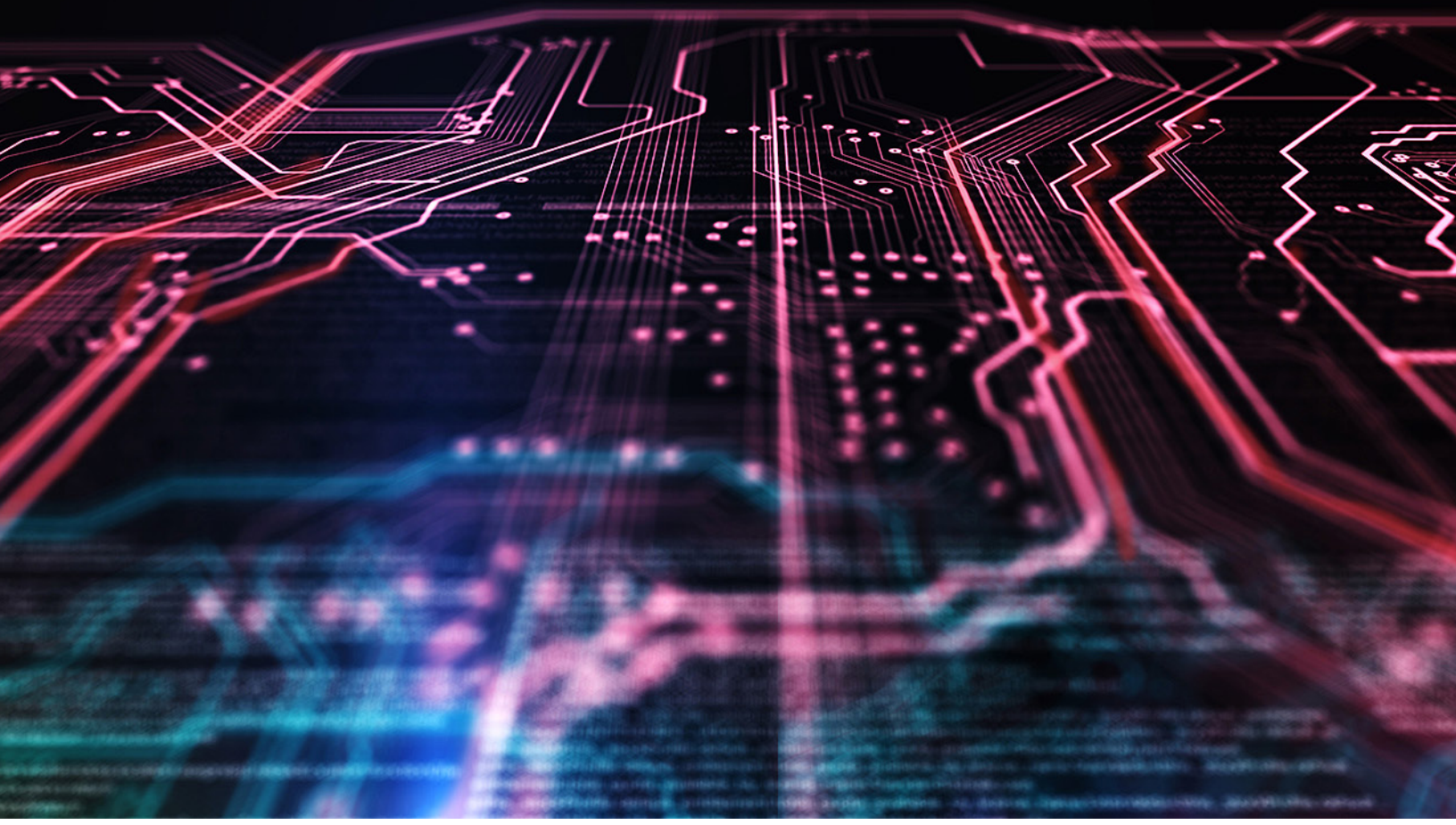
2022 EMERGING TECHNOLOGY TRENDS

MARKET AND LEGAL INSIGHTS FOR INNOVATORS



PERKINSCOIE

SPACETECH

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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.

SPACETECH

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).

SPACETECH

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

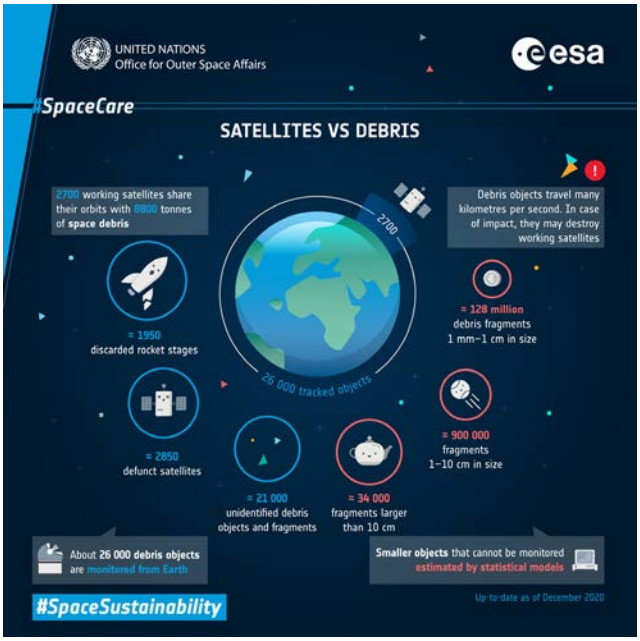
The operational life span of small satellites is short—around five years, in the case of SpaceX's constellation. Fixing small satellites isn't always possible, or economically viable, and there is no obligation to do so. Once a satellite is no longer of use, it can linger in orbit for years (and even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

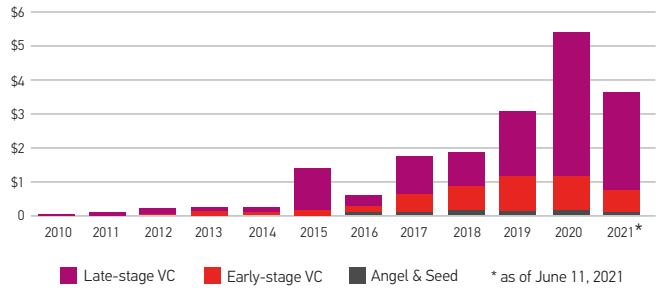
M&A | SPACs Invest Record Sums Into Spacetech

Spacetech is an emerging industry, and as such it includes few publicly listed companies. Of those, fewer still are "pure play" companies. Defense contractors, for example, invest in space technology but shouldn't be counted as "spacetechs."

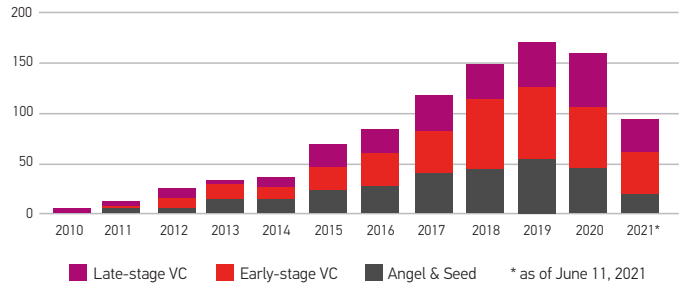
Still, the number of spacetech IPOs is growing. By one estimate, the number of IPOs in spacetech rose from two in 2019 to five in 2020. Special purpose acquisition companies (SPACs) are also investing record amounts in spacetech, although one SPAC is currently the subject of investigation by the U.S.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

SPACETECH VC DEALS ($B) BY STAGE



SPACETECH VC DEALS (#) BY STAGE



Source: PitchBook

LEGAL IMPLICATIONS (CONT'D)

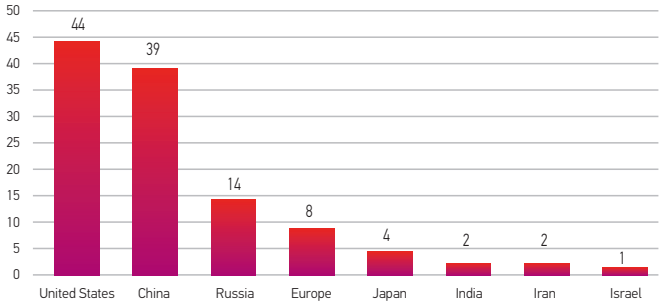
Litigation | 'Space Law' Slows Pace of Commercial Development

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.

SPACETECH

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ABOUT US

Technology Transactions & Privacy | Spacetech

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