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THE ULTIMATE HIGH GROUND—U.S. INTERSECTOR COOPERATION IN OUTER SPACE

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I. INTRODUCTION

“SPACE, THE FINAL FRONTIER.” Those words opened each episode of the original 1960s’ television series *Star Trek*.¹ In a seemingly relentless effort to dominate this final frontier, the second half of the 20th century was marked by a space race of United States and Soviet Union competition to attain superior space capabilities. Those few States² able to achieve orbit comprised an exclusive club, with the technology and finances necessary to successfully launch, orbit, and recover space vehicles embodying State prestige and power. Yet as the campy science fiction films and television series of the 1950s and 1960s gave way to blockbuster space movies and television dramas from the 1970s onward, so too has science fiction and space capabilities transformed from the silver screen to reality. Today, State exclusivity and competition in outer space have been replaced by multinational consortiums and international cooperation in mankind’s continued global efforts to safely and peacefully operate in the area just beyond Earth’s atmosphere.

While forays into space, or even the upper reaches of Earth’s atmosphere, were formerly a sole State endeavor, technological advancements and an increase in private party action has brought space within reach of private industry, local governments . . . , multinational consortiums . . . , and States that were not typically

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¹ See, e.g., *Star Trek: The Man Trap* (NBC television broadcast Sept. 8, 1966).

² “States” in this context refers to countries or nation-states.

“space powers” in the past. . . . Formerly the domain of State flight capabilities, commercial enterprise now leads the way in develop[ing] . . . new launch and flight systems, often partnering with international conglomerates to create a truly multinational flight vehicle. . . .

[T]he growth of space commerce at the end of the 20th century and burgeoning corporate and multinational launch capabilities of the 21st century are making space more accessible.³

The Outer Space Treaty described this shared global interest as a “[d]esir[e] to contribute to broad international co[]operation in the scientific as well as the legal aspects of the exploration and use of outer space for peaceful purposes.”⁴ As space technology has become more mainstream and more affordable, the number of spacefaring nations (which also includes the multi-State partnership comprising the European Space Agency) has increased from the Soviet Union and United States in 1957 and 1958, to eleven different countries with successful satellite launches as of December 2012.⁵ Additionally, corporate interests and capabilities have also increased—at least six private U.S. businesses (above and beyond the traditional U.S. government contractors such as Boeing and Lockheed Martin) pursued launch programs and space missions in the first decade of the new millennium.⁶ As these partnerships and technology have continued to develop, U.S. law and policy has also evolved, thereby furthering this global collaborative effort to reach and utilize space. By examining the progression of U.S. law and policy, and providing a number of current examples of cooperative space efforts, this article offers insight into the merger of our governmental space program with industrial and international insights to safely and successfully operate in this “ultimate high ground.”

³ C. Brandon Halstead, *Hybrid Hops On (and Over) the Horizon: The Future Has Arrived, and Requires a New Look at Air and Space Law*, 34 ANNALS AIR & SPACE L. 775, 776–77, 779 (2009).

⁴ Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, Including the Moon and Other Celestial Bodies pmbl., Jan. 27, 1967, 18 U.S.T. 2410, 610 U.N.T.S. 205 [hereinafter Outer Space Treaty].

⁵ See *Q’n A: Which Countries Were First to Launch Satellites?*, SPACE TODAY ONLINE, <http://www.spacetoday.org/Questions/FirstSats.html> [https://perma.cc/6JGP-JZ86].

⁶ Stuart Fox, *Six Private Companies That Could Launch Humans Into Space*, SPACE.COM (June 4, 2010, 11:56 AM), <http://www.space.com/8541-6-private-companies-launch-humans-space.html> [https://perma.cc/6FPQ-WGYF].

II. DEVELOPMENT OF U.S. SPACE POLICY

For more than fifty years, the United States has played a predominant role “in the national security uses of outer space.”⁷ Many changes have taken place during that time “reflect[ing] new priorities and the nation’s evolving space policies and guidance.”⁸ As the twentieth century drew to a close and the twenty-first century dawned, some of the foremost major changes within the U.S. Department of Defense (DOD) space architecture have included “the global spread of space systems, technology, and information; the growth of commercial space activities; enhanced intersector [(i.e., inter-agency, public, and private sector)] collaboration; and increased international cooperation.”⁹

Furthermore, governments face a diminishing role in the development of space programs as the global space industry has become increasingly commercialized and privatized.¹⁰ Faced with increased costs and a desire to share and spread the efforts of space utilization, the United States ultimately elected to stimulate private sector expansion and development of its government-founded technology in an attempt to “encourage to the maximum extent possible the fullest commercial use of space.”¹¹ Starting in the 1980s and continuing through the 1990s, changes in law and policy enabled increased commercialization of space and signified the end of sole-State action in outer space.¹²

The U.S. Congress drafted legislation to enable this transformation, starting with the Commercial Space Launch Act of 1984, which stood as the cornerstone of U.S. regulation of space transportation for years, and was later amended in 1988, supplemented by the Commercial Space Act of 1998,¹³ and ultimately revised by the Commercial Space Launch Amendments Act of

⁷ OFFICE OF THE SEC’Y OF DEF., U.S. DEP’T OF DEF., MEMORANDUM REGARDING DEPARTMENT OF DEFENSE SPACE POLICY 1 (1999) [hereinafter 1999 DOD MEMO].

⁸ *Id.*

⁹ *Id.*

¹⁰ See Eilene Galloway, *Space Law in the 21st Century*, 26-2 J. SPACE L. 187, 190 (1998).

¹¹ Richard M. Obermann & Ray A. Williamson, *Implications of Previous Space Commercialization Experiences for the Reusable Launch Vehicle*, 14 SPACE POL’Y 17, 17 (1998).

¹² *Id.* at 17, 20–23.

¹³ See William A. Gaubatz, *International Certification for Commercial Reusable Space Transportation*, in PROCEEDINGS OF THE FORTY-SECOND COLLOQUIUM OF THE LAW OF OUTER SPACE 246, 250 (2000).

2004.¹⁴ Additional incentives and protections for private industry space exploration were furthered with the passage of the U.S. Commercial Space Launch Competitiveness Act in late 2015.¹⁵ Key provisions of this latest legislation included the extension of government indemnification of third party damages from commercial launches, in addition to the extension of the “learning period” to determine appropriate safety regulations on commercial spacecraft.¹⁶

The U.S. Space Shuttle program and the pioneering efforts of National Aeronautics and Space Administration (NASA) in the 1980s and 1990s generated numerous advancements in orbital technology, as well as early partnerships with private industry, through the development of the first operational Reusable Launch Vehicle (RLV).¹⁷ This RLV program represented one of the early examples of government-corporate space leveraging, while these changes demonstrated the evolution of U.S. government efforts in space from being primarily defense-oriented in the 1960s and 1970s to being permissive governmental rules promoting commercial space activities.¹⁸ For example, one of the most important of these provisions permits launch companies to use excess DOD property and infrastructure at launch ranges on the east and west coasts.¹⁹ Although it is not free, this expanded access and sharing of resources greatly reduces costs the companies would otherwise incur and helps make U.S. launch companies more competitive in the world market.

Accordingly, the latest U.S. National Space Policy²⁰ and DOD Space Policy²¹ continues to satisfy many governmental space-based needs through private industry capability, and has done so for almost four decades. By outlining these innovative policy parameters enabling such interagency partnerships, one can see

¹⁴ Commercial Space Launch Amendments Act of 2004, Pub. L. No. 108-492, 118 Stat. 3974 (2004).

¹⁵ U.S. Commercial Space Launch Competitiveness Act, Pub. L. No. 114-90, 129 Stat. 704 (2015).

¹⁶ Jeff Foust, *U.S. Senate Passes Compromise Commercial Space Bill*, SPACE NEWS (Nov. 11, 2015), <http://spacenews.com/u-s-senate-passes-compromise-commercial-space-bill/> [https://perma.cc/5NYN-Y3L9].

¹⁷ See Richard L. Witkin, *Shuttle Meets Need for Re-usable Craft that Could Also Serve Military's Ends*, N.Y. TIMES, Apr. 10, 1981, at A18.

¹⁸ See generally 51 U.S.C. §§ 10101–71302 (2012 & Supp. II 2015).

¹⁹ See *id.* § 50504.

²⁰ OFFICE OF THE PRESIDENT OF THE UNITED STATES, NATIONAL SPACE POLICY OF THE UNITED STATES OF AMERICA 10–11 (2010).

²¹ U.S. DEP'T OF DEF., DIRECTIVE NO. 3100.10, SPACE POLICY (2012) [hereinafter 2012 DOD SPACE POLICY].

the success of industrial, intersector, and international cooperation between the U.S. Air Force, DOD, and other private or multinational entities.

“The establishment of partnerships between the defense space sector and the intelligence, civil, and commercial space sectors . . . enable[s] the leveraging of scarce resources and reduce[s] the cost of acquiring, operating, and supporting operational space capabilities.”²² These partnerships not only combine scarce resources but also help “sustain a robust U.S. space industrial base.”²³ Additionally, in this era of increased coalition military operations, international cooperation places a premium on interoperability and facilitates cooperative activities which “strengthen the defense relationships and alliance structures that help underpin U.S. national [and international] security.”²⁴

The basic premise behind the DOD Space Policy is to ensure that “[e]nhanced cooperation with the intelligence, civil, and commercial space sectors will be pursued to maximize assured access to mission capabilities, infrastructure protection, and interoperability, and to ensure all U.S. space sectors benefit from space technologies, facilities, and support services.”²⁵ Actual implementation of this policy is accomplished through what could be called a “Triple A” approach to DOD space cooperation: *Architecture, Augmentation, and Acquisition*.²⁶ The cooperative aspects of the seminal 1999 Space Policy remain just as relevant to the 2012 updates, which incorporated the principles of this foundational document.

“An integrated . . . space *architecture*, including space, ground, and communications link segments,” forms the solid structural backbone to assure national space security and actually incorporates the augmentation and acquisition phases of the DOD Space Policy.²⁷ In other words, our national space architecture is the foundation from which we build the acquisition and integration schemes necessary to maximize global efficiency of space systems and mission accomplishment.

²² 1999 DOD MEMO, *supra* note 7, at 3.

²³ *Id.*

²⁴ *Id.* at 4; see 2012 DOD SPACE POLICY, *supra* note 21, paras. 4(e)–(f).

²⁵ 2012 DOD SPACE POLICY, *supra* note 21, para. 4(o).

²⁶ U.S. DEP’T OF DEF., DIRECTIVE 3100.10, SPACE POLICY paras. 4.6.2, 4.7, 4.10.2 (1999) [hereinafter 1999 DOD SPACE POLICY].

²⁷ *Id.* para. 4.6.2 (emphasis added).

The DOD policy for “space architecture[] [is therefore] structured to take full advantage . . . of defense, intelligence, civil, commercial, allied, and friendly space capabilities.”²⁸ By striving to attain joint technical, system, and operational standards, and interoperability of space services, the resulting space architectures are configured to maximize “mission optimization, availability, and survivability for all aspects of on-orbit configurations and associated infrastructure.”²⁹ This type of integrated planning to emphasize responsiveness and reduce vulnerabilities also helps to eliminate overlapping programs, “minimize unnecessary duplication of missions and functions, achieve efficiencies in acquisition and future operations, [and] provide strategies for transition from existing architectures”—all in support of national security objectives.³⁰

The DOD Space Policy on *augmentation* entails the “[r]equirements, arrangements, and procedures, [such as] cost sharing and reciprocity [agreements], for augmentation of the space force structure by civil, commercial, allied, and friendly space systems.”³¹ Its emphasis is not only on domestic industry cooperation (which drives much of the acquisition phase of DOD Space Policy), but also international partnerships designed to “strengthen alliances, improve interoperability between the United States and allied forces, and enable them to operate in a combined environment in a more efficient and effective manner.”³² The forging of closer space security ties with the United States and allied forces must “be based on the principles of reciprocity and a tangible, mutual benefit” for both sides.³³ Although such cooperation must “be pursued in a manner . . . consistent with U.S. arms control, nonproliferation, export control, and foreign policies,” the DOD policy is to pursue these international partnerships “to the maximum extent feasible.”³⁴

The *acquisitions* piece of the DOD Space Policy equation seeks to balance “opportunities for technology insertion” and “commercial-off-the-shelf solutions for national security items . . . in a manner that reasonably protects and balances U.S. national se-

²⁸ *Id.* para. 4.6.2.1.

²⁹ *Id.* para. 4.6.2.2.

³⁰ *Id.* para. 4.6.2.

³¹ *Id.* para. 4.7.

³² *Id.* para. 4.13.

³³ *Id.*

³⁴ *Id.*

curity and economic interests.”³⁵ To “support the joint vision for military operations and other national security objectives,” “[c]ommercial systems and [leading-edge] technologies shall be leveraged and exploited whenever possible.”³⁶ Acquisition strategies by these competitive bidders require a comprehensive “overview of the system’s capabilities[,] . . . a flexible overall architecture, . . . open systems design, flexible technology insertion [and adaptability for change], and rigorous technology demonstrations.”³⁷

Partnerships with industry show significant change from the former practice of government-only space acquisition and development in the early days of orbital flight. Such partnerships are now routinely pursued to “research, develop, acquire, and sustain space systems and associated infrastructure.”³⁸ DOD policy also requires that we evaluate “opportunities to outsource [and] privatize . . . space-related functions and tasks[] which could be performed more efficiently and effectively by the private sector.”³⁹

The ultimate goal of this “Triple A” approach to DOD Space Policy is improved intersector cooperation on a global scale. To summarize, enhanced cooperation with civil, commercial, and international space entities must be “pursued to ensure that all U.S. space sectors benefit from the space technologies, facilities, and support services available.”⁴⁰ This cooperation will result in “share[d] or reduce[d] costs, minimiz[ation] of redundant capabilities . . . [or] duplicat[ive] . . . missions and functions, [improved] efficiencies in acquisition[s] and future operations, improve[d] support to military operations, and [finally the] sustain[ment of] a robust U.S. space industry and a strong, forward-looking space technology base.”⁴¹

III. INTERSECTOR GROWTH AND COOPERATION

With this understanding of the United States’ policies and methods for linking governmental operations with other public, private, and international sectors, there are numerous examples of partnerships that continue to reach new heights in space

³⁵ *Id.* para. 4.10.3.

³⁶ *Id.* paras. 4.10.4, 4.10.6.

³⁷ *Id.* para. 4.10.2.

³⁸ *Id.* para. 4.10.10.

³⁹ *Id.* para. 4.10.11.

⁴⁰ *Id.* para. 4.12.

⁴¹ *Id.*

launch and exploration. One such partnership includes a U.S. government contract with the company XCOR Aerospace, to eventually utilize the RLV suborbital craft *Lynx*, which has been under development for over fifteen years and is nearing final stages of completion.⁴² XCOR missions will include specialized suborbital and orbital commercial payloads development and integration,⁴³ as well as microsatellite launch options, ballistic trajectory research, and other low Earth orbit experiments.⁴⁴ The U.S. Air Force has taken an interest in *Lynx*'s development, with the awarding of an Air Force RLV Design Contract to analyze the rocket-powered vehicle with "relevance to space lift and other military requirements,"⁴⁵ as well as contracts with the U.S. Air Force Research Laboratory (AFRL) to "supply operational data from the *Lynx* which will help in the development of operationally responsive space craft."⁴⁶ This government-corporate partnership has also recently expanded to include "United Launch Alliance (ULA), the nation's premier launch services provider, [who] has awarded XCOR Aerospace with a new contract through the United States Air Force to develop an upper stage propulsion system for *Vulcan*, ULA's next-generation launch system."⁴⁷

Another suborbital spaceplane similar to the *Lynx* which piqued U.S. government interests is the *XP Suborbital Spaceplane*, designed by the company Rocketplane, Inc. and based on a modified Lear 25 jet.⁴⁸ Offering expanded launch and payload

⁴² See *XCOR Lynx Spacecraft Development*, XCOR AEROSPACE (Sept. 8, 2014), <http://www.xcor.com/news/xcor-lynx-spacecraft-development/> [https://perma.cc/C7GU-XNRR].

⁴³ *NASA Selects XCOR to Participate in \$10 Million Suborbital Flight Contract*, XCOR AEROSPACE (Aug. 12, 2011), <http://www.xcor.com/news/nasa-selects-xcor-to-participate-in-10-million-suborbital-flight-contract/> [https://perma.cc/5H56-VMPD].

⁴⁴ *Mission Capabilities*, XCOR AEROSPACE, <http://science.xcor.com/mission-capabilities/> [https://perma.cc/3TDU-32E6].

⁴⁵ XCOR Aerospace, *Air Force Awards RLV Design Contract to XCOR Aerospace*, PR NEWswire (Apr. 11, 2007), <http://www.prnewswire.com/news-releases/air-force-awards-rlv-design-contract-to-xcor-aerospace-58212527.html> [https://perma.cc/5E7E-7P9S].

⁴⁶ *XCOR Aerospace Tests Lynx Aerodynamic Design in USAF Wind Tunnel*, XCOR AEROSPACE (July 24, 2009), <http://www.xcor.com/news/xcor-aerospace-tests-lynx-aerodynamic-design/> [https://perma.cc/XTJ7-VTTC].

⁴⁷ *XCOR and ULA Awarded US Air Force Propulsion Contract*, XCOR AEROSPACE (Mar. 9, 2016), <http://www.xcor.com/news/us-air-force-awards-ula-and-xcor-rocket-contract-for-upper-stage-propulsion/> [https://perma.cc/8YBW-KRU2].

⁴⁸ See *About Rocketplane*, ROCKETPLANE GLOBAL, http://www.rocketplaneglobal.com/our_company.html [https://perma.cc/XZT9-PJFT].

lift capabilities, Rocketplane and its parent company Rocketplane Kistler also began development of the *K-1* reusable aerospace vehicle in the early 2000s.⁴⁹ By partnering with Orbital Sciences Corporation, Rocketplane Kistler was poised to develop space systems for commercial, military, and civil government customers.⁵⁰ Although NASA selected Rocketplane Kistler as one of the funded commercial partners for the commercial-off-the-shelf program, Rocketplane Kistler encountered funding issues, and as a result of these financial difficulties, had their Space Act Agreement contract terminated in 2007.⁵¹ However, the company has rebounded and reorganized as Kistler Space Systems after coming out of bankruptcy in December 2011.⁵² Kistler continues to develop orbital and suborbital space transportation vehicles, which include the improved *Kistler K-1*, and expects that this vehicle will be capable of taking cargo to the International Space Station (ISS).⁵³ “The *K-1* reusable launch vehicle is composed of two stage vehicles stacked together[:] . . . the Launch Assisted Platform (LAP) and the . . . Orbital Vehicle (OV)[,] . . . [and includes a] family of interchangeable [p]ayload and [c]argo modules . . . attached to the front of the OV prior to launch.”⁵⁴ With cargo and crew module configuration options, successful development of the *K-1* will provide the United States with much needed launch and access options to the ISS.⁵⁵ Until a readily available and reliable commercial launch option is accessible, the United States must continue to rely on Russia and its *Soyuz* spacecraft for access to the ISS.⁵⁶

The corporate sector has recognized this need and has continued to revolutionize space technology. Another commercial entity showing successful government partnership operations in-

⁴⁹ See *About Rocketplane Kistler*, KISTLER SPACE SYS., <http://www.kistler.co/about-kistler.html> [https://perma.cc/379L-SNVG].

⁵⁰ See *Orbital and Rocketplane Kistler Announce Strategic Relationship*, SPACEREF (July 24, 2006), <http://www.spaceref.com/news/viewpr.html?pid=20421> [https://perma.cc/9FCR-JLPQ].

⁵¹ *Commercial Crew & Cargo: Rocketplane-Kistler*, NASA, <http://www.nasa.gov/offices/c3po/partners/rpk/> [https://perma.cc/N4QK-A3T5].

⁵² See *Welcome to Kistler Space Systems*, KISTLER SPACE SYS., <http://www.kistler.co/> [https://perma.cc/ZB2U-U7XM].

⁵³ *Commercial Crew & Cargo*, *supra* note 51.

⁵⁴ *Id.*

⁵⁵ See *id.*

⁵⁶ James Oberg, *Russia Crisis Raises Space Station Questions, But NASA Has Options*, NBC NEWS (Mar. 3, 2014, 2:57 PM), <http://www.nbcnews.com/storyline/ukraine-crisis/russia-crisis-raises-space-station-questions-nasa-has-options-n43331> [https://perma.cc/2QWC-H43P].

cludes the Space Exploration Technologies Corporation, better known as SpaceX. As recently as April 8, 2016, SpaceX utilized the Cape Canaveral Air Force Station to successfully launch its *Falcon 9* rocket carrying nearly 7,000 pounds of cargo in its *Dragon* spacecraft to the ISS.⁵⁷ Representing the first commercial spacecraft in history to deliver cargo to the ISS in 2012,⁵⁸ *Dragon* repeated this feat on April 10, 2016, delivering vital supplies and a prototype inflatable space habitat manufactured by Bigelow Aerospace for the ISS and its six-person crew.⁵⁹ Equally impressive was the successful landing of the *Falcon 9* first stage launch platform onto a drone ship located offshore in the Atlantic Ocean,⁶⁰ thereby confirming the capability and cost savings of reusable launch technology. Through intersector leveraging, NASA created a market for SpaceX and other companies to deliver supplies, and eventually astronauts, into outer space.⁶¹ Not only has SpaceX been awarded twelve commercial cargo contracts, but the aforementioned Orbital Sciences was also awarded contracts for nineteen flights.⁶² As a result of Orbital Sciences' merger with Alliant Techsystems in 2015 to form Orbital ATK, this aerospace manufacturer and defense industry company provides much needed U.S. government access to orbital capabilities, including commercial resupply, spacecraft busses, and satellite life-extension services.⁶³

The U.S. Air Force is furthering intersector cooperation and international collaboration with Australia for hypersonic technology development called Hypersonic International Flight Re-

⁵⁷ Anna Heiney, *Dragon is Healthy, Beginning Pursuit of ISS*, NASA: SPACE X BLOG (Apr. 8, 2016, 6:56 PM), <http://blogs.nasa.gov/spacex/2016/04/08/dragon-is-healthy-beginning-pursuit-of-iss/> [https://perma.cc/E5F2-PL9M].

⁵⁸ *Dragon*, SPACE X, <http://www.spacex.com/dragon> [https://perma.cc/Y53J-8Z62].

⁵⁹ Robert Pearlman, *SpaceX Dragon Arrives at Space Station, Delivers Inflatable Room Prototype*, SPACE.COM (Apr. 10, 2016, 10:02 AM), <http://www.space.com/32528-spacex-dragon-delivers-inflatable-room-space-station.html> [https://perma.cc/5KZS-N8F4].

⁶⁰ Anna Heiney, *Successful First-Stage Landing*, NASA: SPACE X BLOG (Apr. 8, 2016, 5:11 PM), <https://blogs.nasa.gov/spacex/2016/04/08/successful-first-stage-landing/> [https://perma.cc/WJ2Q-XQDP].

⁶¹ Eric Berger, *Without NASA There Would Be No SpaceX and Its Brilliant Boat Landing*, ARS TECHNICA (Apr. 11, 2016, 9:00 AM), <http://arstechnica.com/science/2016/04/without-nasa-there-would-be-no-spacex-and-its-brilliant-boat-landing/> [https://perma.cc/XAJ2-FPT9].

⁶² *Id.*

⁶³ See *Human Space & Advanced Systems*, ORBITAL ATK, <http://www.orbitalatk.com/space-systems/human-space-advanced-systems/overview/default.aspx> [https://perma.cc/6M77-JGAN].

search Experimentation (HiFiRE).⁶⁴ “Hypersonic aircraft are also an emerging field of flight offering affordable, rapid and reliable spacelift capabilities by flying payloads to the upper limits of Earth’s atmosphere and then launching them into orbit using small rocket boosters.”⁶⁵ This international partnership between the AFRL and the Australian Defence Science and Technology Group has already achieved impressive milestones, including completing the “design, assembly and pre-flight testing of . . . hypersonic vehicles and the design of complex avionics and flight systems.”⁶⁶ Previous U.S. Government efforts to advance air-breathing hypersonic flight were primarily seen in NASA’s X-43 aircraft and the U.S. Air Force’s X-51A (developed by industry partners Pratt & Whitney Rocketdyne and Boeing),⁶⁷ but the successful research and development capabilities shared between NASA, AFRL, and the Australian Defence Science and Technology Group is accelerating the program’s success at speeds comparable to the hypersonic flight it seeks to achieve.⁶⁸ Recent testing from 2012 to 2015 achieved speeds between Mach 6 and Mach 8.⁶⁹

As supersonic combustion ramjet [(scramjet)] technology continues to improve, including the . . . development and testing in 2009 of Hypersonic Technology (HyTech) scramjet engines using endothermic hydrocarbon fuel in a vehicle capable of attaining speeds exceeding Mach 7.0+, the ability of such [hypersonic hybrid aircraft] to reach sufficient altitude and speed for suborbital flights [will] become more commonplace.⁷⁰

Such international and industrial cooperation is changing what was once futuristic science fiction into the technology of today.

In another prime example of private industry innovation, Blue Origin’s RLV *New Shepard* advances reusable launch tech-

⁶⁴ See U.S. Air Force Research Laboratory, *Multi-National Agreement to Advance High-Speed Flight*, SPACEFLIGHT NOW (Nov. 14, 2006), <http://spaceflightnow.com/news/n0611/14hifire/> [<https://perma.cc/43FU-X3T9>].

⁶⁵ Halstead, *supra* note 3, at 790.

⁶⁶ See Defense Science and Technology Group, Department of Defence, Australian Government, *HiFiRE Program*, DST GROUP, <http://www.dsto.defence.gov.au/partnership/hifire-program> [<https://perma.cc/VW6M-N5ZL>].

⁶⁷ See *X-51 Scramjet Engine Demonstrator – WaveRider (SED-WR)*, GLOBALSECURITY.ORG, <http://www.globalsecurity.org/military/systems/aircraft/x-51.htm> [<https://perma.cc/SCY6-NP99>].

⁶⁸ See Kathy Barnstorff, *HiFiRE Scramjet Research Flight Will Advance Hypersonic Technology*, NASA (May 10, 2012), <http://www.nasa.gov/topics/aeronautics/features/hifire.html> [<https://perma.cc/5ZS4-736A>].

⁶⁹ *Id.*

⁷⁰ Halstead, *supra* note 3, at 791.

nology to satisfy government and commercial requirements for heavy space lift. Recent launches of *New Shepard* in April 2016 achieved an apogee of 103 kilometers, in addition to showcasing the rigorous testing of its BE-3 engine by successfully initiating a propulsive landing only 3,600 feet above the ground.⁷¹ As founder Jeff Bezos described *New Shepard's* RLV capabilities, “[f]ull reuse is a game changer, and we can’t wait to fuel up and fly again.”⁷² This vehicle will provide crew lift capabilities of up to six astronauts into low earth orbit (LEO).⁷³ Additionally, by partnering with ULA to expand production capabilities for the American-made BE-4 engine, this domestic alternative to the Russian RD-180 engine will power the next generation *Vulcan* launch system and exceed the heavy lift capabilities of the *Atlas V*.⁷⁴ Championing this technological synergy, the *Vulcan* rocket is described as bringing together “decades of experience on ULA’s reliable *Atlas* and *Delta* vehicles, combining the best features of each to produce an all-new, American-made rocket that will enable mission success from low Earth orbit all the way to Pluto.”⁷⁵ By offering high performance, low-cost lift options, Blue Origin’s engine developments provide increased payload and opportunity to satisfy United States’ space needs. And by utilizing federal facilities under the authorities of 49 U.S.C. chapter 701, *Commercial Space Transportation*, and 51 U.S.C. chapter 501 *et al.*, *Space Commerce* (the successor legislation to 42 U.S.C. chapter 141, *Commercial Space Opportunities and Transportation*), Blue Origin’s use of NASA’s Stennis Space Center has enabled more flexible combustion chamber testing.

Under development since 2012, the BE-4 provides the lowest cost and fastest production path to power the nation’s access to space. Selected by United Launch Alliance to serve as the primary propulsion provider for its Next Generation Launch System, Blue

⁷¹ *Pushing the Envelope*, BLUE ORIGIN (Apr. 3, 2016), <https://www.blueorigin.com/news/news/pushing-the-envelope> [<https://perma.cc/6JC9-4C5U>].

⁷² *Blue Origin Makes Historic Rocket Landing*, BLUE ORIGIN (Nov. 23, 2015), <https://www.blueorigin.com/news/news/blue-origin-makes-historic-rocket-landing> [<https://perma.cc/P3FM-PNPV>].

⁷³ *Id.*

⁷⁴ *ULA and Blue Origin Announce Production Agreement for American-Made BE-4 Engine*, BLUE ORIGIN (Sept. 10, 2015), <https://www.blueorigin.com/news/news/ula-and-blue-origin-announce-production-agreement-for-american-made-be-4-en> [<https://perma.cc/22EU-X52H>].

⁷⁵ *Id.*

Origin is developing the BE-4 as an integrated part of America's newest launch vehicle.⁷⁶

As suborbital and orbital flight becomes more feasible, the influence of developing supplementary technologies created to maximize this increased access must also be considered, such as "Microsatellite Technology Experiments (MiTeX), which are being considered for a variety of functions [to address] defense applications and proximity operations around [geostationary orbit] satellites."⁷⁷ Additionally, on-orbit servicing of satellites was once a function outside the realm of possibility for most spacecraft, but is now becoming more commonplace for such smaller, easily-launched payloads.⁷⁸ Satellite servicing has been identified as critical to U.S. national interests "in order to maintain our leadership in space for scientific, commercial, and strategic reasons."⁷⁹ "Starting in the late 1990s, [AFRL] built a series of low-cost 'microsatellites' . . . [including the] XSS-10, launched in January 2003, and XSS-11, launched in April 2005, both of which demonstrated key technologies for satellite servicing."⁸⁰ The U.S. Defense Advanced Research Projects Agency (DARPA) was the first to successfully demonstrate "end-to-end robotic satellite servicing activities."⁸¹ Its engineering of the Autonomous Space Transport Robotic Operations (*Astro*) service craft for on-orbit applications such as inspections, repairs, refueling, and other satellite service features,⁸² and its successful autonomous docking with a prototype modular NEXT-generation serviceable satellite (*NEXTSat*) in March 2007, "provided confirmation that key technologies needed for satellite servicing are now in place."⁸³ NASA is also exploring opportunities with the German Space Agency Deutsches Zentrum für Luft- und Raumfahrt e.V. (DLR), as well as Canada's MacDonald, Dettwiler and Associates

⁷⁶ *Blue Origin Completes Acceptance Testing of BE-3 Engine for New Shepard Suborbital Flight*, BLUE ORIGIN (Apr. 7, 2015), <https://www.blueorigin.com/news/news/blue-origin-completes-acceptance-testing-of-be-3-engine-for-new-shepard-sub> [<https://perma.cc/9XJR-8CKH>].

⁷⁷ Halstead, *supra* note 3, at 791.

⁷⁸ Michael A. Dornheim, *Express Service*, AVIATION WEEK & SPACE TECH., June 5, 2006, at 46–50.

⁷⁹ NASA, ON-ORBIT SATELLITE SERVICING STUDY PROJECT REPORT 3 (Oct. 2010).

⁸⁰ *Id.* at 22.

⁸¹ *Id.* at 23.

⁸² See Lt. Col. Fred Kennedy, *Orbital Express Space Operations Architecture*, DARPA: TACTICAL TECH. OFF., <http://archive.darpa.mil/orbitalexpress/index.html> [<https://perma.cc/7XXK-75XA>].

⁸³ NASA, ON-ORBIT, *supra* note 79, at 23.

Ltd. (MDA), for on-orbit servicing demonstrations, refueling operations, and “moving inoperable satellites into ‘graveyard’ orbits.”⁸⁴ Continued government cooperation with commercial and international entities will reduce the delay between technology “lag” and capability development, until such missions are ready to launch and address orbital needs.

Small Launch Vehicles (SLVs) continue to be pursued by DARPA and the U.S. Air Force, with projects like the Force Application and Launch from Continental U.S. (FALCON), which seeks to attain cost-effective, frequent lift capabilities to place small payloads into LEO with minimal notice and expense.⁸⁵ The U.S. Air Force’s FALCON program is developing a hypersonic technology vehicle (HTV) capable of performing reconnaissance, global strike and transport, and low-cost access to near-space and LEO.⁸⁶ Rocket technologies advanced by partner SpaceX, and the X-51A WaveRider test results, are providing new options for the HTV’s development, with the aim of a new vehicle in service by 2023.⁸⁷

The success of similar SLV assets, such as Scaled Composite’s *SpaceShipOne*, and Virgin Galactic’s *SpaceShipTwo*, has also captured the attention of other DOD entities. By flying at sub-orbital altitudes and thereby avoiding enemy air defenses and national airspace violations, the U.S. Marine Corps is particularly interested in the development of such space-planes to create Small Unit Space Transport and Insertion (SUSTAIN) vehicles.⁸⁸ After Air Force General S. Pete Worden observed the launch of *SpaceShipOne* in 2004, he commented that “a scaled-up version of that would do this (SUSTAIN) mission,” with a military prototype designed to “be bigger, tougher[,]. . . armed[,]. . . [and] reconfigured for longer flights,” and would need to be “robust, responsive and reusable,” with the critical “ability to ac-

⁸⁴ *Id.*

⁸⁵ Brian Berger & Jeremy Singer, *Field Narrows for DARPA’s Falcon Program; Decision Expected Soon*, SPACENEWS (Aug. 29, 2005), <http://spacenews.com/field-narrows-darpas-falcon-program-decision-expected-soon/> [https://perma.cc/39W4-JVG5].

⁸⁶ See *Hypersonic Rocket-Plane Program Inches Along, Stalls, To Restart*, DEF. INDUS. DAILY (June 3, 2015), <http://www.defenseindustrydaily.com/hypersonic-rocket-plane-program-inches-along-0194/> [https://perma.cc/DC7B-7H7M].

⁸⁷ *Id.*

⁸⁸ See David Axe, *The Pentagon’s Plan to Put Robot Marines in Space*, THE WEEK (July 9, 2014), <http://theweek.com/articles/445664/pentagons-plan-robot-marines-space> [https://perma.cc/7KG2-QY3G].

cess space with aircraft-like operations.”⁸⁹ It is also worth noting that military interest in arming such spacecraft is not prohibited under international law. The Outer Space Treaty’s Proclamation and Article 4 prohibit “placing in orbit around the Earth any objects carrying nuclear weapons or any other kinds of weapons of mass destruction”⁹⁰ (WMD), but no space treaty or international law prohibits *suborbital* aircraft or spacecraft from carrying defensive or offensive weapons, while *orbital* craft are only prohibited from carrying nuclear or WMD payloads. During the early stages of SUSTAIN research, “[t]he Air Force considered using [a] SUSTAIN mothership as a first-stage launch vehicle for satellites,” while the Marines explored options for insertion of squadron personnel or possibly robotic deployers into remote locations.⁹¹ With the concept of operations (CONOPS) development transferring to the National Security Space Office in 2008, SUSTAIN research and planning continued until 2012, when economic downturns and subsequent military sequestration eliminated the budget for such programs.⁹² Nonetheless, SUSTAIN planners had envisioned “leveraging and catalyzing” “advancements in [the] space tourism [industry] in order to avoid turning Sustain into a multibillion-dollar, government-only [research and development] program.”⁹³ Despite the program’s cancellation, its CONOPS for industry partnership was prescient; *SpaceShipTwo*’s first successful launch using rocket-powered test flight at supersonic speeds in 2013 and Virgin Galactic’s continued progress in preparing this suborbital spaceplane for space tourism⁹⁴ demonstrate the potential for purely commercial projects to be adapted for government and military applications.

IV. CONCLUSION

The merger of U.S. public and private interests in space embodies the Triple A theory of having a strong architecture, augmentation, and acquisition program for successful U.S. space operations. Continued government cooperation with intersector

⁸⁹ David Axe, *Semper Fly*, POPULAR SCI., Jan. 1, 2007, at 61.

⁹⁰ Outer Space Treaty, *supra* note 4.

⁹¹ Axe, *supra* note 89.

⁹² *Id.*

⁹³ *Id.*

⁹⁴ *See Our Vehicles: These Are the Vehicles That Will Take You to Space*, VIRGIN GALACTIC, <http://www.virgingalactic.com/human-spaceflight/our-vehicles/> [https://perma.cc/E9CB-EDEN].

agents is not only a more cost-effective means for research, development, and access, but also requires continued government involvement, partnership, and supervision under the Outer Space Treaty. Under Article 6:

States Parties to the Treaty shall bear international responsibility for national activities in outer space . . . whether such activities are carried on by governmental agencies or by non-governmental entities, and for assuring that national activities are carried out in conformity with the provisions set forth in the present Treaty. The activities of non-governmental entities in outer space . . . shall require authorization and continuing supervision by the appropriate State Party to the Treaty.⁹⁵

The previous examples of governmental, industrial, international, and intersector space cooperation on a global scale delineate how the synergistic effects of such partnerships are truly greater than the sum of their parts. As this intersector cooperation continues into the future and in efforts to explore the cosmos and further U.S. national security interests, the old adage, “the sky is the limit,” may no longer be true.

⁹⁵ Outer Space Treaty, *supra* note 4.