HARVARD | BUSINESS | SCHOOL

9-722-063

REV: JUNE 27, 2022

MATTHEW C. WEINZIERL

BRENDAN L. ROSSEAU

The United States National Security Apparatus, Multipolarity, and the Rise of Commercial Space

The U.S. national security community crossed a Rubicon in 2019, when the Commander in Chief declared that space was "the world's newest war-fighting domain"[1] and championed a major reorganization of the Department of Defense (DoD). At the heart of these changes were the creation of the U.S. Space Force (USSF), the first new military branch in over 70 years, and the reestablishment of U.S. Space Command (USSPACECOM), a space-focused combatant command that had been internally subsumed in 2002. The new Space Force was tasked with "organizing, training, and equipping" the troops that Space Command would use to "deter conflict, and if necessary, defeat aggression, deliver space combat power […] and defend U.S. vital interests with allies and partners."[2,3]

America's space activity had always reflected a mixture of scientific, economic, political (civil), and military priorities; as journalist Jason Daley wrote, "The U.S. military has been involved with space since the beginning, just, perhaps, not under that name. …[It's] been in space since space was a place you could be."[4] While the National Aeronautical and Space Administration (NASA), a civilian agency, had been the public face of U.S. space efforts, a majority of the nation's space budget consistently was devoted to national security space programs, and virtually all technologies developed for space were so-called "dual-use," meaning that they had both civilian and military applications.[5] (See **Exhibit 1** for a comparison of NASA vs. DoD space spending).

But U.S. policymakers were facing a moment in which decades-old ways of operating in space were being radically challenged and established relationships between actors were being redefined. Private companies seeking to build a space economy were showing how a decentralized, competitive market could both drive innovation and stress existing space governance models, while a growing list of other nations—especially an increasingly adversarial China—were focused on pursuing their own priorities in space. The complexity introduced by these ascendant actors was already evident in Earth orbit, and plans for a surge of activity in cislunar space and on the Moon over the next decade prompted the question: How should the U.S. military pursue its mission in the progressively more crowded, congested, and contested space domain?

As they charted this future in space, policymakers could seek lessons from the first half-century of the Space Age. (See **Exhibit 2** for selected decisionmakers).

Professor Matthew C. Weinzierl and Research Associate Brendan L. Rosseau prepared this case. This case was developed from published sources. Funding for the development of this case was provided by Harvard Business School and not by the company. HBS cases are developed solely as the basis for class discussion. Cases are not intended to serve as endorsements, sources of primary data, or illustrations of effective or ineffective management.

The Cold War space race

In World War II's closing months, the emergence of nuclear weapons lent new importance to long-range rocketry. Soviet and American forces scrambled to reach the German scientists and engineers who had created the infamous V2 rocket, the first artificial object to reach outer space.[6] The highly secretive Operation Paperclip brought "roughly 1,600 of these German scientists […] to the United States to work on America's behalf during the Cold War."[7] Among them was Wernher von Braun, who would later design the Saturn V rocket that brought Americans to the Moon.[8]

Space quickly emerged as a priority for both the United States and Soviet Union, with the latter's 1957 launch of *Sputnik 1* (the first manmade satellite to orbit the Earth) and thus the Cold War space race. Though just a 23-inch sphere carrying a radio transmitter on an ostensibly non-military mission, *Sputnik 1* sent a signal of technological prowess and "superiority as ever-growing nuclear arsenals assured mutual destruction in the event of all-out war."[9]

In the United States, both government leaders and the public demanded a response. In early 1958, the Army launched *Explorer 1*, America's first orbiting spacecraft, and the Navy launched *Vanguard 1*, which pioneered solar power for satellites.[10] Later that year came the launch of the world's first communications satellite, which President Eisenhower used to broadcast that year's Christmas message, marking the first "voice sent from space."[11] Then came Project Corona, a reconnaissance program that surveilled "over 1,650,000 square miles of Soviet Union territory."[12]

In short order, space became a theater of an ideological war. A 1958 U.S. National Security Council Report described these "beginning stages of man's conquest of space" as "characterized by national competition." "The result," it concluded, "has been a tendency to equate achievement in outer space with leadership in science, military capability, industrial technology, and with leadership in general."[13] "The driving motivation [behind space efforts] was a desire to signal status and capability through monumental achievement," wrote NASA Chief Economist Alexander MacDonald.[14]

The organization of U.S. military space

Sputnik 1 had prompted the U.S. government to reinvigorate and reorganize its space efforts, but the nature of the organization which would lead them was hotly debated. To many, including Senate Majority Leader (and future President) Lyndon B. Johnson, it seemed that America's flagship space program should be a military one.[15] "There is something more important than the ultimate weapon," Johnson said in 1958. "That is the ultimate position – the position of total control over Earth that lies somewhere out in space."[16]

"Johnson was probably the first who understood that space was the ideal 'battleground' of the cold war," wrote Professor Andreas Richstein. "[B]y competing with the Soviet Union for technical leadership and peaceful dominance in space, the United States could show that it was the superior nation."[17] But Johnson's "battleground" view of outer space had its detractors, most importantly President Eisenhower, who didn't want a space agency at all.

Eisenhower and Johnson compromised, and the multi-purpose American space enterprise—combining national security, scientific, economic, and political priorities—began to take shape.[18] The public face of space efforts was the newly-minted civil space program: NASA.[19] While the 1958 Space Act established NASA's civilian purpose ("Congress further declares that such activities shall be the responsibility of, and shall be directed by, a civilian agency exercising control over aeronautical and space activities sponsored by the United States…"), it also issued a caveat: "…except that activities peculiar to or primarily associated with the development of weapons systems, military operations, or

the defense of the United States […] shall be the responsibility of, and shall be directed by, the Department of Defense…"[20]

As prominent astrophysicist Neil deGrasse Tyson noted decades later, NASA's public prominence obscured America's parallel military space efforts:

> At the end of July, the National Aeronautics and Space Act of 1958 was passed. In mid-August, the National Security Council issued its secret "Preliminary U.S. Policy on Outer Space," which unequivocally stated that "[a]ny use of outer space, whatever the purpose it is intended to serve, may have some degree of military or other non-peaceful application…" While giving a diplomatic nod to "peaceful purposes," Congress leaves no doubt that the militarization and weaponization of space are inevitable.[21]

In the late 1950s and early 1960s, a "full-court press for control of military space" by Gen. Bernard A. Schriever established Air Force primacy over U.S. military space efforts, making it the "de facto executive agent for military space."[22] The Air Force deemed controlling the high ground of space to be essential, advocated for military "space patrols" and "space denial" (the ability to forcibly reject Soviet attempts to access orbit),[23] and considered taking such bold actions as establishing a military Moon base or detonating a nuclear weapon on the lunar surface as a show of force.[24]

The rise of satellites and space systems

The Cold War space race built not just the institutions but also the foundational technologies of modern space. After the use of space-based nuclear weapons was rejected as impractical and unwise,[25] both the United States and the Soviet Union sought advantage through building space systems: reconnaissance satellites for intelligence on strategic weapons and troop movements, communications satellites to provide "enormously enhanced command-and-control capabilities," early-warning systems for missile launch alerts, geodetic satellites for weapons targeting, and more.[26] The U.S. military in particular began developing, refining, and fielding increasingly mature capabilities, including launch vehicles, orbiting missile warning systems, satellite communications, and the foundations for what would become the Global Positioning System (GPS). With each military and intelligence system deployed, space became further entrenched as an arena for military, as well as economic and ideological, competition.

A contemporary study remarked that satellites were "becoming increasingly important to the military operations of both the US and the USSR,"[27] and satellites became the key asset—and target—in space. "[I]f the Soviets or anyone else started playing around with our satellites," believed Secretary of Defense Robert McNamara, "we should have the ability to do likewise."[28] American anti-satellite (ASAT) efforts began in 1957 and culminated in the deployment of a "ground-based direct-ascent missile system." The Soviets favored a "killer satellite" known as an "orbital intercept system," and tested it "extensive[ly]" starting in 1968.[29] In the end, neither side would attack the other's satellites.

Soviet leader Mikhail Gorbachev's military cutbacks in the mid-1980s severely curtailed the USSR's advanced weapons program, cooling the race for space weapons, and the notion of a potential armed conflict in space waned. But the portfolio of American national security satellites, which had been growing in number, complexity, sensitivity, and range of capabilities, was secure and ready for use.

The First Space War

In August 1990, Iraq's president Saddam Hussein sent 100,000 troops to invade the small, oil-rich neighboring country of Kuwait.[30] A U.S.-led group of nations (the Coalition) condemned Hussein's aggression and mobilized to drive Iraqi forces out of Kuwait. While space units had supported combat operations in previous conflicts, providing satellite-based weather and communications support, the Gulf War would be the first opportunity for an integrated space capability to demonstrate its military promise, marking the conflict as "the first space war."

The Coalition's counterattack on Iraqi forces relied on space systems that the United States, and to a lesser extent other Coalition nations, had built up over the past three decades. Satellites provided "instant, long-range communications," allowing for "synchronization, maneuvering, and surprise use" of Coalition firepower.[31] Using satellite-enabled devices, American soldiers made 700,000 phone calls and sent 150,000 messages each day.[32] Weather satellites provided critical information about battlefield conditions and proved to be the "most reliable real-time source of weather data."[33] Missile warning satellites alerted Coalition forces of incoming Iraqi "Scud" missiles.[34] Perhaps most important was the fledgling GPS system,[35] which provided position, navigation, and timing (PNT) information essential to precision-guided munitions including "stealth bombers, cruise missiles and […] 'smart' bombs."[36]

Space assets gave Coalition forces asymmetric advantages that quickly led to victory. Lacking satellite communications of their own, Iraqi generals were cut off from the front lines. GPS allowed Coalition forces to find their way through terrain deemed unnavigable by Iraqi commanders.[37] Only 100 hours after the Coalition assault began, Iraq sued for peace. Lieutenant Colonel Steven J. Burger, Air Force Space Command's Chief of Space Control Systems, reported that "Spaceborne assets had a dramatic effect on the ability of the operational commander in the Gulf war to prosecute a comprehensive campaign to achieve the objectives of the United States and the coalition […]."[38] Moreover, battlefront reports broadcast around the globe emphasized the importance of U.S. military space systems, sending a clear message that satellites had changed warfare.[39]

Building on its success in the Gulf War, the U.S. national security space community continued to add to its technology portfolio and, along the way, increase it geographical footprint. Space systems provided "hardened" military satellite communications, weather data, PNT through GPS, reconnaissance, missile detection, nuclear detonation alerts, and more. Space-focused military units could be found around the world, from California and Florida launch complexes to sprawling Colorado bases, to outposts in Greenland, Guam, Japan, and many more.[40] As a new millennium dawned, the DoD foresaw a future in which America's national security increasingly leveraged the unique advantages that space systems could offer.[41]

Calls for change

America's multi-purpose space program had achieved much in its first several decades, but its top-down structure had generated weaknesses. On the civilian side, the low-competition, centralized structure of NASA contracts and procurement was blamed for cost and schedule overruns in its flagship Shuttle and ISS programs, which quickly swallowed up the agency's budget.[42] U.S. military space efforts came under criticism as well. Major military acquisitions like satellites were "extremely complex," involving a daunting design, test, and build process that could span a decade or more.[43] "For years," noted a RAND study, "[DoD] space programs suffered large cost growth, schedule delays, and unanticipated technical problems." These issues were so pernicious that "cost growth for [DoD] satellite systems" was worse than "all other categories of defense systems."[44]

In 1999, Congress convened a commission to thoroughly review DoD space activities, and the result was a stern warning. The group, called the "Rumsfeld Commission" after its Chairman (and future Secretary of Defense) Donald Rumsfeld, delivered a sweeping set of findings and recommendations in its 2001 report. The Commission argued that "The extent of U.S. dependence on space [and] the rapid pace at which that dependence is increasing… demand that U.S. national security space activities be recognized as a top national security priority," requiring cooperation across all sectors of America's space enterprise: "commercial, civil, defense, and intelligence."[45] Ominously, the report concluded that the United States was vulnerable to a what it called a "space Pearl Harbor."

The Rumsfeld Commission's warning grew more pressing as continued progress in microelectronics, computation, and the internet caused space systems to be woven into all aspects of modern infrastructure.[46] "For all of us," wrote the Aerospace Corporation's Center for Space Policy and Strategy, "satellites have become integrated into 21st-century society, much as electricity and mass communications became integral to 20th-century modernity."[47] "If these satellites were to stop working," echoed Walther Pelzer, Executive Board Member at the German Aerospace Center, "our modern world would be set back decades in a matter of seconds."[48] Though the "daily life of nearly every person in the world" depended on satellites, this was especially true in the United States.[49] "Nearly half" of the world's satellites were American, and the nation's infrastructure relied on GPS and other space systems.[50]

The American military, in particular, became dependent on space as a source of asymmetric advantage: "[U.S.] warships could not communicate without satellite links. [U.S] smart bombs could not hit their targets without guidance from GPS spacecraft. Each armored brigade contains 2,500 pieces of equipment that depend on space to operate."[51] The U.S. government had regularly outspent the rest of the world combined on space activities for the past half-century,[52] with a majority of that spending devoted to national security.[53] Over the years, security organizations like the DoD, National Reconnaissance Office (NRO), National Geospatial-Intelligence Agency (NGA), Defense Intelligence Agency (DIA), Missile Defense Agency (MDA), and Defense Advanced Research Projects Agency (DARPA), had fielded hundreds of space systems.[54] By the early 2010s, one out of every ten satellites in-orbit was a U.S. national security asset.[55]

The rise of commercial space

In the 2000s, calls for the decentralization of U.S. government space efforts bore fruit. The end of the Shuttle program presented the opportunity to transition to a commercially-led launch industry, which the government pursued through NASA's Commercial Orbital Transportation System (COTS) (2006 – 2013), Commercial Resupply Services (CRS) (2008 – 2016), and other commercially-minded programs offering billions of dollars in contract opportunities.[56] The DOD followed suit, awarding hundreds of millions of dollars in technology development in launch contracts, including the coveted Launch Service Agreement (LSA) worth $2 billion.[57] All told, from 2008 to 2018, the government provided a total of $7.2 billion in funding across 67 different space companies, mainly for launch.[58]

The DoD and NASA provided space startups with much-needed support at their early stages. Between 2002 and 2018, they invested over $133 million via the Small Business Innovation Research (SBIR) and Technology Transfer (STRR) grants.[59] "An early DARPA contract gave us the credibility we needed to raise our seed round," said the CEO of a space startup. "Endorsements from organizations that investors trust (NASA, DARPA, USAF, etc.) have had a positive impact on our business."[60]

Space startup accelerators, such as those started by the Air Force and NASA's Jet Propulsion Lab, were created to encourage promising technologies. Organizations like AFWERX (an Air Force

technology accelerator), the Defense Innovation Unit (an organization connecting the DoD with industry to "rapidly prototype and field" the latest industry technology), and Trusted Capital (a DoD program matching start-ups with "critical" technology to capital) helped nurture companies and signaled the government's "growing interest in working with entrepreneurial space companies."[61]

Buoyed by the U.S. government's commercially-minded approach, a wave of entrepreneurialism hit the space industry. Private capital began pouring into new space companies. Investment grew from near-zero levels in the early 2000s to nearly $8 billion in 2020 alone, fueling the "nearly 400" space startups birthed during that period. Companies receiving DoD and NASA investments proved better able to also attract private capital, receiving an average of "$6 of private investment for every $1 of public funding."[62]

Launch costs dropped. Satellites became smaller, lighter, and more powerful. Spacecrafts began launching into orbit at record rates. Between 2010 and 2020 alone, the number of operational satellites more than tripled, from 958 to 3,371.[63] (See **Exhibit 3** for growth in the active satellite population from 1957 to 2020). The "astounding" growth in satellites was largely driven by commercial industry: in 2020, 89% of all new satellites were commercial.[64]

The space industry's boom seemed to be just beginning, with ideas for expanded space infrastructure and services promising an increasingly diversified and capable sector. Recognizing the success of the "one customer among many" approach, government leaders increasingly sought to leverage the commercial space sector. Many felt that the ascendant private space industry was driving a new, exciting chapter in America's space story, a New Space Age.

Costs of decentralization in the absence of international cooperation

Decentralization brought risks as well, however, as demonstrated by increasing concerns about the crowding and congestion of Near-Earth space.[65] By the 2020s, America's mission-critical, highly-sensitive, billion-dollar satellites had thousands of new neighbors, and many more were on the way, yielding potentially "8000 spacecraft in orbit by 2024."[66] Plans for megaconstellations—groups of hundreds or even thousands of satellites operating in concert—led the American Astronomical Society to suggest that "more than 100,000 satellites" might be orbiting Earth by 2030.[67] And with each launch came more space debris.[68] In 2020, NASA's Aerospace Safety Advisory Panel sounded the alarm: "As the potential for orbital collisions rises with increasing congestion, it is important to recognize that risks to astronauts, critical national security capabilities and global space commerce are also on the rise." Unless the trend reversed, it concluded, "some orbital regimes" might become "impractical," or even unusable.[69]

Space also had few "rules of the road" determining how these swarms of new satellites should or shouldn't move. "The [space traffic management] system that we have today is just really not capable, it will not be capable of handling the traffic that we see in 10 or 15 years," said the National Security Council's Director for Space Policy Audrey Schaffer in 2021. Similarly, the 2020 Defense Space Strategy acknowledged that "International understanding and agreement of what constitutes unsafe, irresponsible, or threatening behavior in space is nascent."[70]

The lack of agreement on debris management was a symptom of a broader lack of international governance in space. The 1967 Outer Space Treaty, the most significant international agreement on space activities, was limited in its ability to deal with the challenges posed by 21st-century advances in space technology. With geopolitical tensions on the rise, prospects seemed dim for a new set of international agreements to establish, much less enforce, the rule of law in space. In the absence of such agreements, countries would likely pursue their own policies, perhaps with allies, to support

commercial activity. For example, in 2015 the U.S. passed the Commercial Space Launch Competitiveness Act to establish property rights for U.S. firms seeking to mine resources in space.

Multipolarity in Space

Traditionally, spaceflight had been limited to the world's wealthiest, most powerful nations, so much so that it had become a hallmark of a superpower.[71] But as costs dropped, a growing number of countries, as well as companies, turned to space in search of value. "[P]erhaps the most striking trend characterising the ongoing evolution of the space sector," wrote the European Space Policy Institute, "is the increase in the number of actors – both private and public, conducting space activities."[72] By 2018, over 70 nations had their own space program.[73] The rise of multipolarity created a new space landscape which, as described by an Atlantic Council report, presented "a range of challenges and opportunities for the United States to achieve security and prosperity in space."[74]

China, Russia, and a new Space Race

The growing multipolarity in space was unfolding against a backdrop of sweeping geopolitical changes, which undoubtedly would shape and be shaped by events in the space domain. "Around the world, there are historic transitions underway that will unfold over decades," stated the 2015 U.S. National Security Strategy (NSS),[75] a statement of the President's national security vision, highlighting that a rising China and "Russia's aggression" promised to "significantly impact the future of major power relations."[76] A 2018 RAND report described the challenges that China and Russia represented to America's security: "Russia is not a peer or near-peer competitor but rather a well-armed rogue state that seeks to subvert an international order it can never hope to dominate." By contrast, China represented a "near-peer competitor that wants to shape an international order that it can aspire to dominate."[77]

Positioning themselves as an alternative to American hegemony, Russia and China seemed increasingly to want to cooperate with each other, especially in the highly-visible arena of space. Russia, whose collaboration with the U.S. on ISS missions had been viewed as a major achievement for both nations, now drew up "ambitious" space collaborations with China, which would "directly compete" with those of the West. The "new era of space competition" prompted by the Sino-Russian space partnership "could be as intense as the first," speculated a *New York Times* article.[78]

"Space is already an area of great power competition," said Secretary of Defense Lloyd Austin in January 2021, labeling China as "the most significant threat going forward."[79]

China Modern China emerged in 1949 with the victory of the Chinese Communist Party (CCP), which quickly saw value in a space program for achieving national goals. Following the launch of *Sputnik 1*, CCP Chairman Mao Zedong declared: "We too will make satellites."[80] China launched its first satellite in 1970, and its rise as a space power paralleled its economic growth over the next several decades. In 1999, China launched the test vehicle *Shenzhou-1*, its first steps towards a manned spaceflight program.[81] Four years later, Yang Liwei became the first Chinese astronaut.[a,82] With the successful manned flight, China became only the third country to "send a man into space with its own rocket."[83]

By the 2000s, China's space efforts began sparking concern among some U.S. national security experts. In 2003, Dr. Joan Johnson-Freese, a department chair at the Naval War College, wrote that

[a] Chinese astronauts are sometimes referred to as "taikonauts," from the Mandarin word for space, "tàikōng."

"China is on a fast track into space. … [Its recent space] achievements, plus pronouncements about timetables, space laboratories, shuttles, space stations, lunar bases, and now Mars missions, naturally make one wonder just what the Chinese are up to."[84] The dual-use nature of space technology made it difficult to characterize and quantify any potential threat. "While one of the strongest immediate motivations for [China's manned space program] appears to be political prestige," noted a 2002 Pentagon report to Congress, "China's manned space efforts almost certainly will contribute to improved military space systems in the 2010–2020 time frame."[85] "Under a worst-case scenario, the Chinese manned efforts are merely a Trojan horse," Dr. Johnson-Freese noted. "Is there a new twenty-first century space race brewing? If there is, who is racing, and toward what goal?"[86]

American concerns about China's space program had visible consequences, including China's exclusion from the ISS, the largest international collaboration in space. In 1999, a congressional study known as the Cox Report demonstrated that China had been engaging in widespread technological theft from the U.S. for decades, particularly to help bolster its military and nuclear program. Though Beijing "strongly disputed" all allegations,[87] the Report and similar documents led the U.S. to limit its cooperation with China on high-tech projects like the ISS.

On January 11, 2007, China launched a "kinetic kill vehicle [rocket] that collided with a non-operational Chinese weather satellite," making it only the third country to perform an ASAT test.[88] The world was caught by surprise, and in the days after the test, "expressions of concern from Washington and other capitals" were met with silence.[89] The ASAT test made clear China's "resolve to play a major role in military space activities," reported a *New York Times* article, once the details were made public. It was "a shot across the bow,"[90] interpreted as "a clear demonstration to the United States that China could wage war beyond the Earth's atmosphere."[91] To U.S. national security leaders, the ASAT test was another in a series of provocative steps: "Now that space is not a sanctuary, this is serious business," testified Air Force Chief of Staff Gen. T. Michael Moseley before Congress in 2008.[92]

In 2011, the U.S. Congress passed the Wolf Amendment, barring NASA from collaborating with the Chinese National Space Agency (CNSA) and from "collaborating in any way with China or any Chinese-owned company."[93]

The election of President Xi Jinping in 2012 marked a new chapter for China and the CCP. Xi "vigorously pursued what he has called a 'great rejuvenation of the Chinese nation' with his China Dream vision."[94] Under Xi, the CCP adopted an "assertive foreign policy," coupled with a major expansion and modernization of its military, the People's Liberation Army (PLA), and a military budget second in scale only to that of the United States.[95]

Xi's vision for China's rejuvenation extended to space. "For years," a *New York Times* article noted, "the Chinese studied -- with growing anxiety — the American military, especially its invasions of Afghanistan in 2001 and Iraq in 2003. The battlefield successes were seen as rooted in space dominance."[96] A 2016 DoD report noted that "Chinese leaders are focused on developing the capabilities they deem necessary to deter or defeat adversary power projection and counter third-party—including U.S.—intervention during a crisis or conflict." As part of that goal, the PLA considered space to be the "commanding height in international strategic competition" and had created "a new force" to handle military space operations.[97] A 2015 report prepared for the U.S.-China Economic and Security Review Commission concluded that the Chinese space program's ultimate goal was "to become militarily, diplomatically, commercially, and economically as competitive as the United States is in space."[98]

China's efforts in space yielded remarkable achievements. China landed a lunar rover in 2013, "the first such 'soft-landing' since 1976, joining the United States and the former Soviet Union."[99] It

conducted additional ASAT tests in 2010, 2013, and 2014.[100] In 2016, China launched the *Tiangong 2* space lab, "part of a broader plan to have a permanent manned space station in service around 2022."[101] In 2019, the *Chang'e-4* spacecraft became the first to land on the far side of the Moon. Although "previous spacecraft have seen the far side" *Chang'e-4* was the first to ever land there.[102] The following year, China launched another lunar probe, an independent mission to Mars, and the final satellite in its Beidou constellation, "completing a navigation network years in the making and setting the stage to challenge the U.S.-owned Global Positioning System (GPS)."[103] As reported by CNBC in the summer of 2021, "President Xi Jinping has declared that China's 'Space Dream' is to overtake all nations and become the leading space power by 2045."[104]

Russia "After the decade-long crisis of the 1990s," noted a 2019 report, the Russian space agency, Roscosmos, was "on the precipice of a systemic state of crisis." Despite the country's enduring status as a "[leader] in space launch and space-based services," the trends weren't encouraging: "Should the country continue on this path, [Russia] may lose its space power status in the long term."[105]

Russia's President Vladimir Putin, who first took office in 2000 and gradually consolidated power over the next two decades, centralized and, according to Western observers, militarized aspects of Russia's space activities.[106] In 2015, Russia "merged its space force with the air force," citing the space domain's growing role in Russian military operations.[107] In 2017, a Russian Air Force official was quoted as saying that "Russia is developing new missiles with the express intent of destroying satellites."[108] A few months later, "images began circulating of a MiG-31 fighter carrying what experts claimed was an anti-satellite missile."[109] In 2018, a spacecraft that Russian officials claimed to be a "space apparatus inspector" began "behaving abnormally," according to the U.S. State Department: the satellite appeared to release a previously undisclosed "sub-satellite," prompting comparisons to a Russian nesting doll.[110, 111]

In 2020, two Russian satellites were observed to be "tailing a multibillion-dollar U.S. spy satellite." This latest incident "underscor[ed] a growing threat to America's dominance in space-based espionage," commented *Time*.[112] Just weeks later, DoD spokespeople announced yet another incident, in which "Russia conducted a non-destructive test of a space-based anti-satellite weapon."[113] "This is further evidence of Russia's continuing efforts to develop and test space-based systems," said Gen. John "Jay" Raymond, Chief of Space Operations of the USSF, "and consistent with the Kremlin's published military doctrine to employ weapons that hold U.S. and allied space assets at risk."[114]

In early 2022, Russia invaded Ukraine, sparking a global geopolitical rift that extended into space. The future of the ISS, which since 1998 had been a symbol of Russo-American collaboration that had survived "wars, assassination attempts, and allegations of political meddling," was at risk.[115] Built as a true partnership between both nations - the Russians maintaining orbital positioning and Americans supplying power -- the ISS was existentially dependent upon its key stakeholders. In the immediate aftermath of Russia's invasion, American sanctions against Russia drew thinly-veiled threats from Russian space leaders that they may abandon the ISS. Though ISS cooperation was temporarily sustained, Roscosmos confirmed that it would sever ties with the Station "as soon as [2024]."[116]

With Russo-American collaboration in space drawing to a bitter close, and Sino-American space collaboration forbidden by law, the era of space serving as a bridge between nations, despite "great power rivalries," appeared to be ending.

Other Space Nations

China and Russia weren't alone in embracing a more military-forward stance towards space. Though they didn't present a direct threat to U.S. space assets, other nations, including India and

France, were preparing for a potential war in space. On one hand, their push for military space capabilities could help deter potential aggression from shared adversaries. But some feared that any militarization of space would invite armed conflict. Moreover, U.S. adversaries, including Iran and North Korea, were also seeking to develop space weapons. "No one today finds U.S. space assets too daunting to think of attacking," said Congressman Jim Cooper. "With so few satellites of their own, [adversaries] can focus on playing offense."[117]

"The time for space as a sanctuary is over," concluded one report. "This is regrettable, it seems, but it is a fact."[118]

India On March 27, 2019, Indian Prime Minister Narendra Modi "declared [...] that the country had pulled off an ASAT missile launch that same day," making India the fourth country with confirmed ASAT capabilities.[119] "India's unexpected launch of an anti-satellite missile test this week sparked surprise (and some alarm) among international and aerospace-industry experts," one article reported. "[The test]," it continued, "reflected the growing sense by countries around the world," specifically India in this case, "that the weaponization of space is forthcoming."[120]

The successful test was part of India's broader plans for "marshaling a globally competitive space warfare capability."[121] That same year, it created two new military space bureaus and conducted its first "integrated space warfare exercise."[122] Within India's defense community, some "argued for more aggressive reforms," seeking to translate the success of India's civil space program (ISRO, the Indian Space Research Organisation) into military strength.

France In a press conference in 2018, French Defense Minister Florence Parly accused Russia of spying on a satellite "providing secure communications for the French military."[123] Within months, Emmanuel Macron, France's President, revealed "that the nation's air force will establish a space command for the purpose of national defense, particularly to protect French satellites."[124] France would embrace what it called "active defence" measures, Parly proclaimed, including potentially "equipping satellites with machine guns and lasers."[125]

Following the announcement, the New York Times characterized France as "nudg[ing] Europe into [the] Space Race," a race in which Europe had "lagg[ed] behind."[126] "Space is increasingly seen as a strategic asset, not only by the major space powers, but also by secondary powers like France," said Jean-Jacques Tortora, director of the European Space Policy Institute. "Space might potentially be the theater of military operations, and this justifies the setting up of dedicated space commands to manage these sorts of operations."[127]

Space arms race in the absence of international cooperation

As nations around the world appeared to be arming for a potential conflict in space, calls for space weapons arms controls grew louder and more desperate. Efforts to prohibit space weapons had existed since the 1950s but had yielded little success. An enduring obstacle was the problem of determining whether a space asset was a weapon, owing to the dual-use nature of most space technology.[128] Among the only successful space arms control agreements were bans on nuclear detonations in space (Partial Test Ban Treaty of 1963) and on the "establishment of military bases, installations and fortifications, the testing of any types of weapons and the conduct of military manoeuvres on celestial bodies" (Outer Space Treaty, 1967).[129] The U.S. had frequently opposed space weapons bans.[130]

"Beyond these provisions, and the oft cited but operationally opaque references to 'peaceful purposes' and to the exploration and use of outer space as the 'province of all mankind' there are no clear guidelines regarding military use of outer space," commented professor and space law expert

Melissa de Zwart.[131] "In addition," de Zwart continued, "military technology and military personnel were and remain essential to the exploration of outer space," noting that most astronauts and cosmonauts had come from military backgrounds.[132]

With space arms control efforts languishing, space powers continued to build up anti-space arsenals, adding to fears of space conflict. "I think the path to war in space is really based upon a space arms race, and we've been fortunate that we've been able to delay it up until this point, but it is perhaps imminent," said Carey Smith, CEO of defense contractor Parsons. "A key reason why the space race is accelerating is that technology is advancing so rapidly […]. A second reason is the absence of 'binding commitments on what the operating norms are going to be in space."

"Without that," Smith concluded, "we're very likely to have a space war.'"[133]

Establishing the U.S. Space Force & U.S. Space Command

Critics had argued for decades that, despite Gen. Schriever's early push for Air Force control, the Service had "showed little interest in space operations as a core institutional goal."[134] Though structural changes were made to reorganize and elevate space matters, such as creating Air Force Space Command (1983) and U.S. Space Command (1985), there continued to be a sense that the Air Force "only grudgingly supported space activities."[135] A 2001 analysis noted that space-related research received "only one-thirtieth" of the DoD's research budget, "hardly enough to pursue an aggressive space technology initiative." "Without additional funds," the analysis concluded, "the Air Force will not be able to implement" the Pentagon's vision for space as a "vital defense area."[136] The 2001 Rumsfeld report criticized the Air Force, which managed "85% of DoD's space-related budget activity," for not "devoting sufficient attention to space policy and programs."[137] (See **Exhibit 5** for a breakdown of Pentagon space spending in 2019 by organization).

As the space domain became more crowded, competitive, and contested throughout the 2010s, the organization of U.S. space activities again became a topic of debate. A critical moment came in 2015, when Pentagon officials met with the House of Representatives Armed Services Committee, and two congressmen—Rep. Jim Cooper (D-TN) and Rep. Mike Rogers (R-AL)—emerged from the meeting as emphatic advocates for greater space security. Reps. Cooper and Rogers created and publicized a vision for a "Space Force" in 2017, which they pushed to include in that year's National Defense Authorization Act (NDAA).

When Donald Trump assumed the Presidency in 2017, Space Force advocates found staunch allies in the new President and in Vice President Michael Pence, who would go on to chair a reborn National Space Council. On March 13, 2018, Trump unveiled a new national security strategy, designating space as a "theater of war." This change, said the President, necessitated the creation of a U.S. Space Force (USSF) as a new branch of the U.S. military. "Space is a war-fighting domain, just like the land, air, and sea," he announced. "Our service members will be vital to ensuring America continues to lead the way into the stars."[138] In June 2018, the White House directed the Pentagon to begin the process of establishing the USSF.[139] Provisions to make this proposal a legislative reality were included in the 2020 NDAA and, with the law's passage on December 20, 2019, the USSF was established as the sixth branch of the U.S. military.[140]

Complementing the USSF were two other space-focused entities, U.S. Space Command (USSPACECOM) and the Space Defense Agency (SDA), re-created and created (respectively) earlier in 2019. USSPACECOM was originally established in 1985 as the combatant command responsible for all U.S. military activities in space. Though it was subsumed into US Strategic Command in 2002,

USSPACECOM was restored as its own combatant command in 2019. The SDA, an experimental agency housed within the DoD, was created to rapidly field national security satellites by taking advantage of off-the-shelf technologies and streamlining the traditional acquisition process. Above all, SDA's mission was speed, which would be essential to stay ahead of evolving threats. Though dwarfed by the broader Space Force (in their 2022 budget requests, the USSF and SDA requested $17.4 billion and $936 million, respectfully), the SDA was being watched closely by the national security space community as a potential catalyst for greater organizational change.[141,142] "I'm hoping that SDA […] will really get the DoD back in the game of rapid innovation and technology development," said Peter Garretson, a senior fellow at the American Foreign Policy Council.[143]

Together, America's new military space organizations had a daunting task. "We've really been given a Buzz Lightyear area of responsibility - to infinity and beyond," said USSPACECOM's Maj. Gen. David N. Miller.[144]

Cislunar space and the Moon

One component of President Trump's space policy was an acceleration of the Artemis program, which would return American astronauts to the Moon and establish a permanent presence on both the Lunar surface and in cislunar space.[145] Artemis was also an effort to solidify international cooperation in space, providing a new opportunity for the United States to extend alliances into space (many Artemis partner countries were also members of NATO) and align on space norms.

The Artemis program was designed with the rising commercial sector in mind, "pulling on the commercial sector" to execute critical program elements. Building on the roadmap used by COTS to spur commercial launch, Artemis both called for significant public investment in mission-critical technologies and incorporated regulatory reforms, such as property rights on the Moon, designed to encourage industry. Using this public-private partnership approach, government space leaders hoped rapidly to achieve a sustained lunar presence, in part as a step on the way to a mission to Mars.

China had its own plans for a series of ambitious lunar missions beginning in 2024. The lunar exploration missions, dubbed Chang'e 6, 7, and 8, would study the lunar surface and its resources, with particular focus on the lunar south pole and its abundant water ice. "The main purpose of these three missions is for China to build the basic model of a lunar research station in cooperation with Russia, with China taking the lead," the deputy head of the China National Space Administration told state media. "The construction of the station can lay a solid foundation for us to better explore the lunar environment and resources, including how to peacefully use and develop lunar resources."[146]

With U.S.- and China-led coalitions unveiling lunar plans, a race for the Moon was on. At stake was not only national prestige, but also potential control over the most strategically significant lunar areas. "We are now seeing other actors go to the moon, go to lunar orbit and we do need to be concerned and interested in what they are doing there," said Lt. Gen. Stephen Whiting, commander of the U.S. Space Force's Space Operations Command.[147] In April 2022, the Space Force designated a new unit, the 19th Space Defense Squadron, to surveilling cis-lunar space. "As commerce, as NASA, as other countries start to go to the moon and beyond," said Lt. Gen Whiting, the U.S. military will also "have to pivot up and out for those orbital regimes."[148]

Looking ahead

Charting a course for the U.S. military's future in space would require policymakers to both learn the lessons of history and respond to—and even channel—the forces revolutionizing the present and near-future of human activity in space.

One decision policymakers faced was what role the military should play with respect to the growing U.S. commercial space industry. Commercial space could deliver innovation, efficiencies, and speed to the military as "one customer among many," helping the military achieve its goals more efficiently. Or, the military could see the development of commercial space as integral to its own goals, investing heavily in promising technologies, promoting healthy competition, and even creating the conditions for the sector's success.

As was dramatically demonstrated during Russia's invasion of Ukraine in early 2022, the commercial space sector was playing an increasingly significant role in core U.S. defense and intelligence operations. Earth observation companies photographed the mobilization and assault of Russian forces in real time, aiding the U.S. government in monitoring the conflict, coordinating and sharing information with allies, and supporting the Ukrainian government's efforts to defend itself.[149]

Months after the conflict began, the U.S. National Reconnaissance Office (NRO) awarded a multi-billion-dollar contract to three commercial satellite companies (*viz* Planet, Maxar, and BlackSky) in a "historic expansion" of the organization's commercial imagery acquisition, signaling to many that the government's appetite for commercially provided data would only increase.[150]

Commercial internet constellations also played an important role in assuring internet access for Ukrainian leaders, despite Russian disruption efforts. In a matter of hours, SpaceX activated access to Starlink – the company's growing internet constellation – and shipped terminals for use by the Ukrainian government. "We are using thousands of terminals with new shipments arriving every other day," said First Vice Prime Minister Fedorov, adding that they were "very effective."[151]

As commercial satellites demonstrated their effectiveness throughout the Russian invasion, they also brought complications. Russian forces' jamming of commercial communications satellites challenged conventions of "legitimate military targets" and raised questions about whether a more destructive attack on commercial systems would provoke a military response. "It is untested whether hitting a commercial satellite rises to the level to justify an armed attack response," said Jack Beard, co-director of the space law program at the University of Nebraska. "It's easy to say that a lot of these things are unsettled, because they are. But they're becoming more and more relevant."[152]

Within months of Starlink's activation in Ukraine, Chinese military researchers released a study concluding that China "needs to be able to disable or destroy SpaceX's Starlink satellites,"[153] and called for "a combination of soft and hard kill methods."[154] Both Chinese and American space leaders recognized that the battle for space supremacy would come down to whose industry could move faster to deliver and field technological advantages for the space domain.

In fact, some had argued that the newly-reformed U.S. national security space apparatus should proactively spur the space industry's broad development. "Just as the Navy and Army have been involved in frontier development since our colonial days—opening new markets and infrastructure across the seas or across the American west," Air Force Lieutenant General Steven Kwast said, "so too today's U.S. military needs to be prepared for similar activity in space. The U.S. military can expect to be a frontier development service once again, establishing the cosmic equivalent of navigational aids, charts, lighthouses, dams, search and rescue services, forts, supply depots, and coaling stations."[155]

The analogy was to the U.S. Navy as a "blue water" fleet, capable of operating globally (across the deep 'blue' waters of open oceans) and protecting an open system of commerce. These capabilities allowed the Navy to use force globally but also to exercise "significant diplomatic and constabulary functions… [including protecting] seaborne commerce and generally [maintaining] order at sea, [including] counterpiracy, drug interdiction, environmental protection, and other law enforcement."[156]

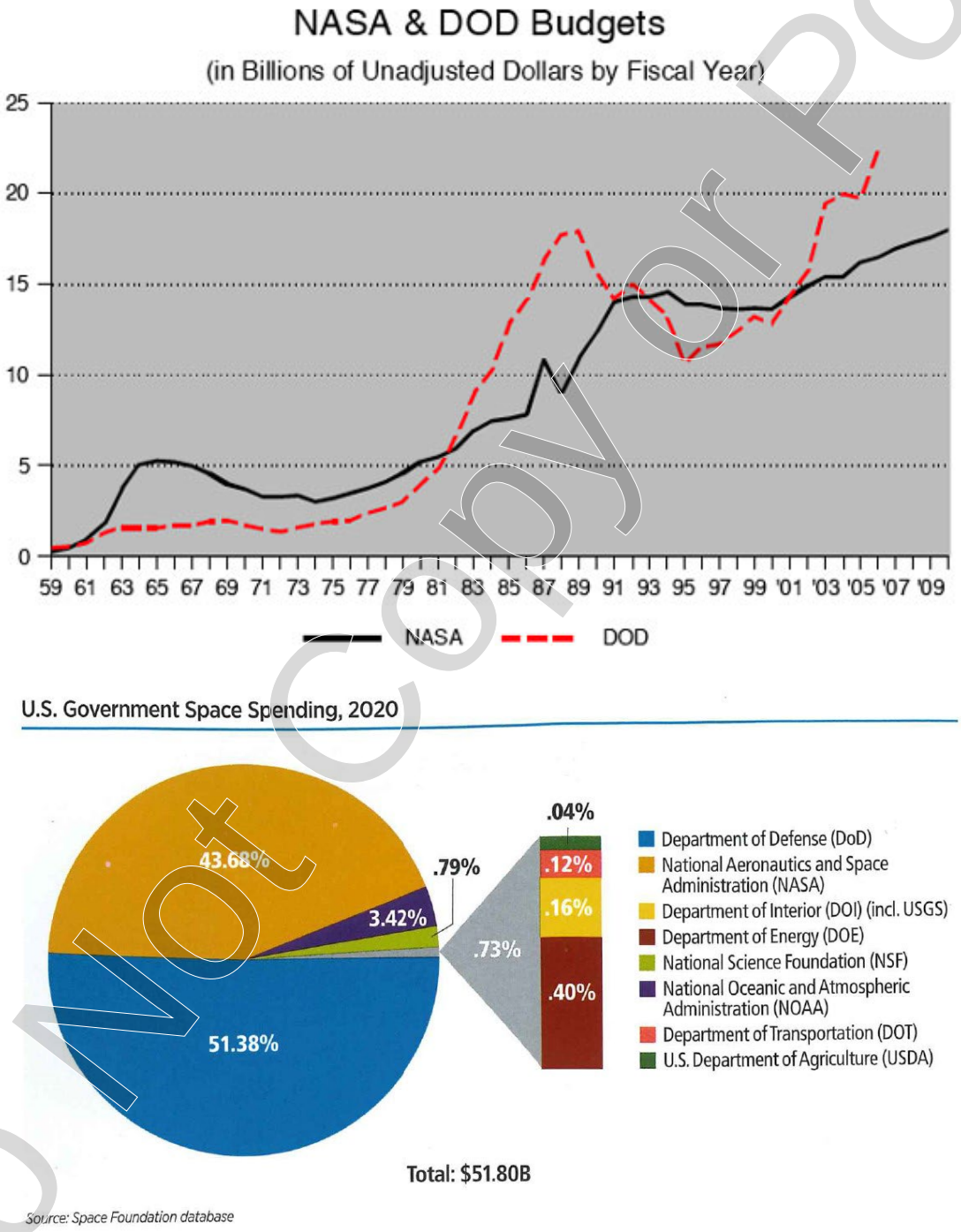
Proponents argued that, in addition to any infrastructure that commercial industry might benefit from, a more robust military presence would be the best way to establish the rule of law in space. The importance of the rule of law, including the credible enforcement of penalties against threatening, dangerous, or irresponsible behavior, to the development of any economy had deep roots. In *The Wealth of Nations*, Adam Smith cited a "tolerable administration of justice" as central to economic prosperity. Professor Douglas Irwin explained: "The administration of justice – a term Smith used frequently – was more than just a means of enabling individuals to 'secure the fruits of their own labor' and provide an incentive for productive effort, it was also a matter of peacefully adjudicating disputes and ensuring just relations between individuals."[157] Proponents for an expanded military presence viewed the U.S. military as perhaps the only organization with the resources and credibility to act as a "rule of law" agent in space. It also had a vested interest in keeping the space domain peaceful and secure, given the U.S. military's heightened dependence on space systems and the potentially disastrous effects of any conflict in space.

Policymakers also knew, however, that there were reasons to proceed with caution, as too strong a role for the military might skew the development of the space industry and be seen as America weaponizing space and escalating the possibility of conflict. Having NASA as the public face of its space enterprise had delivered significant benefits for the United States during the Cold War and beyond, acting as a means for peaceful rather than armed competition. Any bold action by the Space Force or USSPACECOM would risk forfeiting the notion that "activities in space should be devoted to peaceful purposes for the benefit of all mankind," as enshrined in the 1958 National Aeronautics and Space Act.[158] Significantly, most of the laws behind any "rule of law" that the military would be enforcing in space—such as on property rights and debris mitigation—were non-existent or ill-defined, and stakeholders often held divergent views. Under these circumstances, any attempt to enforce laws, especially by a military organization, could be viewed as a dangerous provocation. And if the U.S. military did choose a more assertive path, it wasn't clear how effective it would be at promoting peace. It was anyone's guess if "antisatellite moves and countermoves" would "lower or raise the risks of miscalculation and war," noted a *New York Times* article in 2021. "That debate is just beginning."[159]

If the U.S. military wasn't bold enough, however, it could risk allowing further destabilization of the space domain, or even ceding the advantages of space supremacy to potentially hostile powers. With so many threats and America so dependent on space, was developing counterspace capabilities as a deterrent more important now than ever? Would not doing so be naïve, even dangerous? "It is a historical truth, after all, that wherever humans have ventured, violence has followed," pointed out an article in *Time*.[160] David E. Sanger, national security correspondent for *The New York Times*, described how a possible Chinese invasion of Taiwan would also be a "space war": "[A China-Taiwan war] is one that would largely unfold at sea and of course in outer space. Key to running the Chinese and American navies around Taiwan would be communications, intelligence, and visibility that comes from our satellite assets."[161] China, which increasingly faced a similar strategic choice, seemed to be going to great lengths to encourage its "fledgling—but rapidly growing" private space industry.[162]

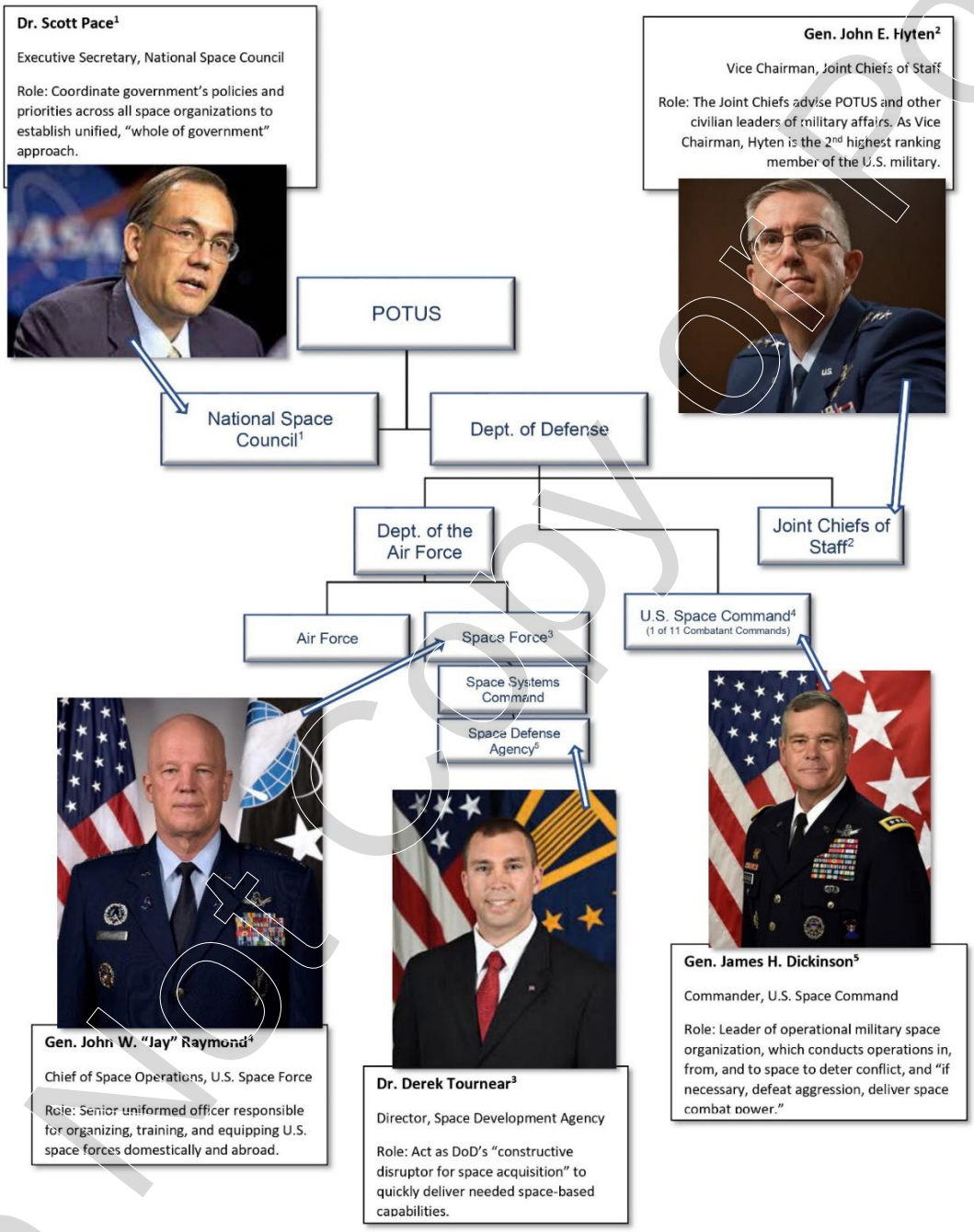
All of these factors were unfolding in Earth orbit and would soon expand to cislunar orbit and the Moon, as companies, space agencies, and militaries raced to define their roles in the next space age.

Exhibit 1 NASA vs. DoD space budget over time (above); USG space spending in 2020 (below)



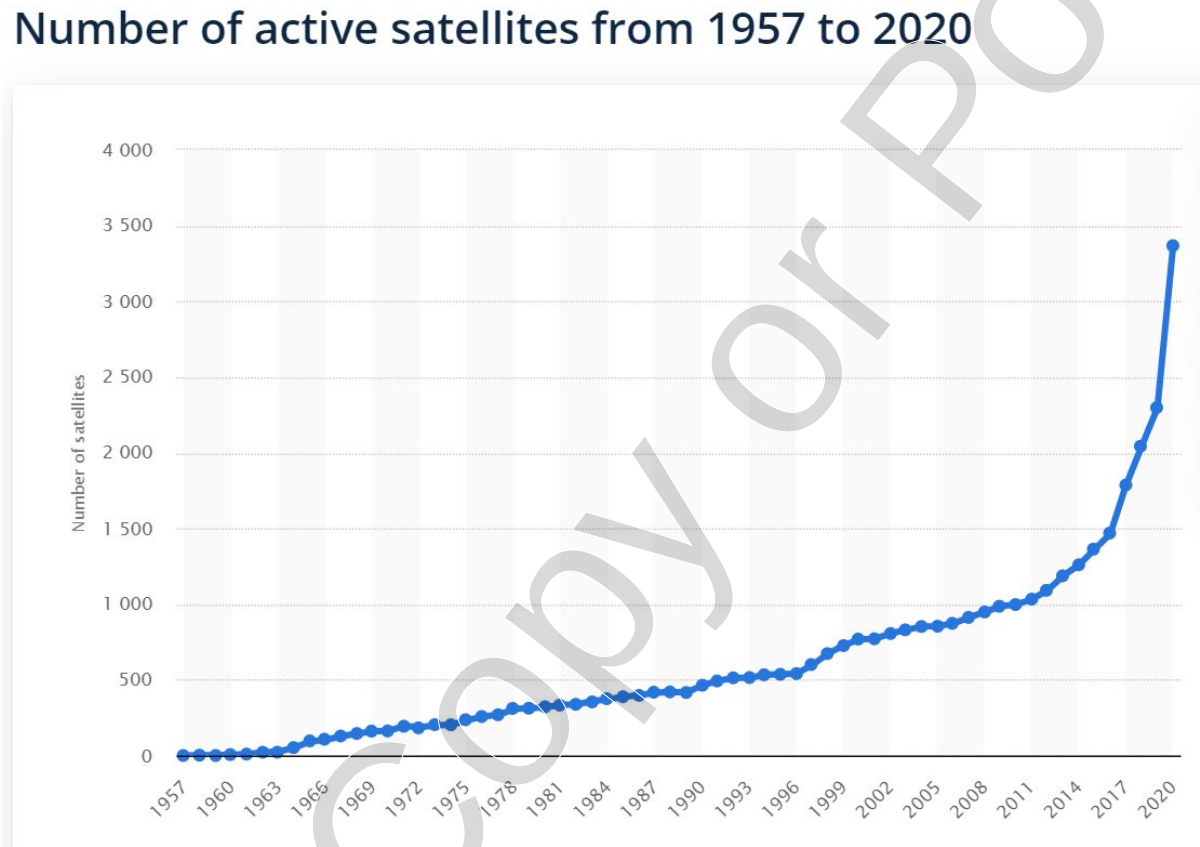
Source: (top) Congressional Research Service (CRS), "CRS Report: U.S. Space Programs: Civilian, Military, and Commercial," Updated May 24, 2005, Order Code IB92011, accessed via http://www.spaceref.com/news/viewsr.html?pid=16917; (bottom): Space Foundation, "The Space Report 2021," (Colorado Springs: Space Foundation, 2021) p.11.

Exhibit 2 Decisionmakers within U.S. military space organizational structure (simplified)



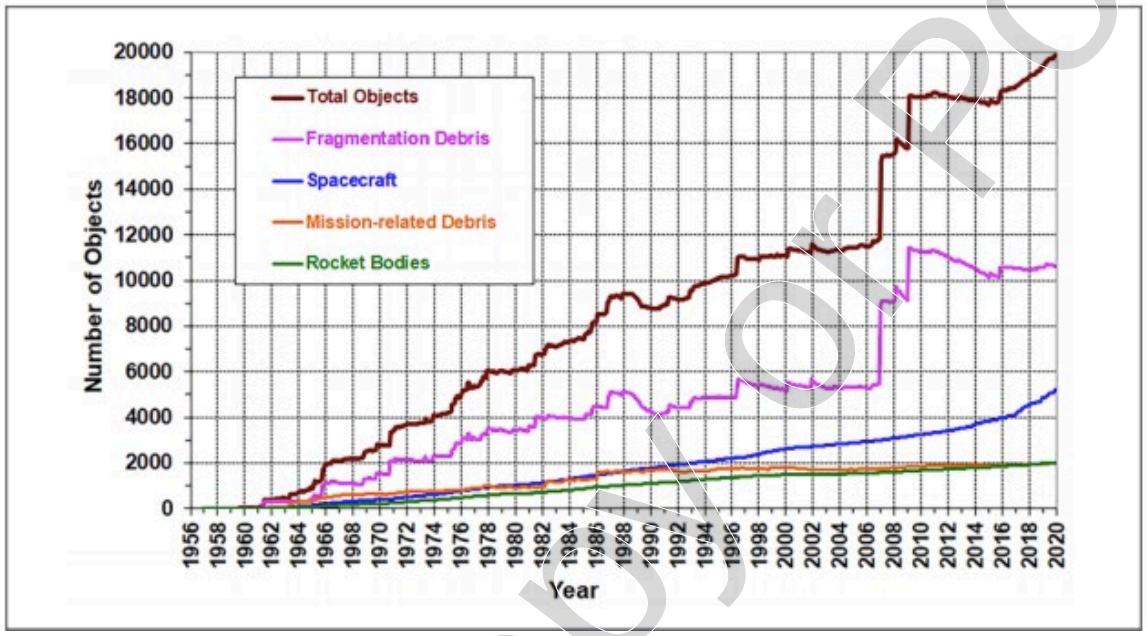
Source: Created by casewriters from (Top left): David Paul Morris/Stringer/Getty Images, accessed via https://www.space.com/37492-trump-appoints-scott-pace-national-space-council.html; (Top right): Lisa Ferdinando/Department of Defense Photo, accessed via https://www.military.com/daily-news/2020/11/13/gen-hyten-embattled-joint-chiefs-vice-chair-will-not-seek-second-term.html; (Bottom left): U.S. Space Force, Leadership – General John W. "Jay" Raymond, https://www.spaceforce.mil/SFB/Display/Article/2040592/general-john-w-jay-raymond/; (Bottom middle): U.S. Department of Defense, Derek M. Tournear, https://www.defense.gov/About/Biographies/Biography/Article/1853377/derek-m-tournear-phd/; (Bottom right): U.S. Space Command, Gen James H. Dickinson, https://www.spacecom.mil/Leaders/Bio/Article/2329436/gen-james-h-dickinson/.

Exhibit 3 Number of active satellites by year (1957 – 2020)



Source: "Number of active satellites by year," Statista, https://www.statista.com/statistics/897719/number-of-active-satellites-by-year/.

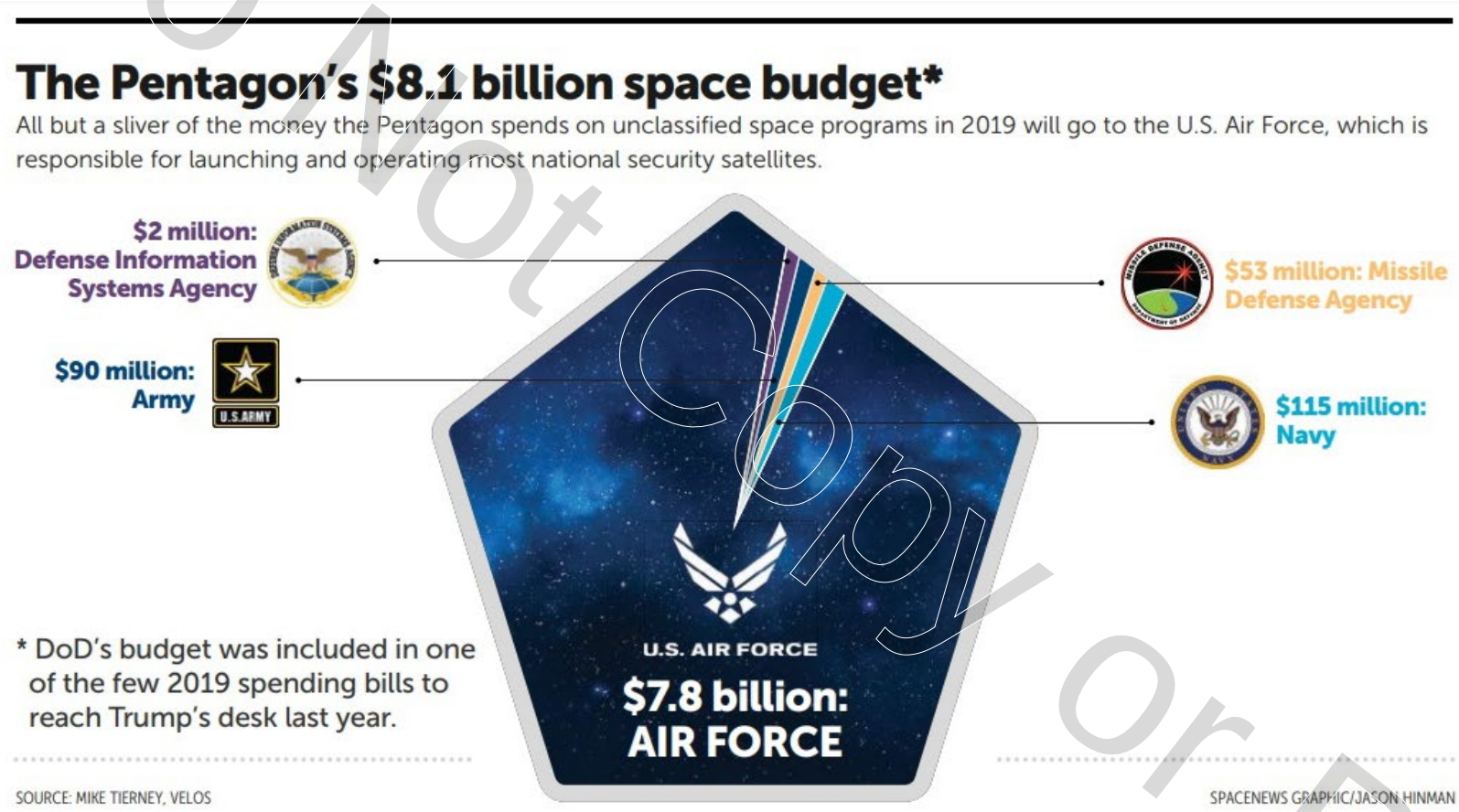
Exhibit 4 Space debris by type, by year



Source: NASA Orbital Debris Program Office (ODPO), "LEGEND: 3D/OD Evolutionary Model," https://orbitaldebris.jsc.nasa.gov/modeling/legend.html.

Note: Chart showing number of objects >10 cm in LEO.

Exhibit 5 Pentagon spending on unclassified space programs, by organization (2019)



Source: SpaceNews Graphics/Jason Hinman, from Erwin, Sandra, "Pentagon space procurement and R&D budget is on an upward trend. How long can this last?" SpaceNews, January 31, 2019, https://spacenews.com/pentagon-space-budget-is-on-an-upward-trend-how-long-can-this-last/.

Appendix A Background on deterrence theory

Throughout the Cold War space race, the theory of deterrence exerted substantial influence on U.S. policymakers. In deterrence theory, a credible threat of costly retaliation can convince a rational adversary to avoid inciting that retaliation, solving a coordination problem and avoiding violence. In this way, deterrence theory was connected with ideas in game theory being developed at the same time, such as Folk Theorems in a repeated-play Prisoner's Dilemma.[163]

Deterrence theory provided diplomats, policymakers, and their advisors a way to understand how the Soviet and American nuclear arsenals, rather than leading to catastrophe, deterred both sides from the most aggressive behaviors and helped keep their enmity "cold." As the theory's pioneer and Harvard economics professor Thomas Schelling wrote, "the use of the power to hurt as bargaining power is the foundation of deterrence theory, and is most successful when it is held in reserve."[164]

According to the theory, a number of nuanced factors determined the effectiveness of a deterrence strategy. The first pertains to military force, which Schelling refers to as "the power to hurt." The threat of military force by Actor 1 in retaliation to an undesired choice by Actor 2 (aggressive military behavior, for instance) reduces that Actor 2's expected utility from this choice. If Actor 1's retaliatory military force is expected to cause more harm than Actor 2 expects to gain via the undesired choice, then Actor 2's expected utility for that choice becomes negative. Assuming Actor 2 is rational, the threat of sufficient military force from Actor 1 has deterred Actor 2 from the "bad" choice; Actor 2 would be expected to choose the "good" choice. Mirroring the situation, in which Actor 2 also has sufficient military force to discourage Actor 1 from choosing what it considers to be a "bad" choice, both sides are deterred from aggressive military behavior, and instead choose the "good" choice, the higher-utility Nash equilibrium.

Here, we arrive at a critical nuance. The utility each Actor assigns to the "bad" and "good" choices are based on *information* it has on how the other is likely to react. For Actor 1 to deter Actor 2, it is not enough for Actor 1 to solely enhance its military force such that it can adequately punish Actor 2 for making the "bad choice." It must also inform Actor 2 adversary of its military capabilities, as well as its willingness to use them to punish Actor 2 if it makes the wrong choice. Likewise, Actor 2 must do the same to Actor 1. Only if both Actors have "common knowledge" are the threats for "bad" choices credible, and each Actor can be counted on to choose the "good" choice. So, while the "power to hurt as a bargaining power" is "most successful when held in reserve," each Actor must communicate how much "power to hurt" it has for deterrence to hold.[165]

Another important factor is relative strength, as well as its converse, relative vulnerability. A fundamental principle of game theory is that players are rational and will make choices that offer the highest expected utility. With this in mind, relative strength and relative vulnerability can be thought of as "multipliers" to the expected utility of "bad" choices. If Actor 1 believes it has significantly greater "power to hurt" than Actor 2, it may see more value in a devastating military strike than a peaceful route, even if it means suffering modest retaliation from Actor 2. Conversely, if both Actors have comparable military strength, but Actor 1 believes itself to be less vulnerable than its adversary, the expected "hurt" from enemy retaliation may be diminished enough that Actor 1 may prefer the "bad" choice. As long as both Actors perceive the "good" choice to have the highest expected value, they can be assumed to choose it and deterrence holds. But if either side sees greater utility in the "bad" choice, perhaps because of an overwhelming military advantage or a perception that it is much less vulnerable, the threat of violence is likely to materialize.

Another nuance emerges when the passage of time is introduced. Over time, the relative strength and vulnerability of the Actors is likely to change. If Actor 2 is rising in strength, Actor 1 may feel compelled to act aggressively before Actor 2 is able to accumulate greater "power to hurt." The seeming inevitability that a more powerful actor will incite war with an ascendant actor threatening its hegemony is known as the Thucydides Trap, named for the ancient Greek author who ascribed "the rise of Athens and the fear that it instilled in Sparta" as the cause of the Peloponnesian War.[166] Another nuance is culture, which may impact how rational actors behave by altering the utility they ascribe to different choices.

Source: Casewriters.

Endnotes

[1] The Guardian. "Donald Trump launches space force for 'world's new war-fighting domain' – video." https://www.theguardian.com/us-news/video/2019/dec/21/donald-trump-launches-space-force-for-worlds-new-war-fighting-domain-video, accessed June 2022.

[2] United States Space Force. "USSF Mission." https://www.spaceforce.mil/About-Us/About-Space-Force/Mission/, accessed June 2022.

[3] United States Space Command. "Mission." https://www.spacecom.mil/About/Mission/, accessed June 2022.

[4] Smithsonian Magazine. "The U.S. Military Has Been in Space From the Beginning." https://www.smithsonianmag.com/smart-news/us-military-has-been-space-beginning-180969403/., accessed June 2022.

[5] Ozy. "IS THE US MILITARY SPENDING MORE ON SPACE THAN NASA?" https://www.ozy.com/news-and-politics/is-the-us-military-spending-more-on-space-than-nasa/92148/., accessed June 2022.

[6] V2 stands for Vergeltungswaffe 2 (meaning "retaliatory weapon")

BBC. "V2: The Nazi rocket that launched the space age." https://www.bbc.com/future/article/20140905-the-nazis-space-age-rocket., accessed June 2022.

[7] Ibid.

[8] Wernher von Braun's life and accomplishments encapsulates the integrated, often complex relationship between civil and military space projects, which both leverage nearly the same technology to accomplish radically different goals. The "Werner von Braun Song" by Tom Lehrer captures the ethical dilemmas reflected in von Braun's life and work: https://www.youtube.com/watch?v=QEJ9HrZq7Ro.

The Tom Lehrer Wisdom Channel. "Tom Lehrer - Wernher von Braun,"

Youtube, published July 5, 2007. https://www.youtube.com/watch?v=QEJ9HrZq7Ro, accessed June 2022.

[9] Werth, Karsten. "A Surrogate for War—The U.S. Space Program in the 1960s." Amerikastudien / American Studies 49, no. 4 (2004): 563–87. http://www.jstor.org/stable/41158096.

[10] Space Capstone Publication, Spacepower (SCP). Headquarters United States Space Force. June 2020.

[11] NASA History Division. "A CHRONOLOGY OF DEFINING EVENTS IN NASA HISTORY, 1958-1998." https://history.nasa.gov/40thann/define.htm, accessed June 2022.

[12] Space Capstone Publication, Spacepower (SCP). Headquarters United States Space Force. June 2020.

[13] US Department of State, Office of the Historian. "FOREIGN RELATIONS OF THE UNITED STATES, 1958–1960, UNITED NATIONS AND GENERAL INTERNATIONAL MATTERS, VOLUME II." https://history.state.gov/historicaldocuments/frus1958-60v02/d442, accessed June 2022.

[14] Yale Scholarship Online. "In the Eyes of the World: The Signaling Value of Space Exploration." https://yale.universitypressscholarship.com/view/10.12987/yale/9780300219326.001.0001/upso-9780300219326-chapter-005, accessed June 2022.

[15] Ozy. "IS THE US MILITARY SPENDING MORE ON SPACE THAN NASA?" https://www.ozy.com/news-and-politics/is-the-us-military-spending-more-on-space-than-nasa/92148/., accessed June 2022.

[16] deGrasse Tyson, Neil, and Avis Land. "Space Is the Ultimate High Ground—That's Why Militaries Fund Astrophysics." Medium, September 4, 2018, https://medium.com/s/story/space-is-the-ultimate-high-ground-thats-why-militaries-fund-astrophysics-67d7510c875, accessed June 2022.

[17] Reichstein, Andreas. "Space – the Last Cold War Frontier?" Amerikastudien / American Studies, Vol. 44, No. 1 (1999), pp. 113-136.

[18] Smithsonian Magazine. "The U.S. Military Has Been in Space From the Beginning." https://www.smithsonianmag.com/smart-news/us-military-has-been-space-beginning-180969403/, accessed June 2022.

[19] Ibid.

[20] NASA. "National Aeronautics and Space Act of 1958 (Unamended)." https://history.nasa.gov/spaceact.html, accessed June 2022.

[21] deGrasse Tyson, Neil, and Lang, Avis. "Accessory to War (Audiobook)." Tracks 103, 106. W.W. Norton & Company, September 11, 2018.

[22] Lambeth, Benjamin S. "A Short History of Military Space." Air Force Magazine. December 1, 2004. https://www.airforcemag.com/article/1204space/, accessed June 2022.

[23] Federation of American Scientists. "Case Study 1 -- The History of US Anti-Satellite Weapons." 1984, https://man.fas.org/eprint/leitenberg/asat.pdf, accessed June 2022.

[24] Haughton, Vince. "Why the Air Force Almost Blasted the Moon with an H-Bomb." History. July 18, 2019, https://www.history.com/news/nuclear-bomb-moon-cold-war-plan, accessed June 2022.

[25] "The period of the late 1950s and early 1960s [...] was full of ideas and concept studies involving space-based nuclear weapons systems," described one report. That the U.S. never developed "nuclear-armed bombardment satellites" appeared to be largely a practical decision. Space-based nuclear deployment systems were "far less attractive than ordinary ICBMs" due to cost, accuracy, reliability, and other concerns. Moreover, both the United States and Soviet Union developed enormous nuclear arsenals, creating a stalemate known as Mutually Assured Destruction in which any direct nuclear attack, including using space-based nuclear weapons, was pointless.

Federation of American Scientists. "Case Study 1 -- The History of US Anti-Satellite Weapons." 1984, https://man.fas.org/eprint/leitenberg/asat.pdf, accessed June 2022.

[26] Ibid.

[27] Ibid.

[28]He directed the Air Force to begin Program 437, a "nuclear-armed anti-satellite system."

Ibid.

[29] Ibid.

[30] Dugdale-Pointon, TDP. "The Gulf War 1990/1991." June 2, 2002, http://www.historyofwar.org/articles/wars_gulf1990.html#gulfwar1991, accessed June 2022.

[31] Bruger, Steven J. "Not Ready for the First Space War: What about the Second?" Naval War College Review, WINTER 1995, Vol. 48, No. 1 (WINTER 1995), pp. 73-83.

[32] Bruger, Steven J. "Not Ready for the First Space War: What about the Second?" Naval War College Review, WINTER 1995, Vol. 48, No. 1 (WINTER 1995), pp. 73-83.

[33] Bruger, Steven J. "Not Ready for the First Space War: What about the Second?" Naval War College Review, WINTER 1995, Vol. 48, No. 1 (WINTER 1995), pp. 73-83.

[34] Bruger, Steven J. "Not Ready for the First Space War: What about the Second?" Naval War College Review, WINTER 1995, Vol. 48, No. 1 (WINTER 1995), pp. 73-83.

[35] At the time of its use during the Gulf War, the constellation of NAVSTAR satellites that made up the early GPS system was not even fully operational, as described in the Scientific American article "GPS and the World's 'First Space War'": "A fully operational GPS constellation requires 24 satellites, something the U.S. would not achieve until April 1995. In early 1991 the U.S. Air Force's Navstar (Navigation System Using Timing and Ranging) constellation included only 16 satellites, and six of those were older research and development units repurposed to help with the war effort."

Greenemeier, Larry. "GPS and the World's First "Space War"." Scientific American. February 8, 2016, https://www.scientificamerican.com/article/gps-and-the-world-s-first-space-war/, accessed June 2022.

[36] Ibid.

[37] Ibid.

[38] Bruger, Steven J. "Not Ready for the First Space War: What about the Second?" Naval War College Review, WINTER 1995, Vol. 48, No. 1 (WINTER 1995), pp. 73-83.

[39] Duffy, Brian, and Cary, Peter. "GULF WAR: WHY IT ENDED IN 100 HOURS." March 15, 1992, https://www.orlandosentinel.com/news/os-xpm-1992-03-15-9203130459-story.html, accessed June 2022.

[40] Robson, Seth. "Space Force units are already operating worldwide, and experts expect more to pop up soon." Starts and Stripes. August, 18, 2020, https://www.stripes.com/theaters/us/space-force-units-are-already-operating-worldwide-and-experts-expect-more-to-pop-up-soon-1.641654, accessed June 2022.

[41] National Research Council. "Review of the U.S. Department of Defense Air, Space, and Supporting Information Systems Science and Technology Program." 2001. Washington, DC: The National Academies Press. https://doi.org/10.17226/10179.

[42] For details on NASA's evolution, see Weinzierl, Matthew, and Mehak Sarang. "The International Space Station, Principal-Agent Problems, and NASA's Quest to Keep Humans in Space." Harvard Business School Case 721-054.

[43] Drezner, Jeffrey A., Mark V. Arena, Megan McKernan, Robert Murphy, and Jessie Riposo. "Are Ships Different? Policies and Procedures for the Acquisition of Ship Programs." Santa Monica, CA: RAND Corporation, 2011. https://rand.org/pubs/monographs/MG991.html.

[44] Kim, Yool, Elliot Axelband, Abby Doll, Mel Eisman, Myron Hunt, Edward G. Keating, Marin C. Libicki, Bradley Martin, Michael McMahon, Jerry M. Sollinger, Erin York, Mark V. Arena, Irv Blickstein, and William Shelton. "Acquisition of Space Systems, Volume 7: Past Problems and Future Challenges." Santa Monica, CA: RAND Corporation, 2015.

https://rand.org/pubs/monographs/MG1171Z7.html.

[45] Smith, Marcia S. "Military Space Activities: Highlights of the Rumsfeld Commission Report and Key Organization and Management Issues." Congressional Research Service, February 21, 2001. https://www.everycrsreport.com/files/20010221_RS20824_f0489c442dba0986a6d7e3ca843938b52559bc9d.pdf, accessed June 2022.

[46] University of Georgia, Online Library Learning Center. "A Brief History of the Internet." https://www.usg.edu/galileo/skills/unit07/internet07_02.phtml, accessed June 2022.

[47] Gleason, Michael, and Sam Wilson. "The Value of Space." The Aerospace Corporation. May 20, 2020. https://aerospace.org/paper/valueofspace, accessed July 2022.

[48] Deutsches Zentrum für Luft- und Raumfahrth (German Aerospace Center). "A new an-i-ma-tion shows 'A day with-out space'." June 11, 2021. https://www.dlr.de/content/en/articles/news/2021/02/20210611_a-new-animation-shows-a-day-without-space.html, accessed June 2022.

[49] deGrasse Tyson, Neil, and Lang, Avis. "Accessory to War (Audiobook)." Track 89. W.W. Norton & Company, September 11, 2018.

[50] Ibid.

[51] Thompson, Loren. "Ten Ways A Space Force Will Make America Weaker." Forbes. August 27, 2018. https://www.forbes.com/sites/lorenthompson/2018/08/27/ten-ways-a-space-force-will-make-america-weaker/?sh=56ecb66e3n4b0, accessed June 2022.

[52] According to the 2021 edition of The Space Foundation's annual "Space Report," U.S. Government space spending in 2020 accounted for 57.4% of the $90.2 billion in global governmental space expenditures. The next greatest share was China with 14.8%.

Space Foundation. "The Space Report 2021." Colorado Springs: Space Foundation, 2021.

[53] Ozy. "IS THE US MILITARY SPENDING MORE ON SPACE THAN NASA?" https://www.ozy.com/news-and-politics/is-the-us-military-spending-more-on-space-than-nasa/92148/, accessed June 2022.

[54] The Space Foundation. "Space Briefing Book: US Government." https://www.spacefoundation.org/space_brief/national-security-space-agencies/, accessed June 2022.

[55] deGrasse Tyson, Neil, and Lang, Avis. "Accessory to War (Audiobook)." Track 89. W.W. Norton & Company, September 11, 2018.

[56] For details on the rise of the commercial launch industry and entrepreneurial space sector, see Matthew Weinzierl, Kylie Lucas, and Mehak Sarang "SpaceX, Economies of Scale, and a Revolution in Space Access" HBS 720-027.

[57] Space Angels. "US Government Support of the Entrepreneurial Space Age." June 17, 2019.

[58] Grush, Loren. "Commercial space companies have received $7.2 billion in government investment since 2000." June 18, 2019. https://www.theverge.com/2019/6/18/18683455/nasa-space-angels-contracts-government-investment-spacex-air-force, accessed June 2022.

[59] Space Angels. "US Government Support of the Entrepreneurial Space Age." June 17, 2019.

[60] Ibid.

[61] Ibid.

[62] Ibid.

[63] Satellite Industry Association. "State of the Satellite Industry Report 2021." Washington, D.C.: Satellite Industry Association, 2021.

[64] Space Foundation. "The Space Report 2021." Colorado Springs: Space Foundation, 2021.

[65] Harrison, Todd, and Nahmyo Thomas. "NASA in the Second Space Age: Exploration, Partnering, and Security." *Strategic Studies Quarterly* (Winter 2016): 2-13.

[66] Curzi, Giacomo, Dario Modenini and Paolo Tortora. "Large Constellations of Small Satellites: A Survey of Near Future Challenges and Missions." Department of Industrial Engineering, University of Bologna, Via Fontanelle 40, I-47121 Forlì (FC), Italy; 7 September 2020.

[67] Generation 1 of SpaceX's Starlink will, by itself, consist of 11,926 satellites, and generation 2 will have 30,000 more. OneWeb, Amazon's Kuiper and China's SatNet combined will deploy over 20,000 satellites. Before these mega-constellations began launching in 2018, the largest constellation of satellites was Iridium's communication satellites, which totaled just 70.

Patel, Neel V. "To solve space traffic woes, look to the high seas" MIT Technology Review. August 23, 2021, https://www.technologyreview.com/2021/08/23/1032386/space-traffic-maritime-law-ruth-stilwell/, accessed June 2022.

[68] For details on space debris, see Matthew Weinzierl, Angela Acocella, and Mayuka Yamazaki, "Astroscale, Space Debris, and Earth's Orbital Commons" HBS 716-037.

[69] Datta, Anusuya. "What are we doing about space traffic management?" Geospatial World. February 2, 2021. https://www.geospatialworld.net/blogs/what-are-we-doing-about-space-traffic-management/, accessed June 2022.

[70] Department of Defense. "U.S. Defense Space Strategy Summary (2020)." June 2020, https://media.defense.gov/2020/Jun/17/2002317391/-1/-1/1/2020_DEFENSE_SPACE_STRATEGY_SUMMARY.PDF, accessed June 2022.

[71] Brooks, Stephen G., and William C. Wohlforth. "The Once and Future Superpower: Why China Won't Overtake the United States." Foreign Affairs 95, no. 3 (2016): 91–104. http://www.jstor.org/stable/43946860.

[72] European Space Policy Institute. "ESPI Report 79 - Emerging Spacefaring Nations - Full Report" June 2021. ISSN: 2218-0931 (print) • 2076-6688 (online).

[73] deGrasse Tyson, Neil, and Lang, Avis. "Accessory to War (Audiobook)." Track 15. W.W. Norton & Company, September 11, 2018.

[74] Starline, Clementine G., Mark J. Massa, Lt Col Christopher P. Mulder, and Julia T. Siegel. " The future of security in space: A thirty-year US strategy." Atlantic Council. April 11, 2021, https://www.atlanticcouncil.org/content-series/atlantic-council-strategy-paper-series/the-future-of-security-in-space/, accessed June 2022.

[75] White House. "National Security Strategy of the United States." Washington, D.C., December 2015, p. 4.

[76] See also the 2017 NSS. Characterizing China and Russia as "revisionist nations," the 2017 NSS described them as aiming "to shape a world antithetical to U.S. values and interests." The two nations, it continued, "challenge[d] American power, influence, and interests," in an attempt "to erode American security and prosperity." "In short," the NSS concluded, they "are contesting [U.S.] geopolitical advantages and trying to change the international order in their favor."

White House. "National Security Strategy of the United States." Washington, D.C., December 2017, p. 27.

[77] Dobbins, James, Howard J. Shatz, and Ali Wyne. "Russia Is a Rogue, Not a Peer; China Is a Peer, Not a Rogue." Santa Monica, CA: RAND Corporation, 2019. https://www.rand.org/pubs/perspectives/PE310.html.

[78] Kramer, Andrew E., and Steven Lee Myers. "Russia, Once a Space Superpower, Turns to China for Missions." *New York Times*, September 16, 2021, https://www.nytimes.com/2021/06/15/world/asia/china-russia-space.html, accessed June 2022.

[79] Broad, William J. "How Space Became the Next 'Great Power' Contest Between the U.S. and China" *New York Times*. January 24, 2021, https://www.nytimes.com/2021/01/24/us/politics/trump-biden-pentagon-space-missiles-satellite.html, accessed June 2022.

[80] *The Economic Times*. "China's 'space dream': A long march to the Moon and beyond." February 10, 2021, https://economictimes.indiatimes.com/news/science/chinas-space-dream-a-long-march-to-the-moon-and-beyond/articleshow/80790849.cms?from=mdr, accessed June 2022.

[81] Qiu, Jane. "China Ramping Up Quest to Become a Space Science Superpower." *Scientific American*, July 28, 2017, https://www.scientificamerican.com/article/china-ramping-up-quest-to-become-a-space-science-superpower/, accessed June 2022.

[82] Phys.org. "China's 'space dream': A Long March to the Moon and beyond." October 16, 2021, https://phys.org/news/2021-10-china-space-moon.html, accessed June 2022.

[83] Reuters Staff. "Timeline: Major milestones in Chinese space exploration." Reuters, December 1, 2020, www.reuters.com/article/us-space-exploration-china-moon-timeline/timeline-major-milestones-in-chinese-space-exploration-idINKBN28B5GE, accessed June 2022.

[84] Johnson-Freese, Joan. "CHINA'S MANNED SPACE PROGRAM: Sun Tzu or Apollo Redux?" Naval War College Review 56, no. 3 (2003): 51–71. http://www.jstor.org/stable/26394006.

[85] Ibid.

[86] Ibid.

[87] BBC. "China rejects nuclear spying charge." April 22, 1999, http://news.bbc.co.uk/2/hi/americas/325633.stm, accessed June 2022.

[88] Weeden, Brian. "2007 Chinese Anti-Satellite Test Fact Sheet." November 23, 2010, https://swfound.org/media/9550/chinese_asat_fact_sheet_updated_2012.pdf, accessed June 2022.

[89] Broad, William J., and David E. Sanger. "China Tests Anti-Satellite Weapon, Unnerving U.S." *New York Times*, January 18, 2007, https://www.nytimes.com/2007/01/18/world/asia/18cnd-china.html, accessed June 2022.

[90] Aero News Network. "Chinese A-Sat Weapon Test Forces NASA To Move Satellite." July 10, 2007, http://www.aero-news.net/index.cfm?do=main.textpost&id=0f5655bc-1ae8-4109-9e51-45112bf56d64, accessed June 2022.

[91] Manaugh, Geoff. "The Growing Risk of a War in Space." *Atlantic*, June 21, 2016, https://www.theatlantic.com/technology/archive/2016/06/weaponizing-the-sky/488024/, accessed June 2022.

[92] Other actions included the following. "[Using] a ground-based laser to "paint" a U.S. military satellite; an incident where a Chinese submarine surfaced within torpedo range of a U.S. aircraft carrier; Chinese threats to invade Taiwan unless the island nation submits to rule by Beijing; and the provocation of a Chinese fighter aircraft slamming into a U.S. Navy intelligence aircraft flying peacefully in international airspace. The Navy plane was heavily damaged, and almost went into the ocean, which would have killed two dozen Navy men and women in uniform. They were taken captive when they landed the crippled Navy plane on Hainan Island, a Chinese area."

Staff Writer. "Air Force Mulls How To Defend Space Assets, Wynne Says." Via Satellite, March 26, 2007, https://www.satellitetoday.com/uncategorized/2007/03/26/air-force-mulls-how-to-defend-space-assets-wynne-says/, accessed June 2022.

[93] "DEPARTMENT OF DEFENSE AND FULL-YEAR CONTINUING APPROPRIATIONS ACT, 2011," Title 10 U.S. Code, Sec, 112, 2011 ed, U.S. GPO, https://www.congress.gov/112/plaws/publ10/PLAW-112publ10.htm., accessed June 2022.

[94] BBC. "Xi Jinping: From princeling to president." May 12, 2021, https://www.bbc.com/news/world-asia-pacific-11551399., accessed June 2022.

[95] Associated Press. "China's Communist Party, with eye on history, gives Xi Jinping the same status as Mao." NPR, November 11, 2021, https://www.npr.org/2021/11/11/1054646063/china-xi-jinping-communist-party, accessed June 2022.

[96] Broad, William J. "How Space Became the Next 'Great Power' Contest Between the U.S. and China" *New York Times*. January 24, 2021, https://www.nytimes.com/2021/01/24/us/politics/trump-biden-pentagon-space-missiles-satellite.html, accessed June 2022.

[97] Department of Defense. "Military and Security Developments Involving the People's Republic of China 2016." 2016 Annual Report. https://dod.defense.gov/Portals/1/Documents/pubs/2016%20China%20Military%20Power%20Report.pdf, accessed June 2022.

[98] Pollpeter, Kevin, Eric Anderson, Jordan Wilson, and Fan Yang. " China Dream, Space Dream: China's Progress in Space Technologies and Implications for the United States." Prepared for the U.S.-China Economic and Security Review Commission. University of California Institute on Global Conflict and Cooperation. March 2, 2015, https://www.uscc.gov/sites/default/files/Research/China%20Dream%20Space%20Dream_Report.pdf, accessed June 2022.

[99] Reuters Staff. "Timeline: Major milestones in Chinese space exploration." Reuters, December 1, 2020, www.reuters.com/article/us-space-exploration-china-moon-timeline/timeline-major-milestones-in-chinese-space-exploration-idINKBN28B5GE, accessed June 2022.

[100] George, Justin Paul. "History of anti-satellite weapons: US tested 1st ASAT missile 60 years ago." The Week. March 27, 2019, https://www.theweek.in/news/sci-tech/2019/03/27/history-anti-satellite-weapon-us-asat-missile.html, accessed June 2022.

[101] Reuters Staff. "Timeline: Major milestones in Chinese space exploration." Reuters, December 1, 2020, www.reuters.com/article/us-space-exploration-china-moon-timeline/timeline-major-milestones-in-chinese-space-exploration-idINKBN28B5GE, accessed June 2022.

[102] Ibid.

[103] Ibid.

[104] Kharpal, Arjun. "China once said it couldn't put a potato in space. Now it's eyeing Mars." CNBC. June 29, 2021, https://www.cnbc.com/2021/06/30/china-space-goals-ccp-100th-anniversary.html, accessed June 2022.

[105] "Measuring Space Power: A theoretical and empirical investigation on Europe (Executive Summary)" European Space Policy Institute. September, 2019.

[106] Ibid.

[107] Bodner, Matthew. "As Trump pushes for separate space force, Russia moves fast the other way." DefenseNews, July 21, 2018, https://www.defensenews.com/global/europe/2018/06/21/as-trump-pushes-for-separate-space-force-russia-moves-fast-the-other-way/, accessed June 2022.

[108] Wall, Mike. "Space Weapon? US Calls Out Russian Satellite's 'Very Abnormal Behavior'." Space.com, August 15, 2018, https://www.space.com/41503-russian-satellite-possible-space-weapon.html, accessed June 2022.

[109] George, Justin Paul. "History of anti-satellite weapons: US tested 1st ASAT missile 60 years ago." The Week. March 27, 2019, https://www.theweek.in/news/sci-tech/2019/03/27/history-anti-satellite-weapon-us-asat-missile.html, accessed June 2022.

[110] Wall, Mike. "Space Weapon? US Calls Out Russian Satellite's 'Very Abnormal Behavior'." Space.com, August 15, 2018, https://www.space.com/41503-russian-satellite-possible-space-weapon.html, accessed June 2022.

[111] U.S. State Department official Yleem Poblete commented on the incident at a press conference: "We don't know for certain what [the sub-satellite] is, and there is no way to verify it. But Russian intentions with respect to this satellite are unclear and are obviously a very troubling development — particularly when considered in concert with statements by Russia's Space Force commander, who highlighted that "assimilat[ing] new prototypes of weapons [into] Space Forces' military units" is a "main task facing the Aerospace Forces space troops."

Longwell, Maddy. "State Department concerned over Russian satellite's behavior." C4ISRNet, August 14, 2018, https://www.c4isrnet.com/c2-comms/satellites/2018/08/14/state-department-concerned-over-russian-satellites-behavior/, accessed June 2022.

[112] Hennigan, W.J. "Exclusive: Strange Russian Spacecraft Shadowing U.S. Spy Satellite, General Says." Time, February 10, 2020, https://time.com/5779315/russian-spacecraft-spy-satellite-space-force/, accessed June 2022.

[113] U.S. Space Command Public Affairs Office. "Russia conducts space-based anti-satellite weapons test." July 23, 2020, https://www.spacecom.mil/MEDIA/NEWS-ARTICLES/Article/2285098/russia-conducts-space-based-anti-satellite-weapons-test/, accessed June 2022.

[114] Hennigan, W.J. "Exclusive: Strange Russian Spacecraft Shadowing U.S. Spy Satellite, General Says." Time, February 10, 2020, https://time.com/5779315/russian-spacecraft-spy-satellite-space-force/, accessed June 2022.

[115] Brumfiel, Geoff, and Alina Selyukh. "Russia's war in Ukraine is threatening an outpost of cooperation in space." NPR, May 23, 2022, https://www.npr.org/2022/05/23/1098348347/russias-war-in-ukraine-is-threatening-an-outpost-of-cooperation-in-space, accessed June 2022.

[116] Metcalfe, Tom. "Russia will pull out of the International Space Station, space agency chief confirms." Live Science, May 2, 2022, https://www.livescience.com/russia-to-leave-international-space-station-chief-says, accessed June 2022.

[117] Cooper, Jim. "UPDATING SPACE DOCTRINE: HOW TO AVOID WORLD WAR III." War on the Rocks, July 23, 2021, https://warontherocks.com/2021/07/updating-space-doctrine-how-to-avoid-world-war-iii/, accessed June 2022.

[118] Pasco, Xavier, and SWF Advisory Committee Member. "Insight - A View of the French Approach to the Militarization of Space." Secure World Foundation, June 5, 2020, https://swfound.org/news/all-news/2020/06/insight-a-view-of-the-french-approach-to-the-militarization-of-space, accessed June 2022.

[119] Urrutia, Doris Ellin. "India's Anti-Satellite Missile Test Is a Big Deal. Here's Why." Space.com, March 30, 2019, https://www.space.com/india-anti-satellite-test-significance.html, accessed June 2022.

[120] Ibid.

[121] Farley, Robert. "Managing the Military Problem of Space: The Case of India." The Diplomat, April 19, 2021, https://thediplomat.com/2021/04/managing-the-military-problem-of-space-the-case-of-india/, accessed June 2022.

[122] Ibid.

[123] Chrisafis, Angelique, and agencies. "'Act of espionage': France accuses Russia of trying to spy on satellite data." The Guardian, September 7, 2018, https://www.theguardian.com/world/2018/sep/07/france-accuses-russia-spying-satellite-communications-espionage, accessed June 2022.

[124] Weitereng, Hanneke. "France Is Launching a 'Space Force' with Weaponized Satellites." Space.com, August 2, 2019, https://www.space.com/france-military-space-force.html, accessed June 2022.

[125] Ibid.

[126] Onishi, Norimitsu. "France Nudges Europe Into Space Race, Where It Lags Behind." *New York Times*, July 18, 2019, https://www.nytimes.com/2019/07/18/world/europe/france-europe-space-race-apollo-11-anniversary.html, accessed 2019.

[127] Ibid.

[128] Rockets can be tools for exploring space or waging orbital warfare. A spacecraft's robotic arm can either repair a satellite, or pluck off its solar array. An orbital imaging system can measure deforestation in the Amazon, or scrutinize a country's defenses. "It's hard to say exactly how many weapons are in orbit," said military journalist David Axe. "With the proverbial flip of a switch, an inspection satellite, ostensibly configured for orbital repair work, could become a robotic assassin capable of taking out other satellites with lasers, explosives or mechanical claws. Until the moment it attacks, however, the assassin spacecraft might appear to be harmless." Almost any satellite could be considered a "sleeper weapon," waiting for the signal to attack.

Managh, Geoff. "The Growing Risk of a War in Space." *Atlantic*, June 21, 2016, https://www.theatlantic.com/technology/archive/2016/06/weaponizing-the-sky/488024/, accessed June 2022

[129] de Zwart, Melissa. "New Technologies Symposium: Contested and Fragile–The Dual-Use Space Environment." OpinioJuris, July 5, 2019, http://opiniojuris.org/2019/05/07/new-technologies-symposium-contested-and-fragile-the-dual-use-space-environment/, accessed June 2022.

[130] Lowell, Spencer. "Inside Space Force: Here's What the New Agency Does." Time, July 23, 2020, https://time.com/5869987/spaceforce/, accessed June 2022.

[131] de Zwart, Melissa. "New Technologies Symposium: Contested and Fragile–The Dual-Use Space Environment." OpinioJuris, July 5, 2019, http://opiniojuris.org/2019/05/07/new-technologies-symposium-contested-and-fragile-the-dual-use-space-environment/, accessed June 2022.

[132] de Zwart, Melissa. "New Technologies Symposium: Contested and Fragile–The Dual-Use Space Environment." OpinioJuris, July 5, 2019, http://opiniojuris.org/2019/05/07/new-technologies-symposium-contested-and-fragile-the-dual-use-space-environment/, accessed June 2022.

[133] Erwin, Sandra. "U.S. generals planning for a space war they see as all but inevitable." SpaceNews, September 17, 2021, https://spacenews.com/u-s-generals-planning-for-a-space-war-they-see-as-all-but-inevitable/, accessed June 2022.

[134] Lambeth, Benjamin S. "A Short History of Military Space." Air Force Magazine. December 1, 2004. https://www.airforcemag.com/article/1204space/, accessed June 2022.

[135] Ibid.

[136] National Research Council. "Review of the U.S. Department of Defense Air, Space, and Supporting Information Systems Science and Technology Program." 2001. Washington, DC: The National Academies Press. https://doi.org/10.17226/10179.

[137] Smith, Marcia S. "Military Space Activities: Highlights of the Rumsfeld Commission Report and Key Organization and Management Issues." Congressional Research Service, February 21, 2001. https://www.everycrsreport.com/files/20010221_RS20824_f0489c442dba0986a6d7e3ca843938b52559bc9d.pdf, accessed June 2022.

[138] Haring, Bruce. "President Trump Floats Idea For A Military "Space Force" To Audience Of Marines." Deadline, March 13, 2018, https://deadline.com/2018/03/president-trump-floats-idea-for-a-space-force-to-audience-of-marines-1202337545/, accessed June 2022.

[139] Pawlyk, Oriana. "It's Official: Trump Announces Space Force as 6th Military Branch." Military.com, June 18, 2018, https://www.military.com/daily-news/2018/06/18/its-official-trump-announces-space-force-6th-military-branch.html, accessed June 2022.

[140] "National Defense Authorization Act for Fiscal Year 2020," Title 10 U.S. Code, Sec. 1790, 2019 ed., https://www.congress.gov/bill/116th-congress/senate-bill/1790, accessed June 2022.

[141] Miller, Amanda. "Space Force's 2022 Budget Adds Satellites, Warfighting Center, More Guardians." Air Force Magazine, May 29, 2021, https://www.airforcemag.com/space-force-2022-budget-request/, accessed June 2022.

[142] Erwin, Sandra. "DoD space agency making contingency plans in case Congress doesn't pass a budget." SpaceNews, December 6, 2021, https://spacenews.com/dod-space-agency-making-contingency-plans-in-case-congress-doesnt-pass-a-budget/#:~:text=DoD%20requested%20%24936.7%20million%20in,communications%20services%20to%20the%20military, accessed June 2022.

[143] Erwin, Sandra. "Congress gives DoD more money for space, with caveats." SpaceNews, March 13, 2022, https://spacenews.com/congress-gives-dod-more-money-for-space-with-caveats/, accessed June 2022.

[144] Maj Gen David N. MIiller (Director of Operations, Training and Force Development, USSPACECOM), from Space Sector Market Conf. Keynote, 9 Sept 21.

[145] White House. "National Space Policy of the United States of America." December 9, 2020.

[146] Jones, Andrew. "China has moon's south pole in its sights with 3 missions launching this decade." Space.com, December 30, 2021, https://www.space.com/china-upcoming-moon-missions-details, accessed June 2022.

[147] Erwin, Sandra. "U.S. Space Force sees future demand for surveillance beyond Earth orbit." SpaceNews, May 16, 2022, https://spacenews.com/u-s-space-force-sees-future-demand-for-surveillance-beyond-earth-orbit/, accessed June 2022.

[148] Ibid.

[149] A Washington Post article in the conflict's early days noted the impact of commercial earth observation systems:

The images are so revealing and, in a time of war, valuable, that Mykhailo Fedorov, the vice prime minister of Ukraine, sent a plea last week to several satellite companies urging them to share their imagery with Ukrainian military. "We badly need the opportunity to watch the movement of Russian troops, especially at night," he wrote on Twitter. "This is really the first major war in which commercially available satellite imagery may play a significant role in providing open-source information about troop movements, military buildups, in neighboring countries, flows of refugees and more."

Davenport, Christian. "Commercial satellites test the rules of war in Russia-Ukraine conflict." *Washington Post,* March 10, 2022, https://www.washingtonpost.com/technology/2022/03/10/commercial-satellites-ukraine-russia-intelligence/, accessed June 2022.

[150] Davenport, Christian. "Spy agency awards 'historic' contracts to commercial satellite firms." *Washington Post,* May 25, 2022, https://www.washingtonpost.com/technology/2022/05/25/spy-satellite-nro-contracts/, accessed June 2022.

[151] Davenport, Christian. "Elon Musk's Starlink is keeping Ukrainians online when traditional Internet fails." *Washington Post,* March 19, 2022, https://www.washingtonpost.com/technology/2022/03/19/elon-musk-ukraine-starlink/, accessed June 2022.

[152] Davenport, Christian. "Commercial satellites test the rules of war in Russia-Ukraine conflict." *Washington Post,* March 10, 2022, https://www.washingtonpost.com/technology/2022/03/10/commercial-satellites-ukraine-russia-intelligence/, accessed June 2022.

[153] Chen, Stephen. "China military must be able to destroy Elon Musk's Starlink satellites if they threaten national security: scientists." South China Morning Post, May 25, 2022, https://www.scmp.com/news/china/science/article/3178939/china-military-needs-defence-against-potential-starlink-threat, accessed June 2022.

[154] Browne, Ed. "China vs. Elon Musk: Scientists Develop Plan to Destroy Starlink Satellites." Newsweek, May 26, 2022, https://www-newsweek-com.cdn.ampproject.org/c/s/www.newsweek.com/china-elon-musk-scientists-plan-destroy-starlink-spacex-1710399?amp=1, accessed June 2022.

[155] Kwast, Lt. Gen Steve. "There won't be many prizes for second place." Politico. 10 August 2018, https://www.politico.com/story/2018/08/10/space-race-kwast-768751, accessed June 2022.

[156] Masters, Jonathan. "Sea Power: The U.S. Navy and Foreign Policy." Council on Foreign Relations. 19 August 2019, https://www.cfr.org/backgrounder/sea-power-us-navy-and-foreign-policy, accessed June 2022.

[157] Adam Smith's "Tolerable Administration of Justice" and the Wealth of Nations Douglas A. Irwin NBER Working Paper No. 20636 October 2014 JEL No. B12,B25,B31,K2,O43,P14,P16,P48

[158] NASA. "National Aeronautics and Space Act of 1958 (Unamended)." https://history.nasa.gov/spaceact.html, accessed June 2022.

[159] Broad, William J. "How Space Became the Next 'Great Power' Contest Between the U.S. and China" *New York Times*. January 24, 2021, https://www.nytimes.com/2021/01/24/us/politics/trump-biden-pentagon-space-missiles-satellite.html, accessed June 2022.

[160] Lowell, Spencer. "Inside Space Force: Here's What the New Agency Does." Time, July 23, 2020, https://time.com/5869987/spaceforce/, accessed June 2022.

[161] NYT Daily Podcast, "Is the U.S. Changing Its Stance on Taiwan?" 24 May, 2022. https://open.spotify.com/episode/5vgtSeVO7HMifTelqCPDrT?si=EqKMbBh7QGy7-01PjujfFg

[162] Patel, Neel V. "China's surging private space industry is out to challenge the US." MIT Technology Review, January 21, 2021, https://www.technologyreview.com/2021/01/21/1016513/china-private-commercial-space-industry-dominance/, accessed June 2022.

[163] See https://www.jstor.org/stable/40651534, page 1121, for example.

[164] http://large.stanford.edu/courses/2017/ph241/baggett2/.

[165] Ibid.

[166] For more information on the Thucydides Trap and its application to the current China-U.S. dynamics, see *Destined for War: Can America and China Escape Thucydides's Trap?* by Graham Allison.