarcity, and reduce waste by more tightly integrating supply chains.

THE $1 TRILLION BIPARTISAN INFRASTRUCTURE INVESTMENT AND JOBS ACT INCLUDES $65 BILLION TO EXPAND BROADBAND INTERNET ACCESS FOR MILLIONS OF AMERICANS WHO REMAIN UNCONNECTED.

IMPACT (CONT'D)

Environmental

Some cities are deploying cloud, IoT, edge computing and wireless technologies to improve transportation and reduce emissions. One city in Portugal set up a cloud-based command center that improved municipal services and reduced energy costs. It was most successful in waste management, where it cut operational costs by 40% and energy costs by 20%. Many other cities can deploy similar infrastructure, to improve the safety and efficiency of their services while reducing their carbon footprint. It's unnecessary to use the fastest wireless networks to create "smart cities," but lower latencies can be useful for devices that rely on real-time data, particularly emergency shut offs.

The industry is seeking ways to mitigate environmental challenges associated with the rollout of new wireless technology, including greater levels of e-waste, higher energy consumption, and the increased demand for materials sourced through intensive mining. Finally, study is ongoing regarding how greater use of the electromagnetic spectrum might affect animals that use the earth's magnetic field to navigate in space, such as bees and birds.

Policy

Beyond the economic investments in the federal government's infrastructure plan, the development and deployment of advanced wireless technologies have triggered national security and trade policy responses from the U.S. government and internationally. The U.S. Secure 5G and Beyond Act of 2020 requires the development of a national strategy to protect next-generation wireless technologies and infrastructure. The National Telecommunications and Information Administration has been tasked with developing the Implementation Plan for the National Strategy to Secure 5G. It identified four lines of effort: (1) facilitating the rollout of 5G in the United States; (2) identifying and addressing cybersecurity risks related to 5G infrastructure; (3) assessing and addressing risks to U.S. economic and national security as 5G infrastructure is deployed globally; and (4) encouraging the responsible development and distribution of secure infrastructure.

Government leaders in the United States are also looking beyond 5G. The U.S. Office of Naval Research, the U.S. Air Force Office of Scientific Research, and the U.S. Army Research Office are helping Princeton University researchers unlock the terahertz band, which the U.S. Department of Defense has identified as a "critical strategical technology" that could aid military communication, improve virtual and augmented reality for troops, and facilitate the deployment of autonomous vehicles. The United States is also partnering in wireless with world leaders, including South Korea, to develop technologies to contain China's growing influence.

LEGAL IMPLICATIONS

OUTLOOK

Cybersecurity | SolarWinds Hack Highlights Vulnerability of US Software Supply Chain

The 2020 cyberattack on SolarWinds was a wake-up call for U.S. Cyber Command and the broader cybersecurity industry. The successful breach of a company that provides infrastructure management software affected thousands of its clients, including the Pentagon and the U.S. Department of Homeland Security, among others. The code gave hackers a back door into client systems, allowing them to install malware. The extent of the breach is unknown, and its resolution could take years. The event highlighted the increased risks associated with converging technologies and an extended software supply chain, and brought to the forefront the importance of vendor security management.

Cybersecurity | Executive Order on Cybersecurity Signals More Uniform Approach

In May 2021, President Biden issued an Executive Order on Improving the Nation's Cybersecurity. The EO comes in response to increasingly sophisticated cyberattacks that threaten both private and public sectors. It identifies the prevention, detection, assessment, and remediation of cyberattacks as a top priority for the nation's security and prosperity. The move signals that the administration seeks to strengthen—and standardize—cybersecurity protections across the government and intends to move away from agency-specific policies in favor of a uniform approach with expanded participation from industry.

Specifically, the order aims to (1) remove barriers to sharing threat information; (2) modernize federal government cybersecurity; (3) enhance software supply chain security; (4) establish a cyber safety review board; (5) standardize the federal response to cybersecurity vulnerabilities and incidents; (6) improve the detection of vulnerabilities and incidents in federal government networks; (7) improve federal investigative

and remediation capabilities; and (8) require the Secretary of Defense to adopt National Security Systems requirements equivalent to or exceeding those set out in the EO.

Cybersecurity | Senators Introduce Cyber Incident Notification Act

A bipartisan group of senators introduced the Cyber Incident Notification Act of 2021. The bill would require critical infrastructure operators, government agencies, and contractors to report cybersecurity breaches to the Cybersecurity and Infrastructure Security Agency within 24 hours of detection. The legislation comes in response to the SolarWinds and Colonial Pipeline hacks that underscored the importance of information sharing to national security.

M&A | Dealmaking Set to Return to Pre-Pandemic Levels, but Long-Term Trends Show Decline

From one perspective, dealmaking in media and telecommunications began to recover in H2 2020, and momentum continued in H1 2021. Globally, there have been around 410 deals and $83 billion of announced deal value in H1 2021.

**ANNOUNCED DEAL VOLUMES AND VALUE**
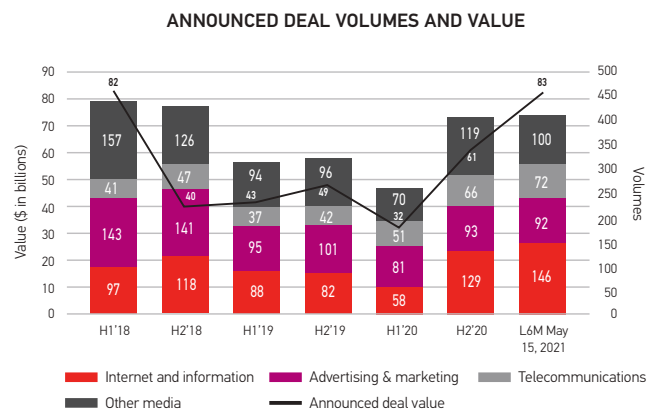
Source: PwC Analysis

LEGAL IMPLICATIONS (CONT'D)

From another perspective, PitchBook data reveals a long-term trend of declining M&A in the Communications and Networking vertical. The following chart shows dealmaking in 2021 on track to reach 2020 levels, but M&A activity has declined almost continuously since 2015:

INVESTMENTS OVER TIME
Deal Count
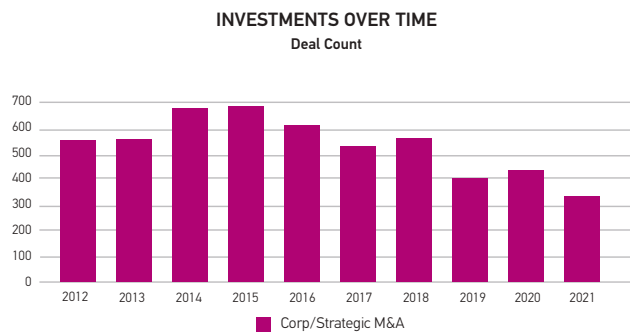
Source: PitchBook Companies & Deals Search (Accessed on September 30, 2021)

In terms of capital raised, the sector has seen a lot of variation over the same period, but there is a general downward trend since 2014:

INVESTMENTS OVER TIME
Capital Raised
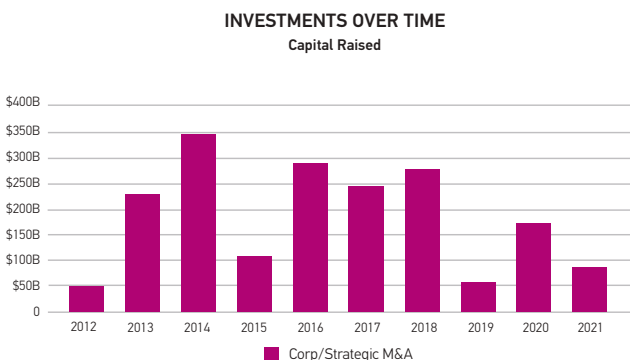
Source: PitchBook Companies & Deals Search (Accessed on September 30, 2021)

One explanation for the significant variation in deal value is the impact of megadeals. The media and telecommunications sector produced underlined several megadeals in recent years, and the trend appears to be continuing.

As noted below, however, future deals may face increased scrutiny from the FCC and the Federal Trade Commission (FTC) as the Biden administration prioritizes national security and antitrust considerations—potentially slowing or restricting M&A approvals.

Antitrust and Consumer Protection | New Executive Order Targets Big Broadband Providers

In July 2021, President Biden issued his Executive Order on Promoting Competition in the American Economy, targeting broadband service and calling for additional protections for subscribers of broadband services by restricting anticompetitive practices in the industry. The order encourages the FCC and FTC to consider rulemakings that would carry out these objectives:

1. Reviving protections for net neutrality, preventing companies from slowing internet content
2. Preventing the undue concentration of spectrum license holdings
3. Supporting the deployment of 5G Open Radio Access Network protocols and software
4. Prohibiting unfair early termination fees for subscription contracts
5. Requiring providers to furnish a consumer label with reliable information about their services
6. Requiring providers to report broadband price and subscription rates to the FCC
7. Preventing landlords and service providers from hindering tenants from changing providers
8. Preventing consumer device manufacturers from interfering with consumers' "right to repair" their own devices

Agency rulemakings can take a year or more to finalize and may evolve along the way. They are also subject to court review. It is unclear whether all these initiatives will become final regulations.

LEGAL IMPLICATIONS (CONT'D)

Antitrust | FTC's Defeated Suit Against Qualcomm Highlights Importance of National Security

A federal appeals court threw out an antitrust verdict against Qualcomm in 2020. The FTC had sued the chip manufacturer in 2017 for monopolistic pricing, denying licenses to its competitors, and blocking them from selling to Apple. Two years later, a federal judge found Qualcomm's behavior to conflict with the Sherman Antitrust Act and directed the firm to renegotiate license deals with its customers. The case was finally settled in Qualcomm's favor in summer 2020, but the reasons for its divisiveness warrant consideration. While the FTC and companies like Apple and Huawei supported the original ruling, the U.S. Department of Justice and telecom firms like Ericsson opposed it. Many of Qualcomm's supporters raised concerns about the ruling's national security implications. The company is the country's leading source of telecommunications chips, which enable drones, smart munitions, and the command of troops, among other military functions.

M&A | Committee on Foreign Investment in the United States and National Security

Apple, Microsoft, Amazon, Alphabet, and Facebook are among the top six publicly traded firms worldwide by market cap and are critically important to the United States and its place in the world. The ninth is China's Tencent. U.S. policymakers have raised concerns over the future of the country's technological leadership, especially as Chinese investment in U.S. high-tech companies continues to grow. In 2020, amendments to the process followed by the Committee on Foreign Investment in the United States (CFIUS) were finalized and went into effect. The updated process upholds the president's authority to prohibit or delay foreign mergers and acquisitions that threaten national security. Some changes include increasing the time allowed for government officials to review investment declarations, analyzing the potential impact of real estate transactions close to property critical to national security, evaluating noncontrolling investment in critical

technology and infrastructure businesses, and discriminating among foreign investors by country of origin and transactions tied to certain countries.

The United States also seeks to counter China's influence through infrastructure investments abroad, including telecommunications. The federal government recently dedicated $60 billion for that purpose. The program is led by the International Development Finance Corporation (DFC). Beyond ports and other strategic assets, the DFC seeks to encourage private-sector investment abroad by both American firms and those of its allies in cell networks.

M&A | Team Telecom, National Security, and Foreign Investment in the United States

Team Telecom is a committee of executive branch agencies responsible for, among other things, assessing the national security implications of transactions involving foreign investment in American telecommunications firms. In 2020, its review process was streamlined, and for the first time, reviews must occur within FCC-mandated time frames. Standard mitigation occurs within these time frames and involves investors who are regular participants in the telecom market, while nonstandard mitigation requires additional time and involves a unique risk profile. Team Telecom will continue to review existing FCC authorizations and recommend revoking them where appropriate. The establishment of review time frames and input from CFIUS is expected to improve alignment between Team Telecom and the U.S. intelligence community.

Regulatory | FCC Rejects Dish's Attempt to Deny C-Band Licenses to T-Mobile and Verizon

In July 2021, the FCC denied Dish Network's bid to prevent its mobile wireless carrier competitors T-Mobile and Verizon from acquiring C-band licenses. According to the FCC, the licenses won by the companies do not exceed spectrum-aggregation limitations. The agency determined that the expansion of 5G services into this band would not significantly shrink the

LEGAL IMPLICATIONS (CONT'D)

number of wireless businesses or consumers in local markets, nor would it lead to a single carrier controlling more than one-third of the spectrum allocated in the United States for commercial wireless use. The move puts an end to around three years of pushback against the spectrum auction.

LITIGATION DEVELOPMENTS

Self-Regulatory Process | Telcos Occasionally Solve Disputes Through BBB National Programs

BBB National Programs delivers self-regulatory and dispute resolution forums, several of which relate to advertising. The National Advertising Division (NAD) reviews national advertising in all media, and the National Advertising Review Board (NARB) is its appellate body. A review of NAD/NARB decisions shows U.S. telecommunications companies occasionally resort to the self-regulatory process. Over the last year, disputes have primarily centered on 5G rollout claims, network reliability claims and network speed claims. Complaints are typically filed by competitors, over the truthfulness of claims related to their rivals' networks, or on the truthfulness of claims disparaging their own networks.

PATENT TRENDS AND OUTLOOK

Chinese State Strengthens Protections for Patent Holders Amid Telecommunications Boom

China's economy stabilized over the last year and picked up steam, especially in 5G telecommunications investment. Complementing these developments in the economy, the Chinese state has initiated several legislative actions aimed at regulating foreign investment in the country. In October 2020, China passed its highly anticipated fourth amendment to the Patent Law of the People's Republic of China, which took effect on June 1, 2021. The amendment involves over two dozen articles affecting rights and procedures regarding the acquisition and protection of patents. The amendment seeks to strengthen Chinese patent law, augmenting the rights of applicants and patent holders, including a wider scope and term for patents and greater compensation for infringement. The amendment is designed to better defend the interests of patent applicants and holders.

MOBILE WIRELESS TECHNOLOGY

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ABOUT US

Technology Transactions & Privacy | Mobile Wireless Technology

With one of the leading groups in the industry, our Technology Transactions & Privacy attorneys possess decades of experience with laws and regulations critical to the communications sector. We maintain productive relationships with key federal agencies including the Federal Communications Commission and Federal Trade Commission, handling traditional proceedings, as well as developing and implementing innovative legal and public policy strategies. Our clients include wireless telecom companies, disruptive connected device manufacturers, and leading and emerging technology companies for whom we serve as product counsel.

PRIVACY & SECURITY

2022 EMERGING TECHNOLOGY TRENDS

MARKET AND LEGAL INSIGHTS FOR INNOVATORS

PERKINSCOIE

The rise of e-commerce, digital platform business models, remote working, and communications and social media are generating new data security risks to businesses, infrastructure, and individuals.

SECTOR OVERVIEW

What Is the Difference Between Privacy and Data Security?

Privacy is essentially the right to be left alone, while information privacy is the right to control how personal information is collected and used. For people to exercise those rights, they must be able to access their personal information and exercise certain rights to their personal information. Under the California Consumer Privacy Act (CCPA), for example, individuals have the following rights (among others), as summarized by the Office of the Attorney General:

- The right to know about the personal information a business collects about them and how it is used and shared;

- The right to delete personal information collected from them (with some exceptions);

- The right to opt out of the sale of their personal information; and

- The right to non-discrimination for exercising CCPA rights.

Relatedly, data security is "the practice of protecting digital information from unauthorized access, corruption, or theft throughout its entire lifecycle," as described by IBM. Privacy and data security are therefore interrelated concepts—it is not possible to have privacy without data security, but it is possible to have data security without privacy.

Associated Sectors

- Technology
- Healthcare
- Manufacturing
- Aerospace and Defense
- Financial Services
- Advertising
- Retail

Data privacy and security crosses all sectors, given the number of organizations that must protect personal information. The list above includes some of the top sectors for data privacy and security.

Why Are Privacy and Data Security Important?

An exceptionally large amount of data is created, captured, copied, and consumed each year globally. Statistical reports an upward trend expected to reach 79 zettabytes in 2021. In fact, the growth rate appears to be exponential, based on the following chart.

VOLUME OF DATA/INFORMATION CREATED, CAPTURED, COPIED, AND CONSUMED WORLDWIDE, 2010–2025

Year	Data Volume in Zettabytes
2010	2
2011	5
2012	6.5
2013	9
2014	12.5
2015	15.5
2016	18
2017	26
2018*	33
2019*	41
2020*	64.2
2021*	79
2022*	97
2023*	120
2024*	147
2025*	181
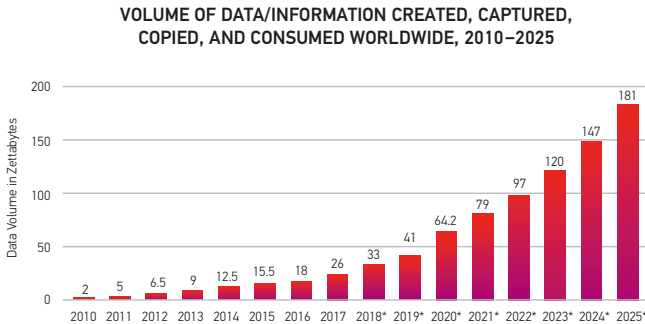
*The data was taken from various publications released over several years: Forecast for the years 2018 and 2019 as of 2018; Forecast for 2020 as of May 2021; Forecast for 2021 to 2025 as of March 2021 based on figure for 2020 provided by the source. Figures were rounded to provide a better understanding of the statistic. The figures from 2021 to 2025 were calculated by Statista based on the 2020 forecast figure and the five-year compound annual growth rate (CAGR) of 23 percent provided by the source. The figures prior to 2020 are based on IDC's forecast from late 2018.

SECTOR OVERVIEW (CONT'D)

> Building resilience into software is needed to reduce the likelihood that power outages or natural disasters will compromise data security, and new technologies are being developed to handle greater volumes of data from more sources as commercial and public infrastructure becomes "smarter."

Included in this data is a very large amount of *personal information*, but it is difficult to produce a reliable global estimate of how much personal information is collected each year or stored at any given time.

Furthermore, the rise of e-commerce, digital platform business models, remote working, and communications and social media are generating new data security risks to businesses, infrastructure, and individuals. As more of the global economy becomes digital, maintaining trust in data security and privacy is a requirement for economic growth.

Data is an asset because it supports business growth, but it can also pose serious business and reputational risks if it is not stored properly.

Privacy also matters because it is a democratic value and a human right enshrined in Article 12 of the Universal Declaration of Human Rights and Article 17 of the International Covenant on Civil and Political Rights, which underpins many global regulatory frameworks that businesses and other organizations must follow to remain in compliance.

ENABLING SCIENCE AND TECHNOLOGY

Synthetic Data

In artificial intelligence (AI) systems, "bias" differs from "discrimination" because it raises issues of fairness or accuracy beyond the scope of human rights law. Bias is simply an undue preference for some features or results when analyzing data. There are different strategies to reduce bias in AI models, one of which is synthetic data.

Synthetic data is created by artificially generating information that replicates real-world statistical components, but without variables that could produce biased outcomes. The added benefit of synthetic data is that it can preserve privacy if the omitted variables are personal information. A 2017 study by researchers from the Massachusetts Institute of Technology showed that 70% of the time, groups using synthetic data produced comparable results to groups using real data. The study concluded that synthetic data produced more reliable

(usernames and passwords) are often not enough to securely access online services, and two-factor authentication (2FA) has limits. Microsoft recommended that its users not rely on 2FA solutions involving short message service (SMS) and voice calls, because of security concerns.

Cryptography

Both privacy and data security demand continuous advances in cryptography and related technologies. Encryption works by applying algorithms to scramble data so it cannot be accessed by anyone but the key holders. The challenge, for cryptographers, is to develop algorithms powerful enough to keep up with increasingly powerful computers. In the United States, the government must protect classified information for 25 years, so if encryption is one tool used to secure such information, it must be at least 25 years ahead of the country's adversaries.

SYNTHETIC DATA IS CREATED BY ARTIFICIALLY GENERATING INFORMATION THAT REPLICATES REAL-WORLD STATISTICAL COMPONENTS, BUT WITHOUT VARIABLES THAT COULD PRODUCE BIASED OUTCOMES.

results than other privacy-enhancing technologies, such as data masking and data anonymization. A more recent study from 2020 similarly found that models trained on synthetic data yielded small decreases in accuracy, deviations characterized as both "expected and manageable."

Hacking Strategies

Hackers have deployed a range of strategies to access and use personal information for illicit purposes. Log-in credentials

Strategies expected to strengthen encryption include lengthening key sizes, developing new algorithms, or deploying homomorphic encryption. The last option differs from typical encryption methods because it allows computation to be performed directly on encrypted data. Common standards are essential for commercial application of these technologies, and these vary internationally, as some governments have enacted restrictions on the import, export, or provision of cryptography services.

ENABLING SCIENCE AND TECHNOLOGY (CONT'D)

Differential Privacy

Similar to encryption, differential privacy works by altering information. However, the technology behind differential privacy algorithms adds enough "noise" to the data to make it statistically improbable that the data can be identified or made identifiable to a natural person. The technology allows organizations to aggregate and analyze data, while still protecting their customers' and users' privacy. Microsoft and Google have both released open-source toolkits to their differential privacy algorithms.

Data Resilience

Building resilience into software is needed to reduce the likelihood that power outages or natural disasters will compromise data security, and new technologies are being developed to handle greater volumes of data from more sources as commercial and public infrastructure becomes "smarter." This is an essential disaster-planning consideration, and one that businesses include in their business continuity plans and policies. There are many strategies for achieving data resilience: backups, snapshots, mirroring, flash copies, logical replication, hardware replication, and software replication, among others.

Quantum Computing

Quantum computing is expected to revolutionize encryption. Amid these advancements, the National Institute of Standards and Technology (NIST) is preparing new standards for post-quantum cryptography. The stakes are high—as explained by NIST, large-scale quantum computers would be able to "break" many of the public-key cryptosystems used today, thus compromising the confidentiality and integrity of encrypted data. NIST's objective is to develop "cryptographic systems that are secure against both quantum and classical computers and can interoperate with existing communications protocols and networks."

Similar efforts are taking place elsewhere, as nations and private organizations increasingly invest in quantum technology to keep up with their competitors. According to one think tank, China is the global leader in quantum communication and cryptography. It recently created an integrated quantum communication network that covers around 4,600 km and allows quantum key distribution over that distance. More recently, a state research body in South Korea developed a platform it claims can verify quantum encryption technology. To prepare for the era of quantum computers, the tool accelerates efforts to find cryptographic algorithms with higher security.

Blockchain

Blockchain platforms utilizing zero-knowledge proof cryptography are another technological means of enhancing data privacy. Zero-knowledge proofs or "ZKPs" is a method of proving something is true without disclosing the underlying data. Data obfuscation is built into the fabric of blockchain technology, so it represents a powerful tool for protecting user privacy.

SECTOR AND INDUSTRY SIGNALS

Legislative Proposals Aim to Strengthen, Streamline US Privacy Law

The United States relies on a sectoral approach to data protection where privacy laws generally apply to specific groups and contexts, such as health information, children's personal information, and financial information. This contrasts with jurisdictions like the European Union which have adopted an omnibus approach to data protection, where the General Data Protection Regulation generally governs personal data of EU data subjects regardless of sector. Some U.S. states such as California, Virginia, and Colorado have adopted state-level privacy legislation. Calls are growing for the United States to enact a comprehensive federal privacy law, particularly after the EU-U.S. Privacy Shield was invalidated by the Court of Justice of the European Union in the "Schrems II" decision in July 2020.

At least two privacy bills have been proposed at the federal level. One is the Information Transparency and Personal Data Control Act, and the other is the Setting an American Framework to Ensure Data Access, Transparency, and Accountability (SAFE DATA) Act. Meanwhile, several state governments are following California's, Virginia's, and Colorado's lead and are proposing or considering their own privacy legislation, as shown by the U.S. State Privacy Legislation Tracker maintained by the International Association of Privacy Professionals (IAPP).

Where legislation already exists, enforcement activity and rulemaking are ongoing. In California, for example, the attorney general recently confirmed that loyalty programs could constitute a financial incentive under the CCPA. A first-year enforcement update from the AG noted that a grocery chain required consumers to provide personal information in exchange for participation in company loyalty programs, but failed to provide a notice of financial incentive to participating consumers. After being notified of its noncompliance, the company amended its privacy policy to include the notice.

At the international level, China recently passed a new personal data privacy law and the government is cracking down on Chinese companies that have allegedly run afoul of existing privacy legislation. Russia amended its Personal Data Law in 2021, Brazil passed a comprehensive privacy law in 2020, and India is currently deliberating on its Personal Data Protection bill.

FCC Sets Aside $1.9B to Remove and Replace Huawei, ZTE Telecom Equipment in the United States

The Federal Communications Commission instituted a program that supports small telecommunications companies in the United States as they remove and replace equipment from Huawei and ZTE. The program represents an effort to secure U.S. networks from the two Chinese firms, which the U.S. government considers to be a national security threat.

DATA IS AN ASSET BECAUSE IT SUPPORTS BUSINESS GROWTH, BUT IT CAN ALSO POSE SERIOUS BUSINESS AND REPUTATIONAL RISKS IF IT IS NOT STORED PROPERLY.

SECTOR AND INDUSTRY SIGNALS (CONT'D)

US Government Restricts Security Software Outsourcing in SolarWinds Cyberattack Aftermath

According to the U.S. Government Accountability Office (GAO), the SolarWinds software hack was "one of the most widespread and sophisticated hacking campaigns ever conducted against the federal government and private sector." The GAO identified the cyberattack as originating with the Russian Foreign Intelligence Service and provided a detailed timeline of the federal government and private sector response. Among other measures, the U.S. government imposed sanctions against certain Russian entities, promulgated an interim final rule to secure the information and communications technology and service supply chain, and issued an executive order on improving the nation's cybersecurity.

Ransomware Attacks and Data Breaches Represent Serious Threats to Business, National Security

Ransomware threats are becoming increasingly common and can cripple business—indeed, a significant part of the U.S. economy—as shown by the recent Colonial Pipeline attack. The U.S. government responded by setting aside $500 million for state and local cybersecurity in May 2021, and by issuing cybersecurity directives for fuel pipelines. In addition to investing in new cybersecurity infrastructure, private businesses are increasingly buying cyber insurance, which the GAO says is in high demand.

Data breaches happen frequently, although they are trending downward globally. By one estimate, there were 1,767 publicly reported breaches in the first half of 2021, which exposed 18.8 billion records. That's 24% fewer data breaches than in H1 2020, but still represents a significant business and reputational risk for anyone affected.

Pegasus Spyware Subject to Growing Public Scrutiny

An investigation by the *Washington Post* and 16 media partners revealed that an Israeli firm's spyware, called Pegasus, was used to hack smartphones belonging to 37 journalists, activists, and business executives worldwide. The spyware was licensed to governments, which then used it in apparent contravention of licensing terms that provide it should be used only against terrorists and major criminals. The company's chief executive responded by saying he was "very concerned" by the Post's reports. He committed to investigating each allegation and terminating contracts wherever the allegations are found to be true.

Facial Recognition Technology in Retail Stores Faces Pushback

Facial recognition is increasingly common in retail stores, as businesses rely on the technology to prevent fraud, track foot traffic, and offer contactless payments. The technology has limitations, as studies show facial recognition algorithms are less likely to correctly identify women and people of color. At the same time, the error rate is quickly decreasing and the best facial identification algorithm had an error rate of just 0.08% in 2020. Privacy advocates launched a campaign pressuring retailers to pledge not to use facial recognition technology, and they maintain a running list of retailers who have made the pledge.

IMPACT

Economic

From a commercial perspective, data analytics and other forms of "big data" have become a sizable market and are expected to continue growing. Whether a company uses its customer data to support its marketing strategy, or to improve customer retention, it is likely to have a competitive advantage over companies that do not leverage their data. User data is also valuable to services that are free of charge—such as social media—because it can be sold to other companies for marketing purposes (subject to compliance with applicable privacy laws).

On the data security side, the economic consequences of security failures are growing in significance as more commercial supply chains and elements of critical infrastructure are controlled by digital technologies. The recent cyberattack on the Colonial Pipeline shut down operations

compromised." The hack is believed to have provided Russian intelligence with critical insights into U.S. government systems, so the complete impact—and cost—is difficult to assess.

Social

When personal information is used for commercial or law enforcement purposes, it creates implications for privacy and trust. The more a person's data is collected and shared among third parties, the greater the risk of data breach and identity theft. Further, customers and users rarely have transparency into what data companies have about them and how those companies are using and sharing their data, even though it has significant value.

As mentioned, legislation in the United States protects the privacy of people in certain groups. For example, the Children's Online Privacy Protection Act (COPPA) applies to the personal

AS MORE OF THE GLOBAL ECONOMY BECOMES DIGITAL, MAINTAINING TRUST IN DATA SECURITY AND PRIVACY IS A REQUIREMENT FOR ECONOMIC GROWTH.

across the eastern United States for five days, causing gas shortages and other hardships. Estimates vary, but the cost of ransomware attacks was said to reach $20 billion globally in 2020, which is close to double the previous year's total.

There are several ways to calculate the damage of cyberattacks, in both economic and qualitative terms. As a result of the SolarWinds hack alone, a Senate policy paper suggested that "it may cost as much as $100 billion over many months to root out malicious code and ensure systems are not

information of children under 13 years of age collected by online operators. The Federal Trade Commission (FTC) has recently taken the unprecedented step of removing a company from the list of seven self-regulatory organizations approved to monitor and certify companies' compliance with COPPA (known as the safe harbor program). The move follows a legislative proposal (recently reintroduced) that would repeal the safe harbor program, signaling a push for stronger enforcement of children's privacy legislation.

IMPACT (CONT'D)

Environmental

The precise environmental footprint of personal data collection and data security is unclear and difficult to calculate. However, data storage does entail a significant environmental footprint. According to the International Energy Agency (IEA), data centers and data transmission networks each accounted for around 1% of global electricity use in 2019.

Policy

One of the biggest questions before U.S. lawmakers is whether to enact federal data privacy legislation. Besides the protection of privacy rights, there are practical reasons for the U.S. federal government to enact such legislation. There is a patchwork of privacy and security laws in the United States, which can often overlap or even conflict. A federal privacy law could provide much needed consistency and clarity to businesses operating in the United States and struggling to comply with the myriad of privacy and security laws. Further, establishing an updated privacy shield framework (which might be possible only if federal legislation is enacted) would support trade between the United States and its European allies. Instituting uniform legislation would also present an opportunity to shape international standards, though this window is closing quickly because the largest economies already have, or are about to have, national data privacy legislation.

In the wake of the SolarWinds and Colonial Pipeline incidents, among others, Congress and many federal agencies are likely to look for ways to bolster cyber and data security across a broad range of government and regulated private sector functions.

LEGAL IMPLICATIONS

OUTLOOK

Transactions and Financing | Cybersecurity Represents Growing Investment Opportunity

Cybersecurity startups received "near-record" levels of funding in H1 2021, according to PitchBook. Venture capital (VC) reached $9.9 billion globally, making up 96% of the total raised in 2020. Startup valuations are rising accordingly, and more than half of the top 10 deals involved U.S. companies, as shown by the chart and table below.

CYBERSECURITY ON THE RISE

VC Deals Approach Annual Record
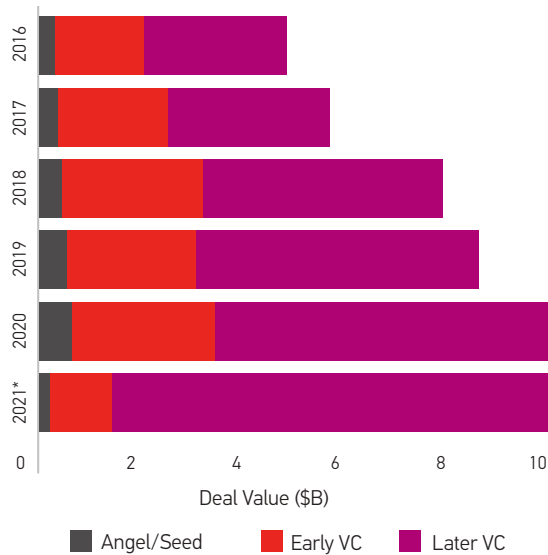
Startup Valuations Skyrocket
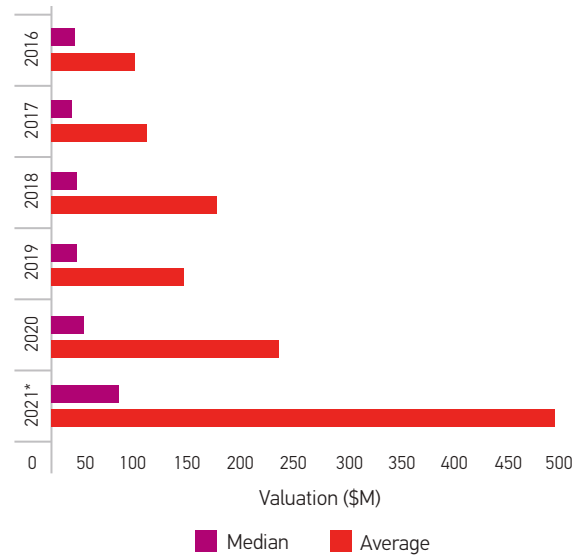
TOP 10 VC-BACKED CYBERSECURITY DEALS OF 2021

	Deal Size (millions)	Post-Money Valuation (billions)	Deal Date	Lead Investors	Company HQ
Lacework	$525	$1.0	Jan. 7	Sutter Hill, Altimeter	San Jose, Calif.
Trulioo	$394	$1.75	June 7	TCV	Vancouver, B.C.
Ledger	$380	$1.5	June 10	1OT Holdings	Paris
Rubrik	$374	$3.67	March 30	Bain Capital Ventures	Palo Alto, Calif.
Forter	$300	$3.0	May 25	Tiger Global	Tel Aviv
Plume	$270	$1.35	Feb. 22	Insight Partners	Palo Alto, Calif.
Acronis	$250	$2.25	May 4	CVC Capital Partners	Singapore
Snyk	$244	$6.47	March 10	Accel, Tiger Global	Boston
OneTrust	$210	$5.1 (Dec. 2020)	April 6	Softbank, Franklin Templeton	Atlanta
Orca Security	$210	$1.2	March 8	CapitalG, Redpoint Ventures	Los Angeles

*All data as of June 15, 2021

Source: PitchBook

LEGAL IMPLICATIONS (CONT'D)

Demand for cybersecurity services increased during the pandemic, as employees increasingly worked from home and the number of remote users, mobile devices, and access points to IT infrastructure and internal corporate networks increased.

M&A | Growing Demand Supports Dealmaking in Information Security Industry

Dealmaking in the information security industry was up for the fifth straight year in 2020, with 162 transactions surpassing the previous year's total of 141. Deal value, however, was lower, at $17.9 billion compared to the previous year's total of $23.2 billion.

The 2019 figure is influenced by two megadeals, namely Broadcom's $10.7 billion purchase of Symantec's enterprise security business and Thoma Bravo's $3.8 billion buyout of Sophos. In 2020, six cybersecurity deals took place that each topped $1 billion in value, whereas only four such deals occurred in 2019.

Of note, private equity (PE) investors are shaping cybersecurity M&A. There were 59 PE-led deals in 2020, up from 43 in 2019 and accounting for over one-third of all cybersecurity deals. Five of the half dozen billion-dollar acquisitions were PE-led.

PE investors appear to step in where security vendors are scaling back. S&P Global points out that just 41 transactions came from traditional security vendors (such as McAfee and Symantec) in 2020, down from 53 deals in 2019.

There are also macro drivers behind the strong M&A trend in information security. These include the popularity of remote work (which expands the enterprise network into the home and other environments), increasing cloud adoption, and speed of technological innovation and connectivity generally.

Trade | State-Sponsored Attacks Highlight Software Supply Chain Risks

Following the SolarWinds hack, both the government and the private sector are more aware of the risks in the software supply chain. The government responded by enacting rules that require disclosing the code's provenance and improving the code's development environment. These new rules might

create opportunity for U.S.-based companies, because the previous approach to procurement often considered price as the determinant factor, making it harder for U.S companies to compete.

The private sector is responding in different ways to software supply chain risks. Companies sometimes establish their own privacy and security compliance standards for third-party vendors, but those standards can also be created through legislation, regulations, or self-regulatory bodies. For example, regarding payment security standards, the PCI Security Standards Council maintains a list of approved products and solutions. NIST's cyber supply chain risk management (C-SCRM) program is another resource.

LITIGATION DEVELOPMENTS

Epiq Systems Lawsuit Addressed Question of Who Is a 'Service Provider' Under CCPA

A California federal court denied legal services company Epiq Systems' motion to dismiss a proposed class action alleging the company failed to maintain reasonable security procedures to protect consumers' data. The court rejected Epiq's argument that it was not a "service provider" under the CCPA, thus clarifying the scope of the CCPA as it applies to private businesses. The court reasoned that the defendant was performing activities of a business and not a service provider, as such terms are defined under the CCPA.

INFOSEC M&A: CYBERSECURITY ACQUISITION VOLUME AND SPENDING 2010–2020
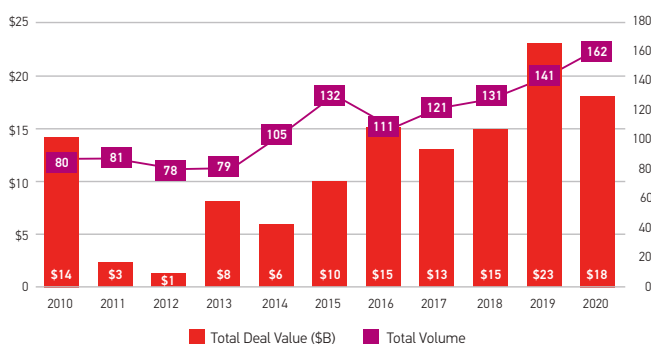
Source: 451 Research's M&A KnowledgeBase, January 2021; includes disclosed and estimated values

LEGAL IMPLICATIONS (CONT'D)

Apple, Miniclip Successfully Avoid Data Privacy Lawsuit

A federal court in California granted Apple and Miniclip's motions to dismiss a proposed class action alleging that Miniclip's 8 Ball Pool application improperly accessed data copied to Apple's "Pasteboard" on app users' smartphones. The court dismissed claims under state and federal law, ruling the plaintiff failed to establish that an invasion of privacy occurred. According to the court, the allegations "simply do not approach the sort of 'egregious' or 'highly offensive' conduct which courts have typically permitted to proceed beyond the motion to dismiss stage."

Cookie Banners Prompt Over 500 GDPR Complaints from noyb

The European Center for Digital Rights (also known as noyb) sent over 500 draft complaints under the EU's General Data Protection Regulation (GDPR) over companies' use of cookie banners. This, noyb claims, is the largest wave of complaints since the GDPR took effect. At issue are web banners that allegedly do not comply with the consent requirements under the GDPR. Noyb says it developed software that recognizes unlawful cookie banners and automatically generates complaints.

PATENT TRENDS AND OUTLOOK

US Senators Direct USPTO to Study Patent Jurisprudence Impact on Critical Technologies

At the request of four senators, the U.S. Patent and Trademark Office (USPTO) is studying the impact that patent eligibility jurisprudence has on investment and innovation, particularly focusing on certain critical technologies. These include quantum computing, AI, precision medicine, diagnostic methods, and pharmaceutical treatments. The USPTO invited public input to assist in preparing the study, with comments due by September 7, 2021. The issues raised by the study have implications for the patentability of advanced cybersecurity technologies.

FBI Director Highlights Chinese Economic Espionage Threat

The counterintelligence and economic espionage threat from China represents "the greatest long-term threat to our nation's information and intellectual property," according to Federal Bureau of Investigation (FBI) Director Christopher Wray. Among other measures, the FBI has stepped up its private sector outreach and coordination efforts through the Office of Private Sector (OPS). For example, the agency shares information with *Fortune* 1000 companies about China's efforts to steal intellectual property. The field offices of the FBI also have private sector coordinators who lead engagement with local businesses and universities.

PRIVACY & SECURITY

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ABOUT US

Technology Transactions & Privacy | Privacy & Security

The current privacy and data security legal climate includes complex and nuanced rules governing the collection, use, storage, and disposal of information that vary by jurisdiction and are continually evolving. We help clients develop and implement internal data protection policies, procedures, and governance structures, and advise on compliance with regional data protection frameworks throughout the world. Our team has provided comprehensive privacy and security assessments and strategic counseling to numerous boards of directors, CEOs, and general counsel of privately and publicly held multinational companies in many sectors. We also regularly draft online terms of use and privacy policies and assist with different phases of product development.

RETAIL & E-COMMERCE

2022 EMERGING TECHNOLOGY TRENDS

MARKET AND LEGAL INSIGHTS FOR INNOVATORS

PERKINSCOIE

Within retail technology, e-commerce platforms rely on an ecosystem of software tools that allow users to build online shops, digitize physical stores, make sales and process payments, and fulfill orders via self-service.

SECTOR OVERVIEW

What Is Retail and E-Commerce Technology?

Retail technology is a broad category comprising any technology that supports or enables the selling of consumer products, including technologies that assist merchandising, support shopper marketing, modernize operations and supply chain management, facilitate order fulfillment (in stores, online, and across other retail channels), and enable new retail formats and experiences. Within retail technology, e-commerce platforms rely on an ecosystem of software tools that allow users to build online shops, digitize physical stores, make sales and process payments, and fulfill orders via self-service.

Associated Sectors

- Retail
- Restaurant and Hospitality
- Financial Services

In addition to the retail sector overall, these technologies are closely associated with industry sectors that have moved more aggressively into direct sales and platform business models, such as the restaurant and hospitality sector and mobility. Industries that are deploying more remote and virtual services, like banks and other financial services, are tied to e-commerce and related technologies.

Why Is It Important?

Retailers globally are undertaking renewed efforts to reimagine the traditional retail experience, capitalizing on pent-up demand generated by the COVID-19 pandemic and a broad expansion of digital shopping. The pandemic accelerated the shift to e-commerce by an estimated five to ten years. In fact, the penetration of e-commerce reached a peak of 33% of total retail sales in July 2020, overtaking earlier expectations that it would reach 24% by 2024. Online penetration has remained about 35% above pre-pandemic levels as e-commerce has exhibited more than 40% growth over the one-year period preceding August 2021.

ONLINE PENETRATION INCREASED WITH THE ONSET OF COVID-19 AND HAS REMAINED ABOUT 35% ABOVE PRE-COVID-19 LEVELS

Retail-oriented online credit-card and debit-card spend % of total[1]

19% (average of previous 12 months)[2]

~35% increase in online penetration since Mar 2020, based on credit-card and debit-card spend
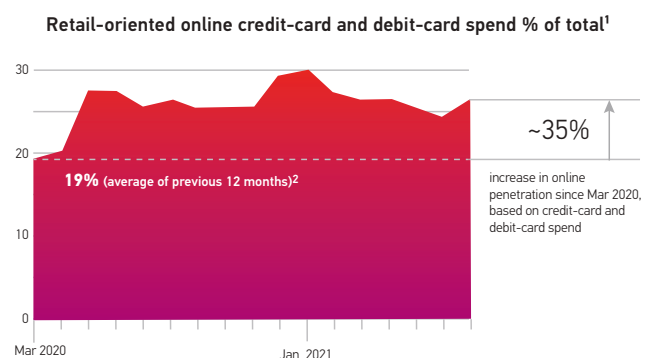
[1]Includes the following retailer categories: Amazon, apparel, club stores, cosmetic, discount stores, drugstores, grocery stores, home stores, mass stores, pet shops, restaurants, software and electronics.
[2]Average monthly online penetration from Mar 2019–Feb 2020.

Source: Affinity Solutions credit-card and debit-card spend data for Feb 2019–Jun 2021; Facteus debit-card spend data for Feb 2019–Jun 2021; Stackline Amazon spend data for Feb 2019–Jun 2021

Growth has slowed since the start of the pandemic, when it jumped 33.6% in 2020 as consumers shopped online during the lockdowns. Nevertheless, consumers in the United States

SECTOR OVERVIEW (CONT'D)

are on track to spend a record $1 trillion online in 2022. Amid this growth, leading e-commerce companies—Amazon, Alibaba, and Wayfair among them—have reported double-digit revenue growth.

The Impact of COVID-19

The physical retail environment is changing, as retailers close stores. Investment firm UBS estimates that upwards of 80,000 retail locations will close in the next five years, which is equal to about 9% of the existing stores in the United States. Although retailers were already rethinking their store footprints due to the rise of e-commerce, the COVID-19 pandemic is forcing them to reconsider store strategies as

more consumers are pushed online, resulting in reduced sales at brick-and-mortar locations. UBS estimates that for every 1% increase in e-commerce penetration, 8,000 stores will need to close. Department stores, already struggling before the pandemic, have been particularly hard hit—some to the point of bankruptcy. Going forward, expectations are that brands will move away from wholesale business and shift toward a direct-to-consumer approach and a model with department stores under which they control their own space and inventory. Retailers may consider alternatives for their physical sites, such as using them as immersive spaces for consumers to experience brands or as centers to provide local support for goods and services.

THE PANDEMIC HAS SERVED AS A CATALYST FOR TECHNOLOGY ADOPTION IN THE RETAIL SPACE, CREATING AN IMPERATIVE FOR COMPANIES TO RECONFIGURE THEIR OPERATIONS, INCLUDING SUPPLY CHAIN MANAGEMENT SYSTEMS AND OTHER OPERATIONAL ELEMENTS.

SECTOR OVERVIEW (CONT'D)

The pandemic has served as a catalyst for technology adoption in the retail space, creating an imperative for companies to reconfigure their operations, including supply chain management systems and other operational elements, as well as sales channels. Retailers were forced to quickly ramp up the transition to e-commerce and launch new convenience services, such as buy online, pick up in-store (BOPIS), curbside pickup, and delivery. As a result, the digitization of customer and supply chain interactions has accelerated by an estimated three to four years. E-commerce shifted from "perpetual top priority on every retailer's three-year plan to a desperately needed lifeline," prompting an estimated $10 billion in e-commerce investments, acquisitions, and partnerships from May to July 2020. COVID-19 also hastened the adoption of in-store technology, particularly noncash payment options.

With the accelerated shift to digital, the gap widened between industry leaders and laggards. Companies with tech-forward operations and strong omnichannel presences, wherein consumers switch regularly between their online and offline channels, experienced strong tailwinds. Those with more robust digital capabilities before the pandemic, including strong platforms and data capabilities as well as the systems needed to support new convenience options, have generally fared better.

As consumers purchase goods, a larger number of websites, online marketplaces, and retailers are increasingly benefiting from platform economics—generating more returns by leveraging the scale and expandability of platform business models, while reorienting to capture a "share of life" outside their traditional products and services. Companies such as Shopify and Square that serve these e-commerce ecosystems are benefiting in turn. Mega platforms including Walmart and Amazon are shifting the landscape by expanding their offerings—and they are expected to continue to outspend competitors. However, niche platforms may also expand by offering unique services or building strong consumer loyalty. With e-commerce business growing, and new startups entering the space, competition in the space will increase.

Outlook

As recovery continues, expectations are that many of the consumer behaviors and business practices adopted during the pandemic will endure—20% to 30% of the pandemic-related digital shift is expected to be permanent. Digital acceleration is predicted to continue, prompting retailers to redirect funds from brick-and-mortar to technology to capitalize on the growing e-commerce market. Globally, e-commerce is projected to reach a record $6.54 trillion by 2022 as demand for digital engagement continues. Since only 30% of retailers rate themselves as having mature digital capabilities, many are planning significant investments to upgrade their e-commerce, contactless capabilities, and store technology.

Future challenges will include institutionalizing the changes that were rapidly deployed during the pandemic, such as improvements to digital and omnichannel business models. Retail and e-commerce technologies will be central to those efforts as tech-driven consumers reshape the retail landscape. As they adapted to new digital realities, 71% of retail CFOs planned to increase IT investments in 2021, including 64% who planned to increase investments in e-commerce.

ENABLING SCIENCE AND TECHNOLOGY

E-Commerce Enablement Services and Platforms

E-commerce software and platforms are central to efforts to increase digital maturity. Companies are investing in unique, stand-alone online sales platforms, mobile shopping platforms, and progressive web apps. They are either investing in end-to-end platforms or developing platforms in-house. Demand for e-commerce enablement solutions has grown markedly, propelling market gap growth, and is expected to continue to do so, with startups emerging that offer new enablement solutions, including "headless commerce" and payment and checkout solutions. Companies are using e-commerce platforms in different ways, including by using solutions focused on increasing page load speed, enabling single-click checkout, and opening new online channels such

as text messages, video chat, and augmented reality. Social commerce is also growing as social media platforms deploy shopping capabilities.

Headless e-commerce architecture, in particular, is attracting market interest. Headless e-commerce decouples front-end customer interfaces, such as storefronts, from back-end core commerce functions, such as payment processing. The technology supports the deployment of mediums such as voice, mobile apps, social media pages, and interactive kiosks, and the establishment of new online touchpoints, such as virtual pop-up stores. Expectations are that adoption of headless e-commerce and lean microservice tech stacks will accelerate in the near term, as e-commerce platform providers such as Shopify begin adding capabilities and startups make

COMPANIES ARE USING E-COMMERCE PLATFORMS IN DIFFERENT WAYS, INCLUDING BY USING SOLUTIONS FOCUSED ON INCREASING PAGE LOAD SPEED, ENABLING SINGLE-CLICK CHECKOUT, AND OPENING NEW ONLINE CHANNELS SUCH AS TEXT MESSAGES, VIDEO CHAT, AND AUGMENTED REALITY.

ENABLING SCIENCE AND TECHNOLOGY (CONT'D)

Online-to-Offline and Hybrid Shopping Enablement Technology

Despite significant expansion in e-commerce, nearly 80% of retail revenue is currently generated offline (based on a 12-month rolling average)—and 74% of retail is expected to remain offline by 2024. Retailers are considering how they can maximize the value that stores generate to support margin expansion, while optimizing consumer touchpoints. They are exploring new ways to bring together their physical and digital operations and reconfiguring physical stores into fulfillment centers. Although only an estimated 10% of online orders are currently fulfilled by stores, that share is expected to double in the next 10 years as stores become fulfillment centers and are used as showrooms. This shift is also driving retailers to consider strategically relocating near dense population centers where they can more effectively provide last-mile delivery.

As part of that trend, online-to-offline (O-to-O) commerce, which converts online channel visits into offline sales, is gaining in importance. Unlike the omnichannel approach, O-to-O merges online and brick-and-mortar marketing to turn e-commerce visitors into physical shoppers. Companies do this by offering convenience services such as BOPIS, home delivery, and in-store returns for online purchases. Going forward, retailers are expected to experiment with retrofitting stores so consumers feel comfortable testing technologies such as contactless checkout, virtual fitting rooms or makeup applications, virtual appointments with sales associates and stylists, self-service kiosks and pickup lockers, and QR codes. Technologies including automation, AI, and robotics are also being used on the back end to support store logistics and maximize fulfillment capabilities.

ADVANCED ROBOTICS AND INTELLIGENT AUTOMATION

Blockchain Inventory Management

Blockchain and decentralized systems can help improve supply chain efficiency and inventory management, leading to lower costs and strengthened security, while improving transparency and traceability for consumers. On the back end, blockchain and smart contracts facilitate relations between retailers, brands, and manufacturers and simplify inventory management.

Last-Mile Delivery Technology

Retailers are investing in new delivery models, such as instant delivery, and scaling up last-mile and reverse logistics technology to remain competitive. Heightened demand for same-day fulfillment and convenience options such as curbside pickup and BOPIS have put pressure on existing distribution models. To meet shifting consumer needs and emerging challenges, while reducing costs and inefficiencies, retailers and logistics providers are experimenting with technology solutions to automate and optimize the last mile of delivery. Technologies being tried include AI, which is being leveraged to optimize delivery routes and reduce last-mile expenses; automated solutions such as micro-fulfillment centers that use automated order picking; warehouses that employ robotic picking; and self-driving, or autonomous, vehicles that deliver to consumers. While some companies are developing delivery and fulfillment centers in-house, others are looking to third parties that allow them to tap into existing infrastructure—not only logistics software but delivery networks as well.

LIVE COMMERCE LINKS ONLINE LIVESTREAM BROADCASTS WITH INSTANT PURCHASING THROUGH E-COMMERCE STORES AND AUDIENCE PARTICIPATION THROUGH CHAT OR REACTION FUNCTIONS.

SECTOR AND INDUSTRY SIGNALS

Walmart to Sell E-Commerce Tech to Other Retailers

As part of its efforts to expand its profit pool beyond its core retail business, Walmart is selling its e-commerce technology to small and medium-sized retailers. The company is partnering with Adobe to provide a suite of cloud-based services, which will be offered through a subscription. Adobe's technology will be used to power e-commerce sites, while Walmart will provide the technology that powers the picking and packing of online purchases and the geofencing technologies that workers need to fulfill orders. Neither Adobe nor Walmart has disclosed the anticipated value of these new ventures.

SOCIAL MEDIA AND INFLUENCERS

Verizon Rolls Out 5G Immersive Retail Accelerator

Verizon, in partnership with U.K. digital technology innovation center Digital Catapult, launched a 5G immersive retail accelerator to help brands—including Burberry, Diageo, and L'Oréal UK and Ireland—explore 5G-enabled solutions. The accelerator will experiment with the in-store experience, out-of-store experience, digital product visualization, and virtual events, drawing on technologies such as immersive experience, AI, and machine learning. The accelerator will also be open to startups and scaleups working within the retail, immersive, or customer experience space.

Trigo, Google Cloud Team Up to Help Retailers Deploy AI in Checkout Process

Trigo and Google Cloud are working together to help retailers use AI to manage the checkout processes in their stores. Under a partnership agreement, Trigo will work with Google to "help retail businesses accelerate their digital transformations with AI-powered autonomous stores." Few details were provided on the partnership, but Trigo has been expanding its efforts in the frictionless retail space with computer vision–based autonomous checkout technology. Trigo, which has attracted more than $100 million in investments, recently

disclosed that it is working with retailer REWE to deploy grab-and-go checkout technology at its store in Cologne, Germany. Tesco, a U.K. supermarket chain, is also testing Trigo's checkout technology.

Walmart Employing AI to Improve Grocery Substitutions

Walmart developed an AI-based technology to help personal shoppers and customers make better substitutions for out-of-stock products by considering hundreds of variables, such as size, brand, individual preference, and price, in real time. Substitutions presented a challenge during the global pandemic, as popular items sold out rapidly. Walmart said that since deploying the solution, customer acceptance of online grocery substitutions has increased more than 95%.

> The pandemic has served as a catalyst for technology adoption in the retail space, creating an imperative for companies to reconfigure their operations.

Bringg Secures $100M in Financing for Last-Mile Delivery Platform

Bringg, a software provider that helps retailers with last-mile logistics, raised $100 million in a Series E round. The funding values the company at about $1 billion, an increase of approximately four times its previous valuation. In the past year, the company saw a 180% increase in new customers. Bringg plans to use the funding to further expand its customer base, build out its capabilities, and likely acquire other companies to consolidate some of the links in the logistics

SECTOR AND INDUSTRY SIGNALS (CONT'D)

and fulfillment chain. Among Bringg's current customers are Walmart, Albertsons, Co-Op in the U.K., Coca-Cola, and Panera.

Supply Chain Disruption

As shifting consumer habits cause more rapid inventory churn, a lack of supply chain visibility has resulted in delays, higher costs, and both lost and shrinking sales. In response, retailers are reconsidering supply chain operations and resiliency, prompting new investments in data analytics, deep learning and machine learning, automation, and AI-enabled supply chain management to reduce logistics costs, optimize

demand forecasting, streamline operations, and enhance omnichannel fulfillment. Order fulfillment is expected to see the most investment, followed by warehouse management and procurement. Companies are experimenting with various solutions, from robots to augmented reality/virtual reality, to automate and improve store and warehouse operations. Although the rollout of robots in retail slowed in 2020 as other projects took priority, robotics is expected to play an expanded role in the retail industry, with some businesses establishing robot-powered micro-fulfillment centers.

HEIGHTENED DEMAND FOR SAME-DAY FULFILLMENT AND CONVENIENCE OPTIONS SUCH AS CURBSIDE PICKUP AND BOPIS HAVE PUT PRESSURE ON EXISTING DISTRIBUTION MODELS.

IMPACT

Economic

While the pandemic resulted in both temporary and permanent store closures, it also helped accelerate the shift to an omnichannel shopping model, providing consumers with more purchase options and increasing potential touchpoints between consumers and retailers as the economy begins to recover. New retail technologies deployed during the pandemic have shown the potential to maintain economic activity even amid significant external pressures. Retail industry executives have called for ongoing financial stimulus for the retail sector to provide liquidity support so that companies, workers, and consumers can capitalize on the new consumer engagement channels created by the digital uptake.

Social

The disruption caused by the pandemic has accelerated the pace of change in the way that consumers interact with retailers and related businesses. The recent proliferation of e-commerce and advanced shopping technologies enabled more local retailers and restaurants to operate during lockdown through shared delivery services, click-and-collect models, and enhanced use of social commerce channels. Longer term, these changes may lead to a reprioritization of values, which could serve as a catalyst for new models of retail in which health and sustainability are larger drivers. Unemployment and income disparities accentuated by the pandemic, for instance, may also prompt an increase in traffic toward discount brands as consumers look to reduce costs.

Environmental

As consumers increasingly emphasize the need for sustainable and environmentally conscious products, technology innovations in the supply chain provide an opportunity to not only meet consumer expectations and build brand loyalty, but also reduce environmental footprints and externalities. With e-commerce reshaping supply chains, there is an opportunity to implement sustainable practices throughout supply chain processes, utilizing more efficient technologies. Efforts to improve efficiency in the supply chain can be aligned with efforts to integrate end-to-end sustainability and reduce emissions. For instance, retailers are considering ways to implement sustainability into last-mile delivery efforts, including by leveraging greener delivery options such as electric vehicles and drones, and by communicating CO_2 delivery footprints. Retailers are also employing e-commerce platforms and reverse logistics, supported by technologies such as blockchain, RFID (radio-frequency identification), and digital authentication, to facilitate re-commerce and expand corporate sustainability efforts.

Policy

In tandem with the growth of e-commerce, there has been an increase in counterfeit goods, prompting U.S. House lawmakers to review a bill that would hold e-commerce marketplaces liable under trademark law for fraudulent products sold on their platforms. E-commerce platforms and marketplaces, such as Amazon, have also invested significant sums to support anti-counterfeiting efforts.

Separately, the emerging appeal of in-app commerce has generated litigation between app developers and app store owners over where and how users pay for in-app purchases. Outside of the courts, state legislatures are considering wading into these issues. Early in 2021, an Arizona bill to allow developers to use their own payment systems to process in-app purchases passed the state house before failing in the senate. It is one of several bills targeting the fees charged to developers for payments made for apps and in-app purchases. Similar legislation is being considered in other states, including Georgia, Hawaii, Illinois, New York, Massachusetts, and Minnesota. North Dakota voted down a similar proposal. App industry groups, such as the Coalition for App Fairness, have supported the legislation. Federal legislators, for their part, have considered the issue as part of broader antitrust conversations about big tech.
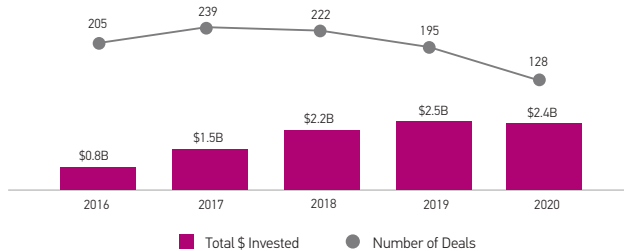
LEGAL IMPLICATIONS

OUTLOOK

Transactions and Financing | Tech Funding, M&A Deal Activity, and Public Listings on the Rise

There is an active private equity/venture capital (PE/VC) ecosystem for retail and e-commerce technology. In Q2 2021, funding reached $31.5 billion, up almost 40% over Q1 2021. Retail tech funding is slated to more than double the annual investment in each of the past four years, with e-commerce driving higher valuations and larger rounds. In Q2, there were 71 mega rounds valued at over $100 million. Although VC activity has declined, the average deal size increased to $11 million in 2020, compared to $9.5 million the previous year.

U.S. ANNUAL VENTURE FUNDING IN E-COMMERCE TECHNOLOGY

**Includes seed venture, corporate, and PE for venture-backed companies
Data as of Jan. 7, 2021**

	2016	2017	2018	2019	2020
Number of Deals	205	239	222	195	128
Total $ Invested	$0.8B	$1.5B	$2.2B	$2.5B	$2.4B

■ Total $ Invested   ● Number of Deals

Source: Crunchbase News

The retail and e-commerce space is also generating mergers and acquisitions activity. Across all market segments and company sizes, the first half of 2020 set a record with 794 mergers and acquisitions involving e-commerce software, platforms, and marketplaces. Total deal value and deal numbers across the space increased in 2020 and into 2021. One niche area attracting more deal activity is headless e-commerce—which is seeing increasing funding and an uptick in bolt-on acquisitions. Retailers may explore new deals and partnerships as they implement new retail models and innovations to meet shifting consumer habits. For instance,

retailers are turning to tech acquisitions to support the reconfiguration of stores as fulfillment centers and to support last-mile delivery. Investors are also exhibiting a stronger appetite for last-mile logistics providers and supply chain optimization technology companies.

As a signal of the retail technology sector's growth and capital attraction, more companies are going public. The top 100 retail tech companies in 2020 identified by CB Insights raised over $14.8 billion in total equity funding across 400 deals—and the list of the top 100 included 19 unicorns. With digital acceleration cited as an investment priority by retail executives, funding and deal activity will likely continue apace.

Cybersecurity | Risks Increase as Attack Surface Expands

Security threats are on the rise as retailers move online, implement IoT devices, and employ new applications and platforms, increasing the number and scope of areas that are potentially vulnerable to attack. Consumers may have privacy concerns over data collection technology, particularly in physical stores, which have no opt-out option for tracking. Store networks and point-of-sale systems are becoming high-value targets. With new avenues for intrusion emerging, security will be a key focus for retail organizations, requiring robust security and an integration of security strategy and cyber defense capabilities. More states are also expected to implement consumer privacy protections in the near term, with lawmakers and regulators alike focusing attention on how companies handle consumer data and protect against cyberattacks.

Privacy | Compliance Critical as Regulations Evolve

As more consumers shop online, privacy becomes an increasingly important consideration for retailers. With state lawmakers enacting a patchwork of new privacy regulations—including Virginia's recently enacted Consumer Data Protection Act (CDPA) and laws being considered in more than a dozen other states—retailers need to be cognizant of their compliance obligations.

LEGAL IMPLICATIONS (CONT'D)

Some new technologies may have implications under more than one privacy act or regulation—for example, virtual try-ons involve compliance with biometric laws *and* applicable state privacy legislation. Businesses should also be cognizant that new business channels—such as social commerce—may raise privacy implications. The questions of who acts as the merchant of record, and who is responsible for making consumer disclosures, maintaining data security, and processing returns, are all key considerations for retailers.

Product Liability | E-Commerce Platforms Face Increased Claims

In past years, e-commerce platforms were not held liable in U.S. courts for injuries caused by products sold on their platforms because they were held to be facilitators of third-party transactions. Recent developments suggest this may be changing—and courts may view e-commerce platforms as essential links in the supply chain—shifting greater liability risk onto e-retailers. In August 2020, for example, a California state appellate court reversed a decision that had found an e-commerce platform was not liable for an exploding battery because it was merely an "online marketplace." This is an area that should be closely monitored as it evolves.

Trademarks | Law May Need to Evolve to Address AI

AI is changing how consumers buy products, acting as a filter between consumers, products, and brands, and serving as something akin to a personal shopper. Rather than merely being responsive to consumer demands, AI makes retail more predictive, raising new questions about trademark law involving the purchasing process and interactions between consumers and brands. AI also has implications for who is considered an average consumer in trademark infringement cases, issues of liability, and comparative advertising.

PATENT TRENDS AND OUTLOOK

As businesses engage in an innovation race, intellectual property will undoubtedly play a key role. A few signals point to significant patent activity within the e-commerce and retail tech space. First, Instacart acquired 250 patents from IBM in February 2021. Second, e-commerce company Shopify has been building its IP portfolio and exploring new patent innovations. A notable development, however, is that Shopify joined the Open Invention Network, the largest patent nonaggression community in history, emphasizing its commitment to open source software.

Overall, the total number of patents granted in the United States in 2020 reached 352,013, representing a decline of just under 1% compared to 2019. However, patent applications increased nearly 5%, a signal of a potential increase in years to come. IBM had the highest number of patents granted. A key area of patent activity is artificial intelligence, as companies look to automate and improve efficiency.

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ABOUT US

Technology Transactions & Privacy | Retail & E-Commerce

Our Retail & Consumer Products team understands the highly competitive environment in which world-class retailers, manufacturers, and distributors, as well as national real estate landlords and tenants, operate. Since *Chambers USA* began ranking law firms in the retail category, Perkins Coie has consistently been ranked Band 1. Our team has experience handling the full range of legal needs for retail and consumer products companies. As the retail landscape continues to change, we also work with attorneys in our Artificial Intelligence, Machine Learning & Robotics; Immersive Technology; Biometric Law; Blockchain, Digital Assets & Custody; Internet of Things; and Unmanned Vehicle Systems groups to navigate these changes.

ROBOTICS & AUTONOMOUS SYSTEMS

2022 EMERGING TECHNOLOGY TRENDS

MARKET AND LEGAL INSIGHTS FOR INNOVATORS

PERKINSCOIE

ROBOTICS & AUTONOMOUS SYSTEMS

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.

SECTOR OVERVIEW

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.

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.

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.

ROBOTICS & AUTONOMOUS SYSTEMS
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 robotaxi 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

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.

SECTOR AND INDUSTRY SIGNALS (CONT'D)

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.

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.

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.

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

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.

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.

LEGAL IMPLICATIONS (CONT'D)

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.

LARGEST AUTONOMOUS DRIVING PATENT OWNERS WORLDWIDE FROM 2010 TO 2019, BY NUMBER OF ACTIVE PATENT FAMILIES
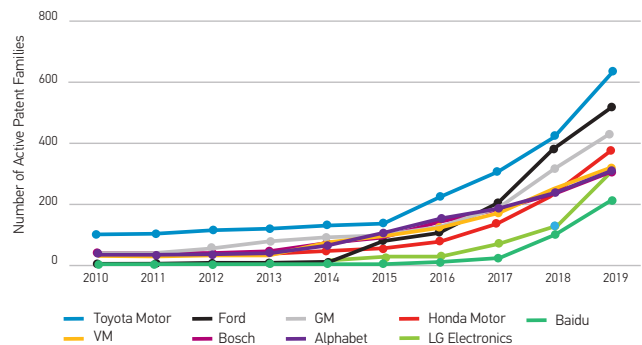
The data, curated by PatentSight, shows that Toyota Motors is currently the world's largest owner of autonomous driving patents.

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.

LEGAL IMPLICATIONS (CONT'D)
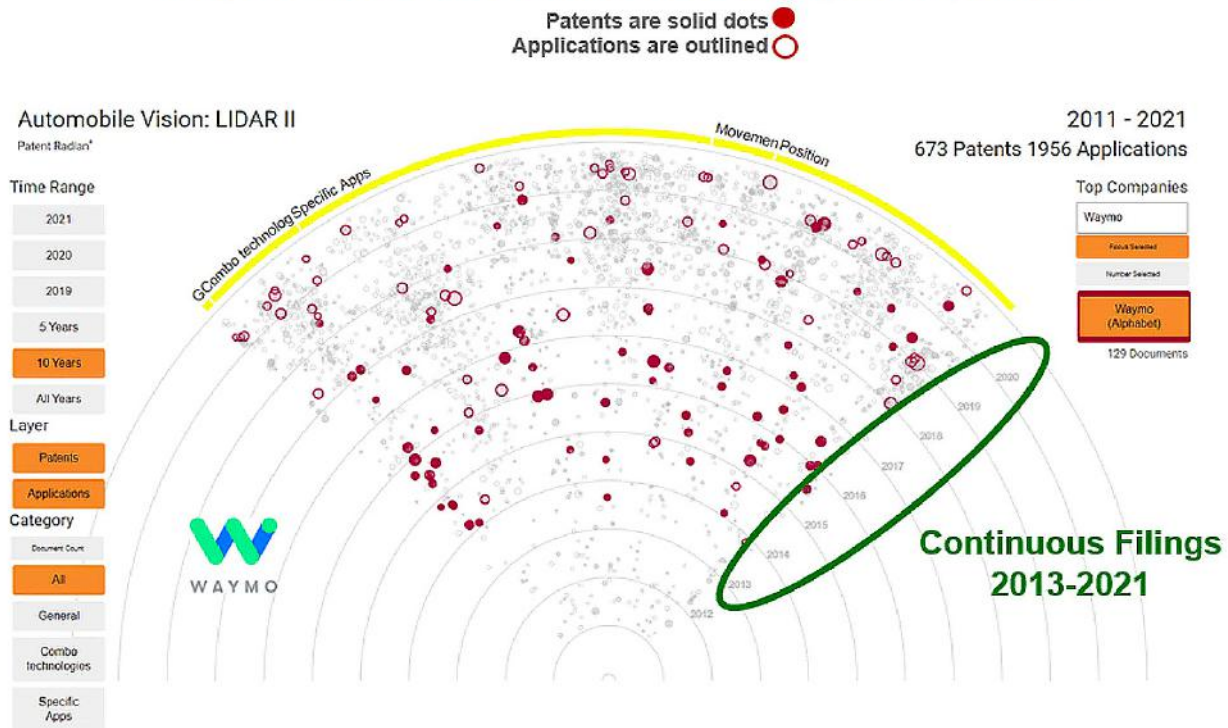
Tech Companies Represent Both Threat, Opportunity to Incumbent Auto Makers

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.

ROBOTICS & AUTONOMOUS SYSTEMS

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ABOUT US

Technology Transactions & Privacy | Robotics & Autonomous Systems

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.

SPACETECH

2022 EMERGING TECHNOLOGY TRENDS

MARKET AND LEGAL INSIGHTS FOR INNOVATORS

PERKINSCOIE

SPACETECH

Long-term strategists look to space for population expansion and risk mitigation. A human presence in space—first on the moon, and then on Mars—is built into NASA's current priorities.

SECTOR OVERVIEW

What Is Spacetech?
The term "spacetech" refers to any technology that supports or enables travel to space or activities conducted in space.

Beyond exploration, spacetech enables commercial and governmental endeavors conducted in space, from communications to scientific experiments.

Associated Sectors
- Communications
- National Defense
- National Intelligence
- Earth Observation
- Materials Science
- Manufacturing

Spacetech includes many technologies that have both civilian and military uses. Launch technologies, satellites, and navigation systems (e.g., GPS) are some of the better-known examples. Today, advancements in spacetech are increasingly funded by both the government and commercial sectors.

Governments continue to invest in space programs to advance technologies with military, scientific, and commercial applications. U.S. efforts to open up new markets for the private sector have accelerated over the last several presidential administrations. NASA Administrator Bill Nelson recently expressed his support for the commercialization of space flights. He was also supportive of privately funded reusable rockets, a new technology that has significantly reduced the cost of space travel.

The Opportunities and Challenges of Spacetech
Spacetech has had a profound impact on our daily lives. Examples include meteorological satellites that allow scientists to predict and track global weather patterns, and geolocation technologies that are embedded in almost all of our electronics.

Of course, with these successes come challenges. The proliferation of satellites and orbital rocket debris is crowding space with objects that pose a hazard to space operations but are difficult to remove after they achieve obsolescence. A solution will likely involve various tools, including debris minimization, removal, and avoidance strategies. Developing and agreeing to these approaches will take the cooperation of the civil, military, and commercial sector players.

Life on Earth Is Vulnerable, but Where to Go?
Long-term strategists look to space for population expansion and risk mitigation. A human presence in space—first on the moon, and then on Mars—is built into NASA's current priorities. Private sector players are also looking to help humans live in space. SpaceX CEO Elon Musk says he is "highly confident" that humans will land on Mars by 2026. While permanent human residences in space may seem part of a distant future, the pace of advancement is accelerating.

ENABLING SCIENCE AND TECHNOLOGY

Low-Orbit Satellites

There has been substantial innovation in the small satellite ("smallsat") area. Thanks to parallel advances in space launch and satellite technologies, companies can now launch thousands of smaller devices to low orbit at much lower cost than before. The technology has given the sector a strong growth outlook. While there will be winners and losers, the sheer number of current players is a testament to the potential.

Repair Systems, Reusable Rockets

As NASA recognizes, spaceflight is more sustainable, affordable, and resilient with the ability to service spacecraft. This includes the ability to refuel, fix, and upgrade equipment. For decades the space shuttle was the only reusable spacecraft. Over the last decade, however, the industry has made substantial strides in reusing entire rocket stages, with SpaceX leading the way.

Debris Removal

Commercial players are exploring approaches to make the spaceways safer and more navigable. Astroscale, a Japanese company, launched a mission in March 2021 to test a system for removing potentially dangerous debris from space.

The End-of-Life Services by Astroscale, or ELSA, will use a magnetic docking mechanism to attach to target objects and then push them toward Earth to burn up in the atmosphere.

In-Space Manufacturing

Additive manufacturing (also known as 3D printing) in space is an emerging technology, but it will be essential to any permanent human settlement in space. If a tool or part is broken or missing, the ability to create another one makes permanent settlement more viable. Scientists are also finding that items manufactured in space can be of benefit right here on Earth given the unique effects that microgravity can have on structure formation.

Resources Mining

Solar system bodies such as asteroids and planetary moons can be rich in resources. They contain materials of value for exploitation on Earth and in space, including that compound so critical for life: water. Both government and commercial players are planning how we might tap these resources. In December 2020, NASA named several companies that had won contracts to mine the moon and provide samples to the agency. These companies are Lunar Outpost, ispace Japan and Europe, and Masten Space Systems. If the costs of access to space (i.e., space launch costs) continue to drop, we can expect to see more commercial resources invested in this sector.

Climate Science

According to Morgan Stanley, "satellite technology and space exploration could be the key to addressing climate change—and could be central to sustainable investing in the coming years." More specifically, satellite technology could provide a more powerful global view of climate data. There are still technical barriers to solve in this area, and more international collaboration is needed.

SECTOR AND INDUSTRY SIGNALS

Spacetech Features Array of Commercial and Government Applications

Spacetech includes a broad range of activities in low orbit, high orbit, and outer space, and is seen as essential to unlocking new growth in wireless telecommunications, autonomous mobility, commercial space exploration, and national defense. Because these activities include both civilian and government applications, there is a broad range of demand indicators to look for when assessing the size and the growth prospects of the spacetech industry.

As discussed below, a wide range of entities are holding "innovation challenges" to spur technological development. Likewise, diverse signals are emerging from private and public markets. "Pure play" companies (businesses whose specialization is space technology) are receiving more late-stage venture capital (VC), and increasingly going public, while incumbents in the aerospace and defense industry are likewise making significant investments in spacetech.

Government, Industry, Consultants Fund Innovation Challenges

Stakeholders from the private and public sectors are encouraging engineers and scientists to develop the technology needed to support space exploration. These include government agencies, universities, defense contractors, and even consultants. There are also international competitions.

Specialist Funds Emerge in Financial Markets, but Few 'Pure Play' Options Exist

The space economy is highly diverse, and the number of companies developing technology in support of space exploration, commercialization, habitation, and defense is large. Because spacetech most often has both space and Earth applications, there are few "pure play" options for investors looking to capture the spacetech trend, and only a handful of those are public companies. However, the financial markets are beginning to offer specialist funds, including exchange traded funds (ETFs).

THE SPACE ECONOMY WILL DRIVE NEW, UNIQUE MARKETS AND DISRUPT TRADITIONAL TERRESTRIAL MARKETS BY INTRODUCING NEW TECHNOLOGIES AND NEW SOURCES OF MATERIALS.

IMPACT

Economic

The space economy will drive new, unique markets and disrupt traditional terrestrial markets by introducing new technologies and new sources of materials. Space resource mining, for example, may supply water to space habitats for drinking, growing food, and radiation protection. Similar mining activity may identify new sources of rare earth metals for use in our ubiquitous personal electronics.

Social

Space programs have always been part politics, part science, and part social experiment. This continues today with increasing complexity as more countries gain access to space and the associated technologies. This is particularly true with respect to current efforts to militarize space. The Center for Strategic and International Studies produces a yearly Space Threat Assessment report that discusses threats to U.S. space systems and highlights international competition in space. Although countries are keen to invest in counterspace weapons, they are not yet able to control the fallout.

Environmental

The operational life span of small satellites is short—around five years, in the case of SpaceX's constellation. Fixing small satellites isn't always possible, or economically viable, and there is no obligation to do so. Once a satellite is no longer of use, it can linger in orbit for years (and even decades).

Policy

Space law is unsettled on big questions such as debris mitigation and space traffic management. The U.S. government adopted Orbital Debris Mitigation Standards in 2001, but there hasn't been a concerted cleanup effort. The question of whether industry should be responsible for safely de-orbiting its own equipment is unresolved, though some industry-led efforts to mitigate debris do exist.

In contrast, space-traffic management could be a revenue-generating opportunity for the U.S. government, just like air traffic control. A report produced by the U.S. Congressional Research Service (CRS) pointed out that "[w]ithin the United States, oversight of civilian satellite activities is in flux," so this is an area to follow for developments. Europe is likewise developing space-traffic management standards.

Governments are also considering the role private industry will play in the space economy. For example, Japan recently became the fourth nation to adopt a space resources law. Such laws allow private businesses to develop resources such as water and minerals in space, on the moon, and on other celestial bodies. This development model is consistent with the development of new markets; however, it contradicts the notion that space is the common heritage of humankind, or "a great commons." That principle, on its own, is nonbinding, but it has supported prior developments in international law. The United States and some of its closest allies recently entered into the Artemis Accords for the exploration of deep space and the extraction of resources in space. The move signals commitment—but not an international consensus—to developing the space economy through private investment.
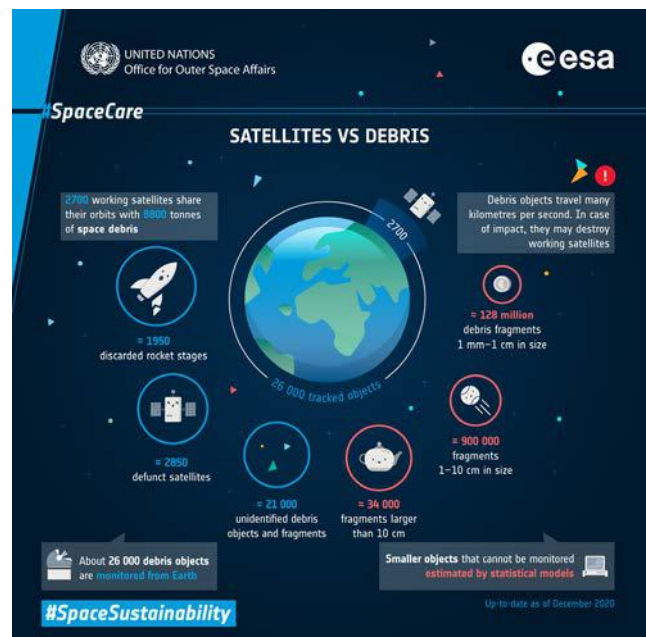
Source: ESA and the United Nations Office for Outer Space Affairs (UNOOSA)

LEGAL IMPLICATIONS

Space law is slowing the pace of commercial development in spacetech. Novel legal questions are being raised about jurisdiction, property rights, the applicability of patent law, and even the applicability of criminal law. No consensus exists among spacefaring nations—or within the broader international community—on which legal principles should apply.

OUTLOOK

Cybersecurity | US Government Developing Standards to Protect Space Assets

Cybersecurity is critically important for systems that can't be accessed in person and are difficult to service, such as satellite equipment. This is an area companies should be aware of, particularly as state interventions are becoming more common. Examples on Earth include the recent SolarWinds hack, which was believed to be backed or conducted by the Russian government. In the United States, government departments and agencies are developing policies and procedures to protect both public and private space assets from cyberattacks.

Transactions and Financing | VC Funding Largely Directed to Late-Stage Companies

There are several ways the spacetech industry can be divided for analysis, all of which have some overlap. To gain a more accurate picture of the size of the space economy, the U.S. Department of Commerce is developing its own estimates. PitchBook's Vertical Snapshot report for the spacetech industry shows that VC activity by dollar value is mostly late-stage funding; however, deal volume is more evenly distributed between angel and seed, early-stage VC, and late-stage VC. The data also shows that most spacetech funding is directed to terrestrial activities, followed by orbital and exploratory activities.

M&A | SPACs Invest Record Sums Into Spacetech

Spacetech is an emerging industry, and as such it includes few publicly listed companies. Of those, fewer still are "pure play"

SPACETECH VC DEALS ($B) BY STAGE
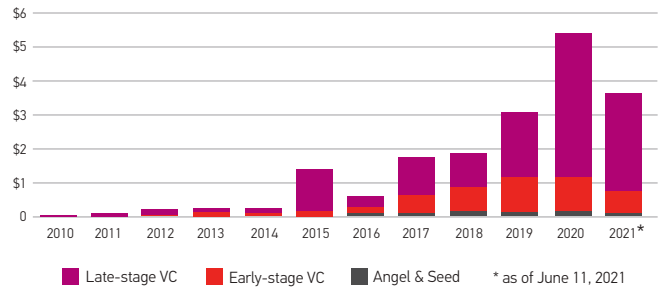
SPACETECH VC DEALS (#) BY STAGE
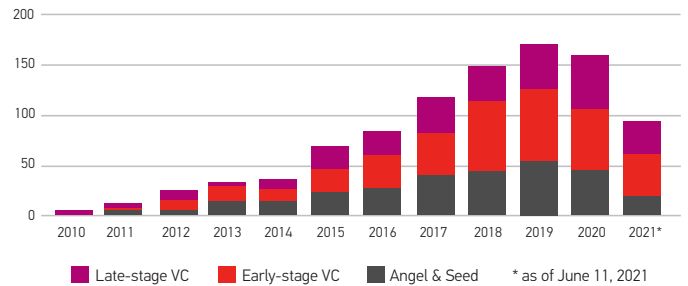
Source: PitchBook

companies. Defense contractors, for example, invest in space technology but shouldn't be counted as "spacetechs."

Still, the number of spacetech IPOs is growing. By one estimate, the number of IPOs in spacetech rose from two in 2019 to five in 2020. Special purpose acquisition companies (SPACs) are also investing record amounts in spacetech, although one SPAC is currently the subject of investigation by the U.S. Securities and Exchange Commission (SEC).

Due to the small number of publicly listed spacetech companies, it's too soon to observe M&A trends. However, the amount of late-stage VC and the growing number of privately held spacetech companies suggest more to come.

LEGAL IMPLICATIONS (CONT'D)

Litigation | 'Space Law' Slows Pace of Commercial Development

Through the Artemis Accords, the United States aims to recognize private property rights in space and encourages other countries to do the same. Overall, there is little national or international regulation in space, and there are even fewer enforcement mechanisms, so space law is a nascent practice area. At the same time, a growing number of legal questions in other practice areas have implications for the space economy.

Trade | US Spacetech Companies Cannot Trade with China

The Wolf Amendment places strict limitations on U.S. cooperation with China in space. According to the think tank the Center for Strategic and International Studies (CSIS,) "many space experts decry this legislation and warn that it hampers NASA's mandate to strive for international outreach and collaboration." Attempts to repeal or soften this law may face steep opposition on national security grounds, however. Data compiled by the Space Report shows that China currently ranks a close second to the United States for orbital launch attempts in 2020. Furthermore, the general organization of China's space industry reveals a close alignment between the private and public sectors. This heightens concerns of state-sponsored industrial espionage.

ORBITAL LAUNCH ATTEMPTS BY NATION, 2020
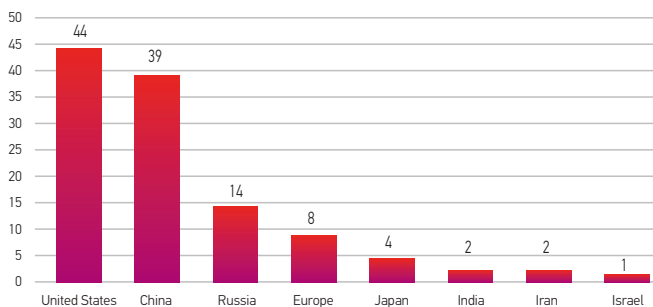
Source: The Space Report

LITIGATION DEVELOPMENTS

Unprecedented Allegations of Crime Committed in Space Withdrawn by US Prosecutors

In 2019, astronaut Anne McClain faced accusations from her ex-spouse that she had improperly accessed a bank account from the International Space Station. Upon further investigation, federal prosecutors found the spouse had lied on important details. A federal grand jury indicted the ex-spouse instead, with two counts of making false statements to NASA's Office of Inspector General and to the U.S. Federal Trade Commission (FTC). Had the case been pursued against McClain, it would have represented the first-ever criminal proceeding based on actions committed in space.

SpaceX Rivals Challenge FCC Approval of Satellite Constellation

Two of SpaceX's competitors—Dish Network and Viasat—and consulting firm the Balance Group each challenged the Federal Communications Commission (FCC) approval of SpaceX's satellite constellation. Dish Network alleged that SpaceX's network will cause "unacceptable interference" with its own services, while Viasat cited the heightened risk of collisions and cost of mitigation measures. The Balance Group alleged the FCC did not conduct a proper environmental review. The three legal proceedings were consolidated, and the lead case is *Viasat, Inc. v. FCC*, case number 21-1123, in the U.S. Court of Appeals for the District of Columbia.

Investors File Insider Trading Allegations Against Former Intelsat CEO and Board Chair

The former Intelsat CEO and chair of the board of directors, along with Intelsat shareholders BC Partners and Silver Lake, are facing an investor class action lawsuit alleging they committed insider trading. Plaintiffs allege the defendants sold $246 million in stock, based on nonpublic information that the FCC intended to hold a public auction for C-band spectrum (which would negatively impact Intelsat shares). The case highlights some uncertainty around when spectrum auctions are public or private, as the regulatory process included several private meetings.

LEGAL IMPLICATIONS (CONT'D)

PATENT TRENDS AND OUTLOOK

IP Issues Raised in Connection with Extraterrestrial Activities: WIPO

IP questions are increasingly being raised in connection with privately funded outer space activities, according to the World Intellectual Property Organization (WIPO). One of the most common IP issues is the applicability of national and regional patent law in outer space, but there are also potential issues under international space law.

For example, the doctrine of temporary presence, which was established by the Paris Convention for the Protection of Industrial Property, limits the exclusive rights conferred by a patent, in order to guarantee freedom of transport. If ships, aircraft, or vehicles temporarily visit foreign countries while having a patented invention on board, licenses on patents in force in these countries are not required in order to avoid infringing such patents. The question of whether the doctrine of temporary presence applies to spacecraft was raised by WIPO in 2004, and remains unresolved today. WIPO says, however, that "intellectual property protection will play an important role in developing successful space business models" and expects that input from the private sector will become more important in the development of space activities.

SPACE LAW IS SLOWING THE PACE OF COMMERCIAL DEVELOPMENT IN SPACETECH. NOVEL LEGAL QUESTIONS ARE BEING RAISED ABOUT JURISDICTION, PROPERTY RIGHTS, THE APPLICABILITY OF PATENT LAW, AND EVEN THE APPLICABILITY OF CRIMINAL LAW.

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ABOUT US

Technology Transactions & Privacy | Spacetech

The extraordinary risk and distinctive characteristics of space ventures demand experienced legal counsel. Our multidisciplinary team of Technology Transactions & Privacy attorneys represent companies, their investors, and other affiliates in commercial transactions related to space technology and communications. Regulation is a major concern for our clients, and we represent them before the Federal Aviation Administration, Federal Communications Commission, and other federal agencies and international organizations as key members of Perkins Coie's New Space industry group.

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2022 EMERGING TECHNOLOGY TRENDS

MARKET AND LEGAL INSIGHTS FOR INNOVATORS

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